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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 6

COCKER *TO* DAIS

ENCYCLOPÆDIA BRITANNICA, INC.

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COCKER *TO* DAIS

COCKER, EDWARD (1631–1675), reputed English author of a famous *Arithmetic*, the popularity of which gave rise to the phrase "according to Cocker," meaning "in accordance with strict rule"; *i.e.*, "quite correct." Cocker was born in 1631. In 1657 he is known to have been living in London, where he worked as an engraver and also taught writing and arithmetic. Samuel Pepys, in his *Diary*, mentions Cocker favourably, and he appears to have been very skilled in his art. He died in 1675, probably in London.

The *Arithmetic* was edited and published in 1678 by John Hawkins, after its reputed author's death, and passed through over 100 editions. Augustus de Morgan in his *Arithmetical Books* (1847) declared that the work was actually written by Hawkins himself, and condemned it as a diffuse compilation from older and better works, but added that "this same Edward Cocker must have had great reputation, since a bad book under his name pushed out the good ones." Cocker's many other works include several writing manuals, *Cocker's Morals or the Muses spring-garden*, a collection of poems suitable for transcription or translation (1685) and *Cocker's English Dictionary* (1704).

COCKERELL, CHARLES ROBERT (1788–1863), British architect and archaeologist, an influential proponent of the classic tradition in 19th-century British architecture, was born in London on April 28, 1788. After training with his father, Samuel Pepys Cockerell (1754–1827), and Sir Robert Smirke (1781–1867), he spent seven years (1810–17) studying and preparing publication on architectural remains in Greece, Asia Minor and Italy. Among his major discoveries were the marbles from Aegina and Phigalia in Greece.

He became a full member of the Royal Academy in 1836, architect to the Bank of England in 1833, and professor of architecture at the academy in 1840. While Cockerell's own architecture occasionally employed a Gothic mode (Lampeter college, chapel at Harrow), he may generally be considered a late adherent of 18th-century neoclassicism, with a more correct antique vocabulary. His principal works were the Ashmolean museum and Taylorian institute, Oxford (1841–45), and the completion of St. George's hall, Liverpool, and the Fitzwilliam museum, Cambridge. He died in London on Sept. 17, 1863. His son, FREDERICK PEPYS COCKERELL (1833–78), was also a distinguished architect. (R. RM.)

COCKERILL, WILLIAM (1759–1832), English inventor, was born in Lancashire in 1759. He began life by making "roving billies" or flying shuttles. In 1794 he went to Russia, having been recommended to the empress Catherine II as a skilful artisan. For two years he flourished, but on the death of the empress he was flung into prison by her successor. Cockerill escaped to Sweden, and there constructed lock gates for the government; but he could interest no one in his own field of spinning machines. In 1799 he moved to Verviers, Belg., and under contract supplied spinning machines for the firm of Simonis and Biolley. His natural skill as a mechanic was quickly recognized, and in 1807 he was able, with the aid of his two younger sons, to open, in Liège, factories of his own for the construction of spinning and weaving machines. In 1810 an industrial commission acknowledged him as an expert, and he was granted letters of naturalization. He retired from business in 1812, and died at Aix-la-Chapelle, France, in 1832. (T. M. S.)

COCKERMOUTH, a market town and urban district of Cumberland, Eng., 26 mi. S.W. of Carlisle by road. Pop. (1961) 5,823. Area 3.2 sq.mi. It is just outside the Lake District National park and stands at the confluence of the Derwent and Cocker, at a focus of ways among the lower western hills of the Lake district (*q.v.*). It is the birthplace of the poet William Wordsworth, whose house in the main street was given to the National Trust in 1938. Fletcher Christian, leader of the "Bounty" mutineers, was born at Moorland Close, 1½ mi. S., in 1764.

Settlement in the neighbourhood goes back at least to Roman times, there being a small fort 1 mi. N.W. of the town at Papcastle. Cockermouth was the head of the barony of Allerdale, and Waltheof is said to have built the castle, under the shelter of which the town grew up. There are remains of Norman work in the keep, but the castle is in part modernized as a residence. The town received no royal charter, but the earliest records mention it as a borough. In 1221 William de Fortibus, earl of Albemarle, was granted a market. The Whitsuntide and Martinmas fairs which originated in the 14th century are still held.

Cockermouth forms the agricultural centre of a wide rural area, and there are also within it several light industries, the largest of which produces shoes and slippers.

COCKFIGHTING, the sport of pitting gamecocks to fight,

and breeding and training them for the purpose. The game fowl is probably the nearest to the Indian red jungle fowl (*Gallus gallus*), from which all domestic chickens are believed to be descended. The sport was popular in ancient times in India, China, Persia and other eastern countries, and was introduced into Greece in the time of Themistocles (*c.* 514–449 B.C.). The latter, while moving with his army against the Persians, observed two cocks fighting desperately and, stopping his troops, inspired them by calling their attention to the valour and obstinacy of the feathered warriors. In honour of the ensuing victory of the Greeks, cockfights were henceforth held annually at Athens, at first in a patriotic and religious spirit, but afterward purely for the love of the sport. On the chair of the high priest of Dionysus, in the theatre at Athens, there is carved a beautiful figure of a winged Eros holding a gamecock just about to fight. Lucian makes Solon speak of quail fighting and cocking, and evidently is referring to an era in Asia, about 3,000 years ago, when cockfighting enthusiasts, lacking the cocks, set quail to fighting quail and partridges to fighting partridges, since both are natural fighters. From Athens the sport spread throughout Greece, Asia Minor and Sicily, the best cocks being bred in Alexandria, Delos, Rhodes and Tanagra. For a long time the Romans affected to despise this "Greek diversion," but ended by adopting it so enthusiastically that Columella (1st century A.D.) complained that its devotees often spent their whole patrimony in betting at the pitside.

From Rome the sport spread northward and was probably introduced into England by the Romans before Caesar's time. Although opposed by the clergy of the Christian church, it nevertheless became popular in the Low Countries, Italy, Germany, Spain and its colonies in the new world and the Philippines, and throughout England and Wales, as well as in Scotland (where it was introduced in 1681). Occasionally the authorities tried to repress it, especially Cromwell, who put a stop to it for a brief period, but the Restoration re-established it among the national pastimes.

From the time of Henry VIII, who added the royal cockpit to his palace of Whitehall, cockfighting was called the "royal diversion," and the Stuarts, particularly James I and Charles II, were among its most enthusiastic devotees, their example being followed by the gentry down to the 19th century. The king's cockmaster presided over the pits at Whitehall. Gervase Markham, in his *Pleasures of Princes* (1614), wrote "Of the Choyce, Ordring, Breeding and Dyeting of the fighting Cocke for Battell," his quaint directions being of the most explicit nature.

Cockfighting mains (matches) usually consisted of fights between an agreed number of pairs of birds, the majority of victories deciding the main; but there were two other varieties that aroused the particular ire of moralists. These were the "battle royal" in which a number of birds were "set" (*i.e.*, placed in the pit at the same time) and allowed to remain until all but one, the victor, were killed or disabled; and the "Welsh main," in which eight pairs were matched, the eight victors being again paired, then four, and finally the last surviving pair.

Among famous London cockpits were those at Westminster, in Drury Lane, Jewin street and Birdcage walk (depicted by Hogarth). The pits were circular in shape with a matted stage about 20 ft. in diameter and surrounded by a barrier to keep the birds from falling off. Upon this barrier the first row of the audience leaned. Hardly a town in the kingdom was without its cockpit, which offered the sporting classes opportunities for betting.

Perhaps the most famous main in England took place at Lincoln in 1830 between the birds of Joseph Gilliver, the most celebrated breeder, or "feeder," of his day, and those of the earl of Derby. The conditions called for seven birds a side, and the stakes were 5,000 guineas the main and 1,000 guineas each match. The main was won by Gilliver by five matches to two. His grandson was also a breeder, and the blood of his cocks ran in the best breeds of Great Britain and the United States. Another famous breeder was a Dr. Bellyse of Audlem, the principal figure in the great mains fought at Chester during race week at the beginning of the 19th century. His favourite breed was the White Pile, and Cheshire Piles were much-fancied birds.

In Wales, as well as in some parts of England, cocking mains took place regularly in churchyards and in many instances even inside the churches themselves. Sundays, wakes and church festivals were favourite occasions for them. The habit of holding mains in schools was common from the 12th to about the middle of the 19th century. When the sport was at its height, the pupils of many schools were made a special allowance for purchasing fighting cocks, and parents were expected to contribute to the expenses of the annual main on Shrove Tuesday, this money being called "cockpence." William Fitzstephen (d. *c.* 1190) reported that the masters themselves directed the mains, from which they derived a material advantage, as the dead birds fell to them. Cockfighting was prohibited by law in Great Britain in 1849.

Cockfighting was introduced into America at an early date, and it is recorded that George Washington, Thomas Jefferson and Alexander Hamilton were devotees of the sport. Always frowned upon in New England, it was soon forbidden by some of the older states; Massachusetts passed laws against cruelty as early as 1836. The sport is expressly prohibited in Canada and in most states of the U.S. it is specifically forbidden or is repressed by general laws for the prevention of cruelty to animals. Although cockfighting ceased as a public sport in the U.S., Canada and the British Isles, it continued to exist in private in those countries. Portable mains were moved from place to place to avoid police raids, and Sunday morning usually was fight time. In the United States the sport was extremely popular along the Atlantic seaboard and in the south.

Cockfighting is not recognized as a form of sport by the Latin-American countries in general. In Argentina cockfighting was once one of the most popular amusements, but it was suppressed by police measures, although it persisted in several provinces. Paraguay prohibited it by law.

In Cuba, however, cockfighting continued to be a patronized sport regulated by the government. Cubans always supported it and, although it was prohibited for a time, it was reinstated during the Gómez administration (1909–13) and was later regulated by municipal decrees. The sport became popular in Haiti, Mexico and Puerto Rico, an important cockfighting centre. Those who enjoy cockfighting insist that theirs is an amateur—not a professional—sport and that the greatest zest to be obtained from it lies in the many chances to gamble before and throughout a fight. Odds against one bird or the other fluctuate constantly and it is not uncommon for a great deal of money to be wagered. The Club Gallístico, Havana, Cuba, has been the scene of as much as $100,000 changing hands in a single afternoon. The betting language employed there was especially interesting, being the same as that used in Spain centuries earlier. With the coming of the Castro regime in 1959 the sport was curtailed.

Breeding and Training.—Breeders of gamecocks stress pedigree. They regard as fit for championship honours only those birds which have been produced by the blending of strains through hundreds of years, of the world's most courageous cocks. Famous among the strains of the 20th century are the Shawlnecks, Irish Gilders, Eslin Red-Quills, Dominiques, Claibornes, Baltimore Topknots, War-Horses, Irish Grays and Hammond-Gordons.

Gamecocks usually are put to the main when between one and two years of age. Preceding their entrance into the fighting pit, they are given intensive training. As youngsters, they are permitted a great deal of exercise to develop muscles. Chief features of their special diet are cooked corn meal, chopped hard-boiled eggs and occasional helpings of raw beef. This is augmented by regular poultry feed. The birds are massaged with a mixture of alcohol and ammonia, which toughens their skin. Their wings are trimmed at the slope; the hackle and the rump feathers are shortened; the comb is cut as close as possible to reduce it as a target for an enemy bird. In time, the cock is taken to a main, held by a trainer, and brought within a foot or two of another trainee, similarly held. The frenzied efforts of the cocks to get at each other add strength to their muscles. Later the birds get actual fight training by being pitted against each other with heavily padded leather over their spurs.

It is not definitely established when metal spurs first were

slipped over the natural spurs of the gamecocks. The first used were silver spurs, later iron spurs, then steel. In some cockfighting countries—notably Cuba—steel spurs are barred. Instead, bone spurs taken from nonfighting cocks and subjected to a special hardening process are employed. The modern short spur of metal or bone is $1\frac{1}{2}$ in. or less in length; the longer spur scales from 2 to $2\frac{1}{2}$ in.

In ancient times cocks were permitted to fight until one or the other was killed. In the more modern era, the rules were amended somewhat. Although some fights still are to an absolute finish, others permit the withdrawal at any time of a badly damaged cock. Other rules fix a time limit for each fight.

On those rare occasions when a gamecock, taking the worst of it, decides he does not wish to continue battle, he makes his intent known by lifting his hackle. The underpart of the hackle is edged with white feathers, and from this act is derived the expression "showing the white feather," which means cowardice. When a cock refuses to fight longer, his handler puts him breast to breast with the other bird. If he still refuses, it is ruled that he has quit and the fight ends.

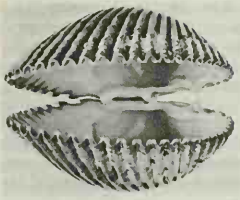
At all mains, the judge is in supreme control. His word is absolute law, even as to the gambling, and it is binding on all those identified, either officially or unofficially, with a cockfight. There is no appeal from his decisions in anything relating to the main.

See A. Ruport, *Art of Cockfighting* (1949); G. R. Scott, *History of Cockfighting* (1957). (F. G. M.; R. R. Ee.)

COCKLE, the common name applied to any species of marine clam belonging to family Cardiidae, also known as heart clams. The latter name describes the shape of the cross section of the opposed valves and is derived from the Greek *kardia*, "heart." The family, a large and important one, is world-wide in distribution and includes about 53 genera and subgenera and perhaps 250 recent species. They range in size from less than one-half inch in diameter to the smooth giant cockle, *Laevicardium elatum*, from California, which may reach nine inches. The shells are equivalve and the sculpture and colour patterns are variable. Many species lack pronounced sculpture while others are ornamented with radial ribs that are often covered with scalelike processes; among the latter kinds is the common cockle, *Trachycardium muricatum*, found from North Carolina to South America. Some species are of a uniform colour, others have radiating bands of colour and in some the pattern is mottled. The colours are usually browns, reds and yellows.

A few species live in the intertidal zone although most live just below the low-tide line and a few, mostly small species, have been dredged from depths of more than 300 fathoms. All species are found in sandy or muddy areas buried to a depth of not more than one inch. Most members of this family probably have a rather extended breeding season. To judge from the work done in the British Isles and Japan, it may extend over a period of five to six months. The eggs and sperm are shed into the sea, where fertilization takes place, and the young larvae are free-swimming for a considerable period before settling to the bottom.

Cerastoderma edule, the best known of the cockles, is an important food in the British Isles and western Europe. Like all other cockles, they are active clams with a large muscular foot and short siphons. They are usually found buried just below the surface of the sand, with the siphons extending to the surface for feeding and respiration. (*See* Bivalve.) They burrow actively, can crawl short distances on the surface and can re-bury themselves when disturbed. Colonies in unprotected areas are often destroyed by storms and consequently the large fisheries are either in protected bays or estuaries, often in areas where there is some admixture of fresh water. The clams are gathered by hand or by using a variety of rakes or scrapers. In some areas the fishermen bring the cockles to the surface by treading. More than 300,000 cwt. are gathered in England and Wales each year. The average marketable cockle is about one inch long and about two to three years old. In preparing the clams for market they are first boiled to loosen the bodies, which are then separated from the shells by sieving. The meats are washed thoroughly and are then sent directly to market or are preserved in salt or vinegar. They are also often eaten raw, though they are not sent to market in this condition. Considerable numbers are canned and these are usually used as hors d'oeuvres.



BY COURTESY OF MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD COLLEGE

OPPOSING VALVES OF COMMON COCKLE OR HEART CLAM (TRACHYCARDIUM MURICATUM)

In most other areas of the world cockles are not found in sufficient numbers to make them commercially valuable. They are eaten, however, wherever they occur. The large basket cockle, *Clinocardium nuttalli*, is fished in Puget sound, Wash.; in Japan the torgai, *Papyridea (Fulvia) mutica*, is one of the most widely used of the edible clams. In Australia clams belonging to the family Glycymeridae are referred to commonly as dog cockles; they are called cockles probably because the shell superficially resembles that of the true cockle, of which there are about 12 species in Australia. The Sydney cockle is a common name applied to *Anadara trapezia*, a species of Arcidae. These clams were an important source of food to the Australian aborigines.

Cockles are also important as a source of food for birds and a variety of bottom-feeding fishes. The ravages of these predators on the commercial beds of *C. edule*, when combined with those of predatory snails and starfish, often become of real concern to the British fishermen.

Cockles are among the most beautiful of the bivalves. They were used by primitive peoples for decoration and utensils and today are sought by shell collectors. The smaller species are used in making shell jewelry.

See also Mollusk.

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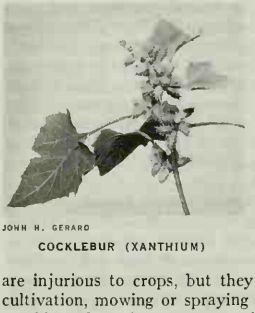
COCKLEBUR, any weedy plant of the genus *Xanthium*, of the family Compositae (*q.v.*), called also clotbur and burweed. They are coarse, rough, sometimes spiny annual herbs with much-branched stems, one to six feet high, and mostly long-stalked, variously lobed leaves. The male and female flowers, both small and inconspicuous, are borne on the same plant. The fruit (achene) is enclosed in pairs in an oblong bur, about an inch in length, covered with hooked spines and ending in a one- or two-toothed beak. The ripe burs adhere to the hair of animals, which widely disseminate the plant.



JOHN H. GERARD

COCKLEBUR (XANTHIUM)

When abundant, cockleburs are injurious to crops, but they may be controlled by intensive cultivation, mowing or spraying with 2,4–D, preferably in bright sunshine when air temperature is 70° F. or above.

The germinating seeds and young plants, while in the seed leaf stage, contain a toxic glucoside and cause fatal poisoning when eaten by livestock. The crude drug stramonium (from *Datura* species) is often adulterated with the leaves of *X. strumarium*. (N. Tr.)

COCKNEY, a colloquial name applied to Londoners generally but more properly confined to those born within the sound of the bells of St. Mary-le-Bow church. The origin of the word has been the subject of many guesses, but the historical examination of the various uses of "cockney" by Sir James Murray (see

Academy, May 10, 1890, and the *New English Dictionary*, s.v.) shows that the earliest form of the word is *cokenay* or *cokeney; i.e.*, the *ey* or egg, and *coken*, genitive plural of "cock," "cocks' eggs" being the name given to the small and malformed eggs sometimes laid by young hens (*cf.* Langland, *Piers Plowman*, A, vii, 272). The word then applied to a child overlong nursed by its mother, hence to a simpleton, and Chaucer, *Reeve's Tale*, used it with *daf; i.e.*, a fool. The application of the term by country folk to town-bred people, with their ignorance of country ways, is easy. Thus Robert Whittington or Whitinton (fl. 1520) speaks of the "cokneys" in such "great cytees as London, York, Perusy" (Perugia). It was not till the beginning of the 17th century that "cockney" appears to have been confined to the inhabitants of London.

The so-called cockney accent was chiefly characterized in the first part of the 19th century by the substitution of a *v* for a *w*, or vice versa. The chief consonantal variation which now exists is perhaps the change of *th* to *f* or *v*, as in "fing" for thing, or "farver" for farther. This and the vowel sound change from *ou* to *ah*, as in "abaht" for "about," were illustrated in the "coster" songs of Albert Chevalier. The most marked change of vowel sound is that of *ei* for *ai*, so that "daily" becomes "dyly." The omission of *h* is not peculiar to cockney.

COCK OF THE ROCK, birds of the genus *Rupicola* (subfamily Rupicolinae) of the cotingas (allied to the manakins; *q.v.*), found in the Amazon valley. They are about the size of a parrot, with orange-coloured plumage marked with black on the wings, a pronounced disklike crest and orange-red flesh; they build their nests on rock. The males hold elaborate courtship dances. *See* Bellbird; Chatterer; Umbrella Bird.

COCKROACH, the name applied to members of the Blattidae, a family (sometimes considered an order, Blattaria) of orthopterous insects, with flattened bodies, long, threadlike antennae and shining leathery integument. The name is a corruption of the Spanish *cucaracha;* in the U.S. it is commonly shortened to "roach." They are chiefly tropical, but certain species have become widely disseminated through commerce and are now cosmopolitan. Cockroaches are nocturnal in habit, hiding themselves during the day. The domestic species are omnivorous but are especially addicted to starchy or sweetened matter of various kinds; they also attack food, paper, clothing, books, shoes, bones, etc., and dead insects. As a rule they damage and soil far more than they consume, and many species emit a disagreeable odour.

The oriental cockroach (*Blatta orientalis*), a cosmopolitan household pest, is dark brown; males are short-winged, females vestigial-winged. The larger, fully winged American cockroach (*Periplaneta americana*) infests buildings throughout the tropics and warm-temperate zones. The German cockroach (*Blattella germanica*), small and pale with two dark lines on the pronotum, occurs with man from the tropics to high latitudes. Eggs of most cockroaches are laid in cases (oöthecae) which are carried protruding from the female's body until hidden in some crevice. Oöthecae of *P. americana* contain 10 to 16 eggs, which hatch in 40–45 days; nymphal life is 11–14 months, adult life 3–12 months. *B. orientalis* lives about one year.

Of the about 1,600 species of cockroaches known, only 62 species, many introduced, occur in North America; Great Britain has only 2 native species. Although blattids are usually drably coloured, some tropical species are elegant in form and beautiful in coloration. Some species are giants with a wingspread of more than five inches. Although these insects are usually viewed with disgust, they are not devoid of interest. They are the most primitive of living winged insects, and are among the oldest fossil insects. Their generalized structure and large size make them convenient for study and dissection, and they are widely used as the most suitable type for commencing the scientific study of insect morphology.

JOHN H. GERARD

ORIENTAL COCKROACH (BLATTA ORIENTALIS)

Insecticides used for cockroach control, most of which are poisonous to animals and man, include chlordane, one of the most effective; DDT; pyrethrum; and sodium fluoride, which was used for many years.

See also Orthoptera.

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COCKSCOMB, cultivated forms of *Celosia argentea cristata* (family Amaranthaceae), in which the inflorescence is monstrous. In some there is a flat "fasciated" axis bearing numerous small chaffy, brilliantly coloured flowers while in others the cluster may be spirelike, or fan-shaped. The plant is a low-growing herbaceous annual, a native of Asia, easily grown in the garden, but tender to frost. In cool regions seed should be sown in the greenhouse six to eight weeks before outdoor transplanting is safe. They do best in regions with plenty of summer heat and reasonable moisture. Seed can be sown directly outdoors in warm regions. (*See* Amaranth.)

Celosia floribunda, a related plant, is cultivated in California under the name cockscomb, but is shrubby. (N. Tr.)

COCLÉ, a small province (area 1,931 sq.mi.) in southern Panamá, facing the Gulf of Panamá. Its eastern border is less than 50 mi. from the Panama Canal Zone, with which the province is connected by modern highways and frequent boat service. Population in 1960 was 93,406, of which over 80% was rural. The province has some of the best agricultural lands of Panamá and produces sugar, coffee, rice, corn and a variety of fruits and vegetables and animal products, large quantities of which are shipped to urban centres in and near the Canal Zone. The provincial capital is Penonomé (pop. [1960] 4,593). (C. F. J.)

COCO (also called the Segovia, Wanks or Yare), Central American river with headwaters in the departments of Nueva Segovia and Estelí, Nicaragua, and Choluteca, Honduras. From the continental divide, which lies within 50 mi. of the Pacific, the river flows northeastward over 300 mi. to the Caribbean which it reaches at the cape and town of Cabo Gracias a Dios, Nicaragua. The middle and lower river form the southern boundary of a zone the sovereignty of which is contested by Nicaragua and Honduras. Canoes navigate between the mouth of the Jícaro and Bocay rivers, tributaries of the Coco. Larger craft operate between Sansang and the coast in the wet season. (J. T.)

COCOA (Cacao), the tropical tree from which cocoa powder and chocolate are derived. Cocoa trees are of the family Sterculiaceae, generally *Theobroma cacao*, rarely *T. pentagona* or *T. spherocarpa;* they are not to be confused with the coconut palm (*Cocos nucifera*) or with the South American coca shrub (*Erythroxylon coca*), the leaves of which contain a stimulant, cocaine.

The cocoa tree, a native of Central and South America, may attain a height of 40 ft. in a natural condition; however, in cultivation it is generally pruned to 15–25 ft. for ease in harvesting the fruit. It has a wide-branching habit; the downy surfaced twigs support drooping leathery leaves, often a foot long. Small pinkish blossoms, borne directly on the tree trunk and on larger branches, are followed by green, podlike fruits, which when ripe range in colour from yellow-orange to dark reddish-purple. The mature pods, resembling enlarged cantaloupes or cucumbers (6–14 in. long and 2–5 in. in diameter), are five-ribbed and woody; within, 25–50 almond-shaped, whitish, lavender or purplish seeds (about 1 in. across) are imbedded in white or pinkish, mucilaginous pulp.

The fact that these seeds provide materials useful as food and drink was well known to the pre-Columbian natives of its source area, tropical Middle America, particularly to the Mayas and Aztecs who used the beans also as a medium of exchange. The Aztecs

used cocoa as a beverage, the ground roasted seeds being whipped up in hot water and flavoured with vanilla and spices. On his fourth voyage in 1502, Columbus took back cocoa beans to Spain, where the drink was greatly improved by the addition of sugar. For nearly 100 years the Spaniards kept their secret, but the use of cocoa spread slowly to other parts of Europe. In 1657 a Frenchman opened a shop in London, at which solid chocolate for making the beverage could be purchased at 10*s.* to 15*s.* a pound. At this price only the wealthy could afford to drink it, and there appeared in London, Amsterdam and other European capitals fashionable chocolate houses, some of which later developed into famous clubs. About 1700 the English improved chocolate by the addition of milk. The reduction of the cost of the beverage was hampered in Great Britain by the imposition of high import duties on the raw cocoa bean, and it was not until 1853, when the duty was lowered to a uniform rate of 1*d.* a pound, that chocolate became popular.

Chocolate manufacture started in the American colonies in 1765 at Dorchester, Mass., using beans brought in by New England sea captains from their voyages to the West Indies. James Baker financed the first mill, which was operated by an Irish immigrant, John Hanan. Water power was used for grinding the beans.

The ground cocoa bean, prior to further processing, is 50% or more natural vegetable fat, called cocoa butter; in the manufacture of cocoa powder part of the fat is removed and in the manufacture of chocolate, cocoa butter is added. The development of both products therefore depended upon a method of extracting fat from the ground beans. The use of presses for this purpose was mentioned in books as early as 1753, but it was not until 1828 that Conrad J. van Houten took out a patent on the use of presses in the production of cocoa powder. This made available cocoa butter as a by-product, and when sufficient quantities became commercially available the manufacture of sweet eating chocolate became practical. This eating chocolate became popular around the middle of the 19th century and coating chocolate for use on candies and biscuits (cookies) came into use soon afterward. Milk chocolate was introduced in Switzerland in 1876 by M. D. Peter and its popularity spread throughout the world.

Cocoa Production.—Centres of production have changed with time, but commercial cultivation is limited by natural factors to the tropics; practically all development is within 20° north and south of the equator, and the main African belt is less than 10° from the equator. High temperatures, a mean shade temperature of approximately 80° F. with diurnal and seasonal variation of not more than 15° F., appear necessary. The cold limit apparently is an absolute one, whereas temperatures of 100° F. or more, accompanied by high humidity, do no harm.

Well-distributed rainfall of at least 50 in. a year (if not irrigated), absence of disease, a considerable population to provide harvest labour and access to export markets are all factors favouring development. In South America there are large areas apparently suitable for cultivation except for disease. Favourable site factors include a well-drained, porous soil of considerable depth and rich in humus, an altitude of a few hundred feet, protection from strong winds and some shade.

Centres of production, judged by exports, soon shifted from Mexico to Venezuela; Ecuador was the principal area from about 1850 to 1910, after which Brazil led for a time, only to be surpassed by the rapidly developing west African cocoa belt, which was the leader after 1920 and by mid-century was producing approximately two-thirds of the expanded world crop of about 2,000,000,000 lb. annually. Production in the Americas has continued at an annual rate of nearly 200,000 tons over many years.

In the 1950s a trend toward incipient decline appeared in the major centres of production, especially those of Africa. The spread of plant disease was a partial explanation, though chemical sprays appeared to offer a solution to at least some disease problems. Many major plantings were passing beyond the most productive age period; new plantings apparently did not keep up with the loss of trees, partly because of economic competition with other production. Price uncertainties were a factor. Plantings in some new or minor areas were expanding, but the high cost of establishing plantations and bringing them to producing age made such ventures somewhat speculative.

The Cocoa Farm.—Most of the world's cocoa production comes from the modest two to five acres of small farmers. Probably not more than 10% of the African production of base-grade cocoa—but more of the American production of flavour grades—is from larger plantations under co-operative native groups or non-native management.

Cultivation.—Preparation of the area for planting consists mostly in slashing and burning existing vegetation, perhaps girdling tall trees and leaving others for shade. Planting, except under more advanced management, is by rather closely spaced seeding, sometimes later thinned to keep the stronger plants. In other cases, nursery-grown and selected seedlings are transplanted when about two feet high, with field spacing ten feet or more apart. There is some tendency to abandon the use of seedlings in favour of more certain vegetative propagation of superior strains by cuttings and bud grafting. Shade by food plants, especially bananas, is provided in most areas for the thinner plantings. The tree, which would grow eventually to 30 to 40 ft. in height, is generally pruned to 15 to 25 ft. to aid harvesting. There is little cultivation or fertilization other than slashing undergrowth. The tree begins to bloom and fruit three or four years after planting and reaches full production about the eighth year. There is disagreement as to the length of fruiting life, but 30 to 40 years is common and nearly 100 years is reported. There is some evidence that from the standpoint of production and disease control it is desirable to replace trees after 15 to 30 years.

Cocoa trees are victims of a number of plant diseases. The most widespread is a fungus disease known as black pod, caused by *Phytophthora,* which in many cases destroys up to 40% of the potential crop. It can be controlled by spraying with Bordeaux mixture. A second fungus known as witches'-broom (*q.v.*), caused by *Marasmius perniciosus,* is prevalent in Trinidad, Ecuador and eastern Venezuela. *Monilea* pod rot is found in Ecuador. A virus disease, swollen shoot, has caused great damage in west Africa, the best remedy being to cut out and burn affected trees. Many insects also cause direct damage to the trees.

Harvesting and Treatment.—A full-grown tree produces annually approximately 6,000 small pink blossoms directly on the trunk and main branches, of which from 20 to 40 mature into fruit pods. Though these ripen intermittently throughout the year, most ripen in one or two main periods. Four-fifths of the world crop is harvested in the period from September to March. The pod is simply cut from the tree and the tough, fibrous hull opened with a machete, after which the seeds and adhering pulp are scooped out and fermented. The fermenting, whether carried out in a primitive pile on the ground or in a more modern perforated box or tank under cover and high temperature, takes 3 to 10 days, depending on the type of cocoa, and involves draining away the juicy "sweatings" of the pulp and the mixing and stirring of the beans to obtain an even fermentation and to avoid under- or over-fermentation. The germ in the seed is killed by the heat, temperatures as high as 124° F. develop, and at this time are formed the precursors responsible for chocolate flavour when the beans are roasted. The beans become plump and full of moisture; the interior develops an even, reddish-brown tint and a heavy, sharp fragrance. The pulp is easily removed. The beans are then dried, in some cases after washing. Drying is sometimes done on special mats or racks, and it may be by sun or artificially; it takes a few days or weeks, until the water content is reduced to 6% to 8%. The beans may then be bagged in burlap for handling. Unwashed, sun-dried beans seem to be preferred; unfermented beans are not desired. The yield on the average is 1 to 2 lb. of cured beans per tree per year, or about 350 lb. per acre. Selected plantings with above-average care will yield much more. There is some evidence of higher yields in alternate years. A major problem, other than that of disease, is how to combine peasant production with more advanced techniques to get higher yields and better quality, preferably at lower cost. Typical costs are extremely difficult to estimate, but west Africa, with its small farmers depending largely on family labour, is the lowest-cost producing area.

Grades and Marketing.—Cocoa is classified in world trade

as base or flavour grades, or as ordinary and fine. In general, these grades relate not to difference in processing but to varieties, of which there are many, the two main groups being Criollo and Forastero. Approximately 10% of world production is of the fine or flavour grades called Criollos, Trinitarios or high Forastero, marketed especially under the trade names of Arriba, Maracaibo, Caracas and Trinidad Estates and produced mostly in Venezuela, Ecuador, The West Indies, Ceylon and Java. They are largely grown under a plantation system utilizing 100 ac. or more. Forastero types constitute the base or common grades, marketed as Accra from Ghana (where they constitute half the export trade and the main source of income for the majority of the people) and Bahia from Brazil, as well as Lagos from Nigeria and Sanchez from the Dominican Republic. They usually constitute about 90% of the world's crop, are hardier and give larger yields of medium-quality beans selling for lower prices than the flavour grades. Quality standards for cocoa deteriorated during and after World War II, not only because of increased use of ordinary grades, flavour grades being available in comparatively small amounts, but also because of relaxed standards under wartime conditions. However, governments intervened in an effort to improve grading and to provide premiums for quality.

The annual crop of cocoa moves into world commerce promptly, partly because local use is not large. Though the beans will keep for a year or more under the best of storage conditions, two or three months is about the limit under the tropical conditions prevailing in the producing areas. The major markets are western Europe and the United States. Four-fifths of the exports go to five countries, and ten countries take 95% of the beans entering world trade. Cocoa was bought and sold before World War II essentially on a free but unstable market, involving active middlemen and comparatively wide price fluctuations. Growers of cocoa had no experience with international regulatory agreements; most of the proposals at prewar conferences were in the direction of increasing consumption by advertising and keeping prices as low as possible. There were tight controls over trade during the war: the same price was paid for all west African cocoas during 1942–46, whereas except during periods of short supply the best grade sold for about three times as much as the lowest. Stocks were much reduced at the end of World War II, and production had declined fully one-fifth, not because of war devastation of the producing areas but largely because of a general disruption of the production pattern and as a result of disease. In the early postwar years, world cocoa trade was governed in a general way by the International Emergency Food council. Allocations ended in 1949. Though world production staged some recovery after 1948, particularly in Latin America and French African territories, the major African areas continued below prewar production. Supplies available to the more important consuming countries were about 10% less per capita than prewar. Demand associated largely with recovery in Europe and the Korean outbreak inflated prices to new record levels. Spot Accra sold at a record price of 72.9 cents per pound in 1954. Though the search for acceptable synthetic or other substitutes appeared generally unsuccessful, chocolate bar goods were lightened and coatings thinned.

Manufacture and Uses.—The United States has the world's largest industry, ordinarily taking as much as 30% of the world's exports and reducing the raw cocoa beans to the several products. There are also major cocoa-manufacturing centres in several western European countries and in Canada, Australia and India.

Processing Cocoa Beans.—After being cleaned and sometimes washed, the beans are carefully roasted at 275° to 350° F. to develop flavour, colour and aroma and to aid shelling; they are then broken into particles called nibs by a rolling or cracking process, and winnowed to remove the fibrous shells. The shells, 10%–14% of the total weight, may be used for cocoa "tea" but usually are used in fertilizers. The nibs of desired grades and flavours are blended and ground to a cocoa mass or chocolate liquor, which after cooling sets into a hard brown block. Part of the natural fat —cocoa butter—may then be removed by hydraulic pressure. Various types of chocolate may result, depending on the amount of butter remaining, flavouring added and further processing. Unsweetened chocolate or baking chocolate is the ground nib molded into bars. Sweet drinking chocolate has had sugar added and has been somewhat refined. Eating chocolate contains more cocoa butter and flavouring.

Sweet Chocolate.—In the manufacture of sweet chocolate, granulated or pulverized sugar is mixed with the chocolate liquor and the resulting paste is ground by passing it over steel roll refiners. As the addition of sugar reduces the over-all fat content, additional cocoa butter must be supplied to the mix to maintain sufficient fat to permit further processing and molding. A typical sweet chocolate contains 42% chocolate liquor, 42% sugar and 16% added cocoa butter. After the processing, the sweet chocolate is cooled and molded into cakes for use by the candy industry as a coating for centres or it may be cast directly into small bars suitable for eating.

Milk Chocolate.—Milk chocolate is sweet chocolate in which the flavour has been modified by the addition of whole milk solids. The U.S. standard calls for a minimum of 12% whole milk solids, but good quality chocolates may contain as much as 20% to 22%.

Cocoa Powder.—Part of the fat or cocoa butter has been removed from cocoa powder, but it contains from 10% to 22% or more fat and is sometimes treated with an alkali salt which neutralizes the natural acidity of the cocoa and deepens the colour.

Cocoa Butter.—The pure fat extracted by pressure from the ground and crushed cocoa bean is used in the manufacture of confectionery and in toilet preparations. Cocoa butter is also sold free from combination with other drugs for treating skin irritations where a pure fat is necessary.

Chocolate and cocoa are used in several ways in the confectionery, baking, dairy and soft drinks and ice cream industries. Of all candy flavours, chocolate is generally the most popular. In addition to the mild stimulating effect caused by theobromine (2.2%) and caffeine (0.1%), cocoa is a concentrated food containing about 40.3% carbohydrates, 22% fat, 18.1% protein and 6.3% ash, with small amounts of water and fibre; it provides approximately 2,214 cal. per pound. *See* also CONFECTIONERY MANUFACTURE.

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(J. K. R.; N. W. K.)

COCO DE MER (DOUBLE COCONUT), a palm, *Lodoicea maldivica,* native of the Seychelles Islands. The flowers are borne in enormous fleshy spadices, the male and female on distinct plants. The fruits, among the largest known, take ten years to ripen; they have a fleshy and fibrous envelope surrounding a hard, nutlike portion that is generally two-lobed, suggesting a double coconut. The contents of the nut are edible. The empty fruits (after germination of the seed) are found floating in the Indian ocean, and were known long before the palm was discovered.

COCONUCO, a group of South American Indians in south highland Colombia whose language was probably a branch of the Macro-Chibchan phylum (*see* CHIBCHAN). Assimilated by the Spaniards soon after the conquest, their culture is known only from scant historical references. The Coconuco, together with the Moguex, comprised a dozen or more tribes which resembled their Andean neighbours in carrying on intensive agriculture and having a dense and settled population, federated states and developed warfare. Unlike their neighbours, the Coconuco proper were not cannibals.

See Henri Lehmann, "The Moguex-Coconuco" in *Handbook of South American Indians,* ed. by Julian H. Steward, Bureau of American Ethnology bulletin 143, vol. 2, pp. 969–974 (1946). (J. H. Sd.)

COCONUT OIL AND CAKE: *see* COPRA.

COCONUT PALM (*Cocos nucifera*), best known of the palms and famed as one of the world's most important crop trees. Its slender, leaning, ringed trunk arises (often 100 ft.) from a swollen base, and is surmounted by a graceful crown of giant, featherlike leaves. About a dozen new leaves appear periodically

each year, and an equal number of compound flower stalks, protected by woody spathes, push out from the base of the older leaves. About 10,000 male flowers and about 30 female flowers appear on each stalk. They mature at different times, assuring cross-pollination. Flowering begins in trees five years old and is continuous thereafter. Fruits require a year to ripen; the annual yield per tree may reach 100, but 50 is considered good.

Mature fruits—ovoid or ellipsoidal in shape, 12 to 18 in. in length and 6 to 8 in. in diameter—have a thick fibrous husk surrounding the familiar single-seeded nut of commerce. A hard shell encloses the insignificant embryo with its abundant endosperm, comprised of both meat and liquid. The three "eyes" of the coconut shell indicate that three ovarial cavities exist in the flower, but only one persists at maturity.

Coconut fruits float readily and have been dispersed widely by ocean currents, and also by man, throughout the tropics. Actually the native home of the coconut palm is unknown, but it probably originated somewhere in Indo-Malaya, where the palm exists in many natural forms. Marco Polo was among the first Europeans to describe coconuts, but the great voyages of discovery such as that of the navigator William Dampier made the species better known. Coconut palms flourish best close to the sea on low-lying areas a few feet above high water where there is circulating ground water and an ample rainfall. The palm sometimes is grown far inland and at altitudes up to 2,000 ft., but in such places production declines. Most of the world's coconuts are produced on small native plantations. Propagation is by the unhusked ripe nuts. These are laid on their sides close together in nursery beds and almost covered with soil. After four to ten months the seedlings are transplanted to the field where they are spaced at distances of 25 to 30 ft. Various annual crops are often interplanted in young plantations until the palms start bearing, usually after five to six years. Full bearing is obtained in 15 years. Yields continue to be profitable until trees are about 50 years old.

Like most cultivated plants, the coconut palm is subject to many pests and diseases. Particularly serious are the rhinoceros beetle, the red coconut weevil and a bud rot disease—all of which destroy many palms by fatally injuring the tender terminal bud.

The coconut attains its greatest marketable value as copra (*q.v.*), the dried extracted kernel, or meat, from which coconut oil, the world's ranking vegetable oil, is expressed. It is estimated that 1,000 mature nuts will yield more than 500 lb. of copra, from which 25 gal. of oil may be obtained. The oil is a white solid substance at ordinary temperatures with a peculiar, rather disagreeable odour. The Philippines and Indonesia lead in copra production, and throughout the southeast Pacific area copra is one of the most important export products. In the early 1960s approximately 400,000 metric tons of coconut oil entered world trade annually. The principal importer and consumer is the U.S., which imports both copra and crude coconut oil in large quantities. Western Europe—particularly west Germany, the Netherlands, France and the U.K.—is important also as a consumer of copra and coconut oil. Coconut oil has many uses, entering into the manufacture of soaps and shampoos, detergents, edible oils, margarines, vegetable shortenings, synthetic rubber, glycerin, hydraulic brake fluid and plasticizers for safety glass. Copra meal is a livestock feed and fertilizer, and shredded coconut is a familiar item on grocers' shelves.

Although the coconut finds its greatest commercial utilization in the industrial countries of the western world, its usefulness in its native areas of culture is even greater. Indonesians claim that coconuts have as many uses as there are days in the year, and these are not limited to the oil-yielding nut. Besides the edible kernels and the refreshing and palatable drink obtained from green nuts, the husk yields coir, a fibre highly resistant to salt water and used in the manufacture of ropes, mats, baskets, brushes and brooms. Coir is a by-product of copra production obtained by retting the husks in water and then separating out the fibres by hand or machinery. The best coir comes from green husks. Three types of fibre are produced—mat fibre, bristle fibre and curled fibre. Coir dust, or coco peat, is a peat substitute of use to horticulture.

When wounded or cut, the young inflorescence stalks produce a sweetish sap which yields toddy, a beverage drunk fresh, fermented or distilled; toddy is a source of sugar as well as alcohol. As with other palms, the delicate young bud cut from the top of the tree is eaten as a salad vegetable, palm cabbage; the mature leaves find use in thatching and basketry; and the fibrous decay-resistant trunk is of value not only to the islanders, who incorporate it into the construction of huts, but also as an exported cabinet wood, porcupine wood.

See also PALM; and the references under "Coconut Palm" in the Index. (WR. H. H.)

COCOPA, a Yuman (*q.v.*) tribe at the delta of the Colorado river in Mexico. The 3,000 Cocopa in the period of Spanish contact dwindled to about 600 by 1942, half of whom were in the United States. Cocopa customs closely resembled those of the Mohave (*q.v.*) and Yuma but diverged in social and religious life. Agriculture provided a third of their subsistence as against a half among the Mohave, and their warlike proclivity was less. Modifications of social and ceremonial life were in the direction of southern California tribes. Women were known by clan names but also bore personal names. Dreams of supernaturals, rather than of myth episodes, gave special abilities, with the administration of jimson weed to induce dreaming. An initiation to manhood was held at puberty. At a six-day commemorative ceremony dancers impersonated the dead, and a building dedicated to the dead was burned with offerings.

See E. W. Gifford, *The Cocopa,* University of California Publications in American Archaeology and Ethnology, vol. 31, no. 5 (1933). (L. SP.)

COCOS (KEELING) **ISLANDS,** two atolls forming an isolated Australian territory in the Indian ocean, lie about 840 mi. S. of the equator and about 2,300 mi. W. of Darwin, Austr. Pop. (1961) 606. Land area about 5 sq.mi. The southern atoll, which is the main one, supports about 24 linear islets, of which Home, Direction and West Island are inhabited; about 16 mi. N. is the lesser atoll, from which rises only the uninhabited North Keeling Island.

The main atoll is about 10 mi. across at its widest point, and at the north end has an entrance to the shallow lagoon. Periodical earthquakes are experienced. The climate is healthful and equable with a temperature range of 70°–89° F.; the southeast trade wind blows for most of the year but in the early months damaging cyclones may occur. Except for imported plants and grasses the main growth is coconut palms. There are no indigenous mammals; sea birds abound and turtles live in the lagoon. The giant robber crab *Birgus latro* subsists on fallen coconuts.

Discovered in 1609 by the British mariner William Keeling, the islands were first settled in 1823 by the adventurer Alexander Hare, who set up a harem and retinue of slaves brought from the Malay archipelago. In 1827 John Clunies Ross, a Shetlander, settled on Direction with his family. He and his descendants improved the natural coconut plantations and employed the Malays as labourers. In 1857 the Cocos Islands were taken under British protection and in 1878 placed under the governor of Ceylon. In 1886 George Clunies Ross received from Queen Victoria a grant of the islands in perpetuity; in 1903 the group was made part of the Straits Settlements and incorporated with Singapore.

In World War I men from the German cruiser "Emden" landed on Nov. 9, 1914, to destroy the cable and radio installations on Direction Island. Summoned by radio, the Australian cruiser "Sydney" engaged the "Emden," which was driven ashore in flames on North Keeling Island. In 1945 an airstrip was built on West Island and in 1951 the British government agreed to hand over administration to Australia, subject to the Ross family retaining their property; the transfer took effect in 1955. The airstrip is a stopping place on flights between Perth, Austr., and Johannesburg, S. Af.

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COCTEAU, JEAN (1889–1963), French poet and writer, whose originality, versatility, and vast output in almost every art form have made his name known throughout the world. The

friend, and often the collaborator, of writers (Blaise Cendrars), musicians (Stravinsky), painters (Picasso), choreographers (Diaghilev), and film workers (Jean Marais), he appears to have found the secret of eternal youth in switching from one "manner" to another.

Born at Maisons-Laffitte, near Paris, on July 5, 1889, of a family of wealthy Parisian lawyers, he was educated at the Lycée Condorcet (1900–04). He attracted attention with his first volume of verse, *La Lampe d'Aladin* (1909). Although medically unfit, he managed, under an assumed name, to follow a regiment of marines to the front in 1914. Transposed, these adventures figure in his novel *Thomas l'Imposteur* (1923; first Eng. trans. 1925). His wartime flights with the aviator Roland Garros inspired many of the poems in *Le Cap de Bonne-Espérance* (1919). His connection with the theatre began with his share in *Parade* (performed 1917), Diaghilev's unorthodox ballet, with music by Erik Satie. Other works in which he collaborated, usually as scenario writer, with composers, include *Le Boeuf sur le toit* (Milhaud), *Les Mariés de la Tour Eiffel* ("Les Six," the group which he helped to form in 1917), *Oedipus-Rex* (Stravinsky), and, in 1959, *Le Poète et sa muse* (Menotti).

After the death of Raymond Radiguet (1903–23), the young prodigy novelist whom he had discovered in 1918, Cocteau took to opium. However, influenced by Jacques Maritain (*q.v.*), he contributed to the intellectual rehabilitation of Catholicism, and set out to prove that religion and freedom in art are not incompatible (*Lettre à Jacques Maritain*, 1926). A precise description of his disintoxication is given in *Opium* (1930; Eng. trans. 1932).

As a creation of the French avant-garde cinema, his *Le Sang d'un poète* (1932) is a classic of its kind. Of the many films which he wrote or directed, the most memorable are *L'Éternel Retour* (1944), *La Belle et la Bête* (1946), *Orphée* (1950), and *Le Testament d'Orphée* (1960), in which he played the principal part.

In 1935, emulating Jules Verne, he went around the world in less than three months (*Mon Premier Voyage*, 1936; *Round the World Again in 80 Days*, 1937). Later journeys took him to America (1948–49), the eastern Mediterranean (1949), Greece (1952), and Spain (1953 and 1954). In 1956 he visited England, where he received an honorary doctorate at Oxford. He was elected to the Académie Française in 1955. His last years were spent mostly painting (*e.g.*, a triptych for the French church, London), making pottery, and continuing to produce illustrations. He died at Milly-la-Forêt, near Fontainebleau, on Oct. 11, 1963, of a heart attack brought on by the news of the death (on the same day) of his friend Edith Piaf, the French *chanteuse*.

To Cocteau, his numerous activities were all various forms of poetical expression; the name he gave to his entire work is "*poésie*." His "*poésie de théâtre*," for instance, includes *Orphée* (publ. 1927; Eng. trans. 1933), *La Voix humaine* (1930; Eng. trans. 1951; filmed 1947), *La Machine infernale* (1934; Eng. trans. 1936), *Les Parents terribles* (1938; *Intimate Relations*, 1951; filmed 1948), and *L'Aigle à deux têtes* (1946; *The Eagle Has Two Heads*, 1948; filmed 1948). The two studies of adolescence, *Le Grand Écart* (1923; Eng. trans. 1925) and *Les Enfants terribles* (1929; Eng. trans. 1930; filmed 1950), belong to his "*poésie de roman*"; wishing to disown his early poetry, he dated his literary debut with the publication of his first novel, *Le Potomak* (1919). His weekly articles for *Le Figaro*, collected as *Portraits-Souvenir* (1936; *Paris Album, 1900–1914*, 1956), and the essays of *Le Rappel à l'ordre* (1926; Eng. trans. 1926) are termed "*poésie critique*." Continuing to write verse throughout his life, he extended his technical experiments to many fields. An extremely prolific and ubiquitous personality, with a taste for paradox and aphorism, he stood, above all, for unconventionality.

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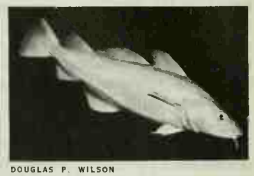
C.O.D.: *see* CASH ON DELIVERY.

COD are typical fish of the cold- and temperate-water family Gadidae, a group that includes some of the world's most valuable food fishes, the common cod, the haddock and the hakes and pollocks. The common or Atlantic cod (*Gadus morhua*) has three dorsal and two anal fins; the upper jaw projects beyond the lower; the chin has a barbel; the lateral line is pale; and the tips of the ventral fin are not conspicuously prolonged as filamentous feelers. The colour varies considerably through shades of gray green, olive, brown, orange and brick red. They inhabit continental shelf and offshore bank areas across the North Atlantic, on the American side from Cape Hatteras northward to Hudson strait and southern Greenland, and on the European side from the Bay of Biscay to Iceland, West Spitzbergen and Novaya Zemlya. The Pacific cod, which some authorities consider to be a subspecies, *G. morhua macrocephalus*, extends from Oregon on the American side and from Japan on the Asian side northward into the Bering sea.



DOUGLAS P. WILSON

ATLANTIC COD (GADUS MORHUA)

Although cods typically live on or near the bottom, at depths ranging from 30 to 250 fathoms or more, cod sometimes swim near the surface when migrating or when pursuing food. They feed on any kind of bottom-living or pelagic invertebrate or fish which is not too elusive for them to catch or too large to swallow. In turn they are preyed upon by larger fishes, especially sharks.

The time of spawning depends on temperature and occurs in some part of the range of the species from November to August. A 40-in. female produces about 3,000,000 eggs a year. The buoyant eggs, 1.10 to 1.82 mm. in diameter, drift with the currents in the plankton community. They hatch in 10 to 50 days, according to temperature, and the young fish continue to drift for several weeks before they descend to the bottom. Their growth rate varies widely. They may average 5 to 8 in. by the end of their first year, 21 to 36 in. by the end of their sixth. The largest specimen caught off North America was over 6 ft. and weighed 211¼ lb.; however, commercial catches consist of specimens usually much smaller, from 2½ to 25 lb.

Cod migrate seasonally, northward and into shallower water in summer, southward and into deeper water in late autumn. Fishermen of all northern maritime nations fish for cod, with trawls and hand lines, taking altogether nearly 2,000,000 metric tons a year. Most of the catch is made into frozen fillets and fish sticks, or is split, salted and dried. The livers are used in the preparation of cod-liver oil (*q.v.*), and the eggs or roe are used as ground bait in the sardine fishery of France; a variety of isinglass (*q.v.*) is made from the air bladder.

Among the other cod fishes are: polar cod (*Arctogadus glacialis*) and Greenland cod (*Gadus ogac*) of the North Atlantic; and saffron cod (*Eleginus gracilis*) of the Pacific.

See also references under "Cod" in the Index. (L. A. WD.)

CODE. The word code has many meanings, ranging from the "teen-age" codes found in many secondary schools in the United States to the elaborate civil codes of France, Germany and Switzerland. Its general purport, however, is that of a more or less systematic and comprehensive written statement of rules on a given subject. The rules may or may not be authoritatively promulgated, and the subject may be broad or narrow, but the rules are always written and are always presented in a relatively systematic and comprehensive fashion.

The oldest known code is that of Hammurabi (*q.v.*). Roman law began with the Twelve Tables and culminated in the code of Justinian, which was given the force of law in A.D. 534 (*see* ROMAN LAW). The peoples who overran the Roman empire also made codes of law; *e.g.*, the law of the Salian Franks and other Frankish laws (*see* GERMANIC LAWS, EARLY; SALIC LAW). A famous compilation of rules of maritime law, known as the Rhodian sea

law, was originally put together between A.D. 600 and 800; and various collections of maritime customs, drawn up for the use of merchants and lawyers, acquired great authority throughout Europe in the 14th and 15th centuries (*see* MARITIME LAW).

In modern practice, the ambiguity of the word code is particularly noticeable in the United States, where efforts to bring order out of chaotic masses of statutory law have resulted in different usages.

The basic law of the several states of the United States is, except in Louisiana, the common law—the unwritten rules and principles derived from the decisions and opinions of courts. There are also vast numbers of statutes, ordinances and regulations adopted by legislative and administrative bodies to supplement and change the common law. These laws are ordinarily promulgated in chronological order, with the result that this body of law soon becomes chaotic and unmanageable. Various methods have been devised to put it into orderly and manageable form.

The method most often employed to accomplish this result is the compilation of existing statutory laws of a general and permanent nature, in their current form, into a systematic whole, classified according to subject matter. Repealed, local, special and temporary laws are omitted, and amended laws are included in their latest amended form. The compilation has two chief characteristics. First, the laws included in the compilation are compiled without change in text. Second, the compiled laws are never enacted or adopted as new laws; they may have no official standing whatsoever and at most are given official recognition as presumptive evidence of the current statutory law. Compilations in the United States are usually entitled compiled laws or general laws; but in some quarters, although purists object to the appellation, they are occasionally called codes.

The compilation does not permit the consolidation of similar provisions of different laws or the elimination of inconsistent provisions. And since it is at best only evidence of the law, it does not alleviate the necessity for examining the authentic texts of the laws included in the compilation.

The revision, as distinguished from the compilation, is designed to eliminate these shortcomings. Like the compilation, a revision takes the existing statutory law of a general and permanent nature and organizes it into a systematic whole, classified according to subject matter. But unlike the compilation, a revision is always prepared by authorized officials, changes in the texts of existing statutory laws are made and the revision is always enacted as new law. The magnitude of the textual changes depends upon the reviser's authority and the action of the legislative body that enacts the revision as new law. Sometimes legislative bodies are reluctant to undertake a wholesale revision of all the statutory law. Fearing inadvertent changes and omissions, they prefer piecemeal revisions of the statutory law on particular subjects. But whether wholesale or piecemeal, a revision purports to be a revision of only the statutory law, not the common law.

In the United States, wholesale revisions are usually entitled revised statutes, and piecemeal revisions codes, laws or acts, qualified by a description of the subject matter revised. Sometimes, however, wholesale revisions are called codes, and many of those who object to the use of "code" for compilations regard this usage as entirely proper. In England, different terms are employed: the piecemeal revision is known there as a consolidation, a terminology employed also in New York.

Occasionally, something more comprehensive than a revision is required. Because of conflicts or gaps in the common and statutory law and the need for a comprehensive statement of substantially all the rules of law on a given subject, statutes are enacted embodying for a broad or narrow subject the prevailing statutory and common law with whatever modifications are required in the circumstances. These are usually known as codes, though sometimes as laws (*e.g.,* Negotiable Instruments law) or acts (*e.g.,* Uniform Sales act). In England, the term codification is reserved for legislative enactments of this kind.

Codification in the United States.—Codification of law in the comprehensive English sense got under way at an early date in the United States. Early in the 19th century, Louisiana, because of its French and Spanish law heritage, enacted comprehensive codes, based largely upon the Napoleonic codes. Louisiana enacted a comprehensive civil code in 1824 and a code of practice in 1825. These were the work of Edward Livingston (*q.v.*) and two other jurisconsults. Livingston also prepared a commercial code and the celebrated work called *A System of Penal Law,* which comprised a code of crimes and punishments, a code of procedure, a code of evidence, a code of reform and prison discipline, and a book of definitions. Louisiana, however, did not adopt either of these two comprehensive drafts.

About a decade later in Massachusetts a distinguished commission headed by Joseph Story issued a report favouring the codification of large portions of Massachusetts common law. The commission's recommendations, however, were dismissed with little public controversy. And the great debate over codification of the common law in the United States did not develop until the latter half of the 19th century when David Dudley Field (*q.v.*) engaged in a grand struggle for the codification of New York law.

In New York the movement for codification of the law began smoothly. A code of procedure popularly known as the "Field code," which covered part of the law of civil procedure, was enacted in 1848 with very little dissent (*see* PRACTICE AND PROCEDURE: *United States*). Other drafts of New York codes encountered greater opposition. Objections to the penal code and the code of criminal procedure delayed their enactment until 1880–81, and hostility to the political code and code of evidence led to their defeat. It was Field's civil code that aroused the strongest opposition and touched off the great debate over codification. Field's principal opponent in the debate was James C. Carter, who, as a disciple of a school of historical jurisprudence, decried codification of the common law. After many stormy sessions in the New York legislature the civil code, largely as the result of Carter's influence, was finally defeated in 1886.

Although California and a few other states adopted civil and political codes, the movement for wholesale codification of the common law ended with the decisive defeat of these codes in New York. But codification on a narrower scale continued throughout the United States. Many states enacted codes of civil and criminal procedure, penal and probate codes, and the partial codes represented by some of the "uniform" acts prepared by the National Conference of Commissioners on Uniform State Laws. Perhaps the most comprehensive of these is the Uniform Commercial code prepared by the American Law institute and the uniform-state-law commissioners.

England.—The movement for codification was less effective in England than in the United States. Except for such partial codes as the Sale of Goods act, 1893, drafted by Sir MacKenzie Chalmers, England has confined its efforts to the revision and consolidation of its statutory law. Codification was much more successful in British India, where both Field's and Livingstone's works had considerable influence.

Civil Law.—In civil-law jurisdictions comprehensive codification of the law is the rule rather than the exception. The movement for codification in these jurisdictions had its effective beginning with the adoption of the five Napoleonic codes of 1803–10, though there were codes on a different scale before that time. The five French codes were the civil code, code of civil procedure, commercial code, code of criminal procedure and penal code. Since then, similar codes, though not always covering the same subjects, have been enacted by most of the nations outside the common-law world. (*See* CODE NAPOLÉON; CIVIL LAW; for more detailed treatment of the codes of the civil-law countries, *see* FRENCH LAW; GERMAN LAW; ITALIAN LAW; JAPANESE LAW; etc.)

International Law.—Despite considerable effort devoted to the codification of international public and private law, the results were meagre. Between 1893 and 1928 the Diplomatic Conference of The Hague on Private International Law adopted six conventions, dealing with such matters as marriage and guardianship, but few of them were wholly successful. The International Institute in Rome for the Unification of Private Law prepared drafts of proposed uniform international laws on such matters as arbitra-

tion and the sale of goods; and the International Law commission of the United Nations undertook a series of important studies looking to the codification of various aspects of international law. Greatest success in the codification of international law was achieved in Latin America, where the celebrated Bustamante Code of International Law, prepared by Antonio Sánchez de Bustamente, was adopted by the Sixth International Conference of American States in 1928 and later ratified by 15 countries, 6 without reservation.

See also INTERNATIONAL LAW, PUBLIC.

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(R. C. McC.)

CODEINE occurs naturally in opium, being one of the alkaloids (*q.v.*) of the phenanthrene group and a derivative of morphine (*q.v.*), retaining in a modified form the characteristic physiological action of the latter. It is commonly used orally in cough sirups and hypodermically to relieve pain, spasm and as a sedative. It crystallizes with one molecule of water, in large translucent prisms, and behaves as a monoacidic base forming salts of which the sulfate and the phosphate are those most frequently used in medicine. (F. L. A.; X.)

CODE NAPOLÉON. The Code Napoléon (French civil code) was enacted into law on March 21, 1804, under the title Code Civil des Français. This title was changed to Code Napoléon in 1807 to honour Napoleon I, the emperor who, as first consul of the republic, had taken active interest in the drafting and had brought to completion this monumental legislative undertaking. With the fall of the Napoleonic regime, the original title was restored in 1816. Reference to Napoleon was reinstated in the title of the code in 1852 by a decree of Louis Napoleon (Napoleon III), then president of the French republic. Since Sept. 4, 1870, however, statutes have referred to it simply as the "civil code."

Forces Behind Codification.—The demand for, and the beginning of, codification in France preceded the Napoleonic era. For centuries the law had been unwieldy in bulk and uncertain in form; diversity of laws was the dominant characteristic of the prerevolutionary legal order. Roman law governed in the south of France, while in the northern provinces, including Paris, a customary law had developed based largely on feudal Frankish and Germanic institutions. Marriage and family life were almost exclusively within the control of the church and governed by canon law. In addition, starting with the 16th century, a growing number of matters were governed by royal decrees and ordinances and by a case law developed by the *parlements* (supreme courts). As Voltaire put it, the traveler in those days changed laws as often as he changed horses! Further, the law was full of obsolete rules, and important questions that had been debated for centuries were still unresolved. People complained that the law was so confused that nobody, including the judges, was able to know it with certainty. The courts had become very unpopular and aphorisms such as "God save us from the justice of the courts" were common. Thus, even before the Revolution the states-general had expressed their wish for new and uniform national legislation. Vested interests, however, blocked such codification since it was apparent that reform would necessarily encroach on their privileges.

After the Revolution, codification had not only become possible but almost necessary. Powerful control groups such as the manors and guilds had been destroyed; the secular power of the church had been suppressed; and the provinces had been transformed into subdivisions of the new national state. On the other hand, the Revolution had strengthened the nation's consciousness of unity and had resulted in a thorough political unification of France which, in turn, demanded a new body of law uniform for the entire state. The demand for codification was also in accord with current ideas concerning the purpose and function of law in society, namely, the conviction that the main role of the law ought to be the preservation of the social status quo. The achievements of the Revolution could and should be consolidated in an authoritative and enduring text in the form of a code. In connection with these ideological trends, Napoleon's personal aspirations and the attitude of powerful Jacobin groups should also be mentioned. Napoleon's vivid interest in codification has been explained partly as the result of a well-known rivalry with monarchical absolutism and partly due to the influence of Rousseau. Indeed, Napoleon was an admirer of Rousseau who, along with other 19th-century philosophers, considered legislation as the most important governmental activity and the legislator as a molder of men and states. The Jacobins, also influenced by Rousseau, regarded legislation as a good in itself, enabling every man to comprehend "the principles of conduct" in a social milieu.

The Process of Codification.—Giving expression to a widespread popular feeling and to the needs of the revolutionary government, the constituent assembly of 1790 adopted a unanimous resolution providing that "There shall be a code of civil laws common for the entire realm" (Sept. 4, 1791). Further steps toward the actual drafting of a civil code, however, were first taken by the National Convention of 1793, which established a special commission headed by the duc de Cambacérès and charged it with the task of completing the project within a month. This commission prepared within six weeks of its creation a draft code consisting of 719 articles. Though truly revolutionary both in intent and content, the draft was rejected by the convention on the ground that it was too technical and detailed to be easily understood by all citizens. A second, much shorter draft of 297 articles (1794) was little debated and had no success. Cambacérès' persistent efforts produced a third draft (1796), containing 500 articles, which was equally ill fated. Another commission, established in 1799, presented a fourth scheme prepared in part by Jean Ignace Jacqueminot. Finally, the consulate, with Napoleon Bonaparte as first consul, resumed the legislative work, and a new commission was nominated. A final project was pushed forward until it received definitive form in a draft submitted first to the legislative section and then to the plenary assembly of the newly created council of state (*conseil d'état*). There it was minutely discussed, and with the steadfast participation and vigorous support of Napoleon as chairman it was enacted into law piecemeal, in the form of 36 statutes passed between 1801 and 1803. On March 21, 1804, these statutes were consolidated in a single body of law—the Code Civil.

The Code as Rational Legislation.—The Code Napoléon was superior to all prior enactments also referred to as "codes" by virtue of its ideological premises and formal qualities. Pre-Napoleonic codifications, such as the Justinian legislation (*Corpus Juris Civilis*) and the Prussian code of Frederick the Great (*Allgemeines Preussisches Landrecht*), were systematic compilations of statutes, customs and judicial decisions that intended to coordinate and restate pre-existing law rather than to supersede it completely. The chief purpose of the Justinian legislation was to achieve, without significant alterations, an orderly arrangement of the law, convenience of ascertainment and general accessibility to the public. Similarly, the code of Frederick the Great was conceived, in accordance with natural-law ideas of an enlightened despotism, as an authoritative legislative restatement of the law in the form of specific rules prescribing definite legal consequences for all foreseeable sets of facts. The Code Napoléon, on the other hand, was conceived as a complete legislative statement of principles rather than rules and as a truly revolutionary enactment designed to remake the law in the image of a new and better society. It was founded on the premise that for the first time in history a purely rational law should be created, free from all past prejudices and deriving its content from "sublimated common sense;" its moral justification was not to be found in ancient custom or monarchical paternalism but in its conformity with the dictates of reason. And thus its fundamental precepts are presented with the claim of universality, namely, as an assertion that

a legal order is legitimate only when it does not contradict such precepts.

One of the most important characteristics of the code as a product of rational legislation is its reliance on reason and logic as essential factors in the judicial process. Human reason, according to the prevailing rationalistic philosophy, had the inherent ability to regulate all legal relations. Consequently, a code could and should be complete in its field and self-sufficient; it should lay down general principles in accordance with a logical scheme; and it should have such inner consistency that logical reasoning should furnish answers to all questions arising within its framework. Resort to other sources or to any other method of implementing its provisions should be excluded, and the judge should never refuse to give judgement on the ground that the law is obscure or that the question in hand is not answered by the code. All apparent gaps ought to be filled by logical reasoning and by analogy from other provisions. Thus, in spite of the early revolutionary trend that tended to strip the courts of any power except a literal application of the statute, the code succeeded in balancing the function of the legislature with that of the courts.

The formal qualities of the code elevate it to the position of one of the most elegant achievements of juristic thought. The code possesses an extraordinary measure of lucidity and is almost completely free from the intrusion of nonjuristic elements, confusing casuistry and sterile abstractions. Its legal precepts have a tangible clarity; the definition of legal concepts was avoided except in a comparatively small number of instances; and qualifications, limitations and exceptions were kept to a bare minimum. Numerous provisions sound epigrammatic and have become part of common parlance in France as legal proverbs. Provisions such as "A contract properly concluded takes the place of law for those who have made it" (art. 1134) and "Every act of man which causes harm to another binds the one through whose fault it has occurred to repair it" (art. 1382), forming respectively the foundation of contractual and delictual liability, may sacrifice juristic precision to vivid form, but at the same time express legal concepts in the everyday language of the French people and furnish to laymen a comprehensible standard of conduct.

Contents.—The Code Civil has been described as an effort "to consolidate the achievements of the Revolution, to reconcile the customary law with the Roman law, and to effect a smooth transition from the past to the present." The substantive provisions of the code thus represent a fusion of revolutionary ideas with the customary law of the northern provinces, expressed in the conceptual technique of 18th-century Roman law. To achieve that end, the drafters relied heavily on the work of earlier commissions and on the extensive writings of two great jurists of previous generations, R. J. Pothier (1699–1772) and J. Domat (1625–96), who had laid the foundations for a uniform French law. Pothier had laboured to establish an "area of agreement" between conflicting local customs and to digest them in the form of a "customary common law." Domat, on the other hand, had contributed to the development of a conceptual technique and the simplification of the Roman law then prevailing in the southern provinces.

Under the code all citizens are equal: primogeniture, hereditary nobility and class privileges are extinguished; civilian institutions are emancipated from ecclesiastical control; freedom of the person, freedom of contracting and inviolability of private property are fundamental principles. Yet its provisions strike a successful balance between a "prudent liberalism" and an "enlightened conservatism" rather than pushing revolutionary claims to an extreme. The revolutionary and the traditional outlook, the old and the new, were successfully combined in a spirit of moderation and as an organic whole. This balance of conflicting values was the philosophy of J. É. M. Portalis, one of the main drafters, who wrote: "The spirit of moderation is the true spirit of the legislator; the political and the social good is always found between two extremes."

The 2,281 articles of the Code Civil are systematically arranged in a preliminary title dealing with law and its application in general, and in three "books" dealing with the law of persons, the law of things and the methods of acquiring rights.

Law of Persons.—The first book of the code deals with the enjoyment of civil rights, the protection of personality, domicile, guardianship, tutorship and curatorship, relations of parents and children, marriage, personal relations of spouses and the dissolution of marriage by annulment or divorce.

The drafters of the code regarded the family unit as the fundamental institution in a civilized society. Accordingly, though preserving the revolutionary conceptions of secularized marriage and family life, they laboured to strengthen family ties. According to the code, the husband is the chief of the family and the wife owes him obedience. In the absence of other marriage settlement, movables owned by the parties at the time of marriage and all acquisitions during marriage form a community fund; this fund as well as the separate property of the wife are managed by the husband. Originally, the wife was practically incapable of any act in the economic sphere without the written consent of her husband; her condition, however, was drastically changed by a number of statutes which placed the spouses on an almost equal basis. Freedom of divorce, which prevailed during the Revolution, was substantially limited by the code and became available only on certain grounds. The relevant articles of the code were repealed in 1816 and divorce was reintroduced only in 1884.

Law of Things.—The second book of the Code Civil regulates property rights: ownership, usufruct and servitudes. Feudalism, as a hierarchy of persons tied to a hierarchy of lands, could have no place in the code. Accordingly, the predominant relationship between persons and things is ownership, which is a complete, free and almost absolute right. Usufructs and servitudes are permissible but cannot involve a personal duty; they are simply charges "laid on an estate for the use and utility of another estate belonging to another owner" (art. 637). The code imposes certain limitations on real-estate ownership to guarantee to adjoining owners the normal enjoyment of their property. In addition to these "neighbourhood rights," restrictions on property have been imposed by eminent domain exercised in the interest of the public and by judicial expansion of the notion of abuse of right.

Acquisition of Rights.—The third book of the code deals with the methods of acquiring rights by succession, donation, marriage settlement and obligations. In the last chapters, the code regulates a number of nominate contracts, legal and conventional mortgages, limitation of actions and prescription of rights.

In the field of succession, freedom of disposition is limited in favour of surviving children and by public-policy considerations relating to the prohibition of fideicommissa (bequests which the donor asks the recipient to transfer to another). Wills may be holographic, secret or publicly declared. In the absence of a will the estate devolves to blood relatives in accordance with a well-defined order of succession, and the surviving spouse is called to inherit only in the absence of blood relatives up to the 12th degree.

With regard to obligations, the law establishes the traditional Roman law categories of contract, quasi contract, delict and quasi delict. Freedom to contract is not spelled out explicitly but is an underlying principle in many provisions. The law of contract reflects in general a highly individualistic spirit, and limitations on contractual freedom arise mostly from general considerations of public policy.

The code reflected the social facts of 1804 and could not possibly have continued unchanged into the 20th century. Thus, in the long period in which it has been in force the code has been modified by a large number of statutes, and a body of case law has grown around its provisions. Further, a number of important statutes enacted during the 19th and 20th centuries, though bearing on civil-law matters, were left outside the code. Technical views about codification have also changed, and thus revision came to be regarded as highly desirable in France. In 1904, after the celebration of the code's centenary, a commission was nominated to prepare a revision. In 1945 a new commission was charged with the preparation of a complete revision, and its work is published annually in special volumes.

Dissemination of the Code.—The code was originally introduced into areas then under French control: Belgium, Luxem-

bourg, the German territories on the left bank of the Rhine, the Palatinate, Rhenish Prussia, Hesse-Darmstadt, Geneva, Savoy, the duchies of Parma and Piacenza, Piedmont and the principality of Monaco. As the armies of Napoleon swept through Europe, the code was introduced into the newly conquered territories: in Italy, the Netherlands, the Hanseatic territories and the grand duchy of Berg. Napoleon's victories opened the door to the code even beyond the conquered territories; through direct persuasion, exercised by Napoleon personally and by his envoys, the code was introduced in Westphalia, Hanover (united to Westphalia in 1810), the grand duchies of Baden, Frankfurt and Nassau, the free town of Danzig, the grand duchy of Warsaw (a part of Russian Poland), several Swiss cantons and in the Illyrian provinces. As the backbone of the code was Germanic custom enacted in accordance with the conceptual technique of 18th-century Roman law, its expansion did not meet great resistance; several of these territories did not even associate the Code Civil with French imperialism and actually preserved it for a long time after the fall of the empire. The code thus remained in force in those parts of Germany situated on the left bank of the Rhine, in the grand duchy of Baden, and in a small sector of the Rhine province east of the Rhine until 1900; in Geneva until 1912; and in Belgium, Luxembourg and Monaco until the present time.

During the 19th century the Code Napoléon was voluntarily adopted in a number of European countries either in the form of simple translation or with considerable modifications. Thus in Italy the civil codes of the two Sicilies (1819), Parma (1820) and Modena (1852) and the Albertine code of Sardinia (1837) derived directly from the Code Napoléon. The Italian civil code of 1865, enacted after the unification of Italy, had as its model the Albertine code—and thus a close, though indirect, relationship with the Code Napoléon. The new Italian code of 1942 has to a large extent departed from this tradition.

In the Low Countries, the Dutch civil code of 1838 preserved much of the spirit, content and legislative technique of the Code Napoléon. In the mid-20th century, however, revision was underway which indicated the possibility of recodification along different lines. In the Balkan peninsula the civil code of the Ionian republic (1842) was largely modeled after the Code Napoléon, while the civil code of Rumania (1864) was practically a free translation of the French original. Finally, in the Iberian peninsula, the civil codes of Portugal (1867) and Spain (1889) had as their main source the Code Napoléon.

Further, the Code Napoléon has become the foundation of several codes of the new world. In Louisiana, the only civil-law state in the U.S., codification of civil law was attempted as early as 1808. It is not known whether the drafters of that early codification possessed the definitive text of the Code Napoléon, but divergencies from the latter were not very great. The Louisiana civil code of 1825 (revised in 1870 and still in force) is clearly and closely connected with the Code Napoléon. Civil codes enacted during the same period in other states of the U.S. had nothing in common with the Code Napoléon since they were essentially compilations of common-law materials and restatements of the law rather than codes in the continental sense. Such codes had as their prototype a draft civil code prepared for the state of New York by David Dudley Field in 1862. In Canada, the civil code of Quebec (1866) was largely based on the Custom of Paris; however, it displays a great similarity to the Code Napoléon with regard to both legislative technique and substance.

In Latin America, the Code Napoléon was introduced in French in Haiti (1825) and in the Dominican Republic (translated into Spanish in 1884) and is still in force there. The civil codes of Bolivia (1830) and Chile (1855) followed closely the arrangement of the Code Napoléon and borrowed much of its substance. The Chilean code was in turn copied by Ecuador (1857) and Colombia (1873) and closely followed by Uruguay (1868) and Argentina (1869). The civil codes of Puerto Rico and the Philippines are related to the Code Napoléon only indirectly, reproducing with slight amendments the Spanish civil code of 1889.

In the near east, the Egyptian codes of 1875 and 1883 and the civil code of Lebanon (1934) were founded directly on the Code Napoléon. The new Egyptian civil code of 1948 did not completely depart from the French tradition. Finally, in the far east a draft code prepared by the French jurist G. E. Boissonade along the lines of the Code Napoléon was applied in Japan from 1880 to 1896 even without legislative approval.

The influence of the Code Napoléon diminished at the turn of the century as new types of codification were started with the introduction of the German civil code of 1896 and the Swiss civil code of 1912. The logical rigour of the former and simplicity of the latter offered a certain attraction; Turkey adopted the Swiss civil code in translation (1926) and Japan the German civil code with significant alterations (1898). The codes of Brazil (1916), Mexico (1928), Peru (1936), pre-Communist China (1931) and Greece (1940) were largely products of a comparative method; ideas borrowed from the German, French and Swiss civil codes were successfully combined with indigenous institutions. However, in spite of all modern tendencies, and after more than a century and a half since its promulgation, the Code Napoléon is still living law in a great part of the world. History has thus partly justified the melancholic words uttered by Napoleon in exile: "My real glory is not the forty battles I won, for Waterloo's defeat will destroy the memory of as many victories . . . What nothing will destroy, what will live forever, is my Civil Code."

See FRENCH LAW; *see* also references under "Code Napoléon" in the Index.

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CODES AND CIPHERS: *see* CRYPTOLOGY.

CODEX, the name given to the earliest forms of manuscript in book form (*i.e.*, the collection of written pages stitched together) which replaced the earlier roll of papyrus and the wax tablets (which when hinged or bound together formed the first codex or caudex); also the Latin form of the English word "code" (*q.v.*), meaning a body of law or regulations. For examples of famous codices, *see* the articles BIBLE; LIBRARY; and PALEOGRAPHY.

CODIAEUM, a small genus of Indo-Malayan shrubs belonging to the family Euphorbiaceae (*q.v.*). One species, *C. variegatum*, a native of Polynesia, is cultivated in many varietal forms as an ornamental or potted plant under the common name of "croton" for its magnificently variegated leaves.

CODINUS, GEORGE (GEORGIOS KODINOS CUROPALATES) (fl. probably late 15th century A.D.), was wrongly credited with the authorship of certain Byzantine topographical and historical works:

1. *Patria*, divided into five sections: (*a*) the foundation of Constantinople; (*b*) its topography; (*c*) its works of art and sights; (*d*) its buildings; (*e*) the construction of the church of Hagia Sophia. Written and revised in the earlier Macedonian and Comnenian periods this was perhaps copied by Codinus, whose name it bears in some (later) manuscripts. The chief sources are: the *Patria* of Hesychius Illustrius of Miletus, an anonymous *Brief Chronological Record* (*c.* 750), and an anonymous account of Hagia Sophia (ed. by T. Preger in *Scriptores originum Constantinopolitanarum*, fasc. i; 1901). Other sources appear to have been Procopius' *De Aedificiis* and the poem of Paulus Silentiarius on the dedication of Hagia Sophia.

2. *De Officiis*, an account of court and higher ecclesiastical dignities and ceremonies (*cf., De cerimoniis aulae Byzantinae* of Constantine Porphyrogenitus). This probably comes from the mid-14th century and is a valuable source for late Byzantine administrative history.

3. A chronological outline of events from the beginning of the world to the taking of Constantinople by the Turks.

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251 (1952–53); vol. 15, pp. 214–219 (1954); vol. 16, pp. 97–112 (1955); K. Krumbacher, *Geschichte der Byzantinischen Literatur*, pp. 422–427 (1897); G. Moravcsik, *Byzantinoturcica*, i, pp. 276–277 (1958); G. Ostrogorsky, *History of the Byzantine State*, p. 423 (1956).
(J. M. Hy.)

CODLING MOTH (*Carpocapsa pomonella*), a small dark gray moth, the larva (a pinkish-white caterpillar) of which is very destructive to apples and other fruit. Indigenous to Europe, it has spread, through the agency of commerce, wherever the apple is cultivated.

The most effective methods of moth control are by binding the tree trunks with chemically treated paper or sacking and by spraying the top growth with lead arsenate when most of the petals have fallen.

COD-LIVER OIL (Oleum Morrhuae), the oil obtained from the liver of the Atlantic cod (*Gadus morrhua*) and other species of the family Gadidae. The chief producing countries are England, Norway, Iceland and Canada. The oil is made by steam, water, acid or alkali digestion of fresh livers. Alkaline digestion appears to be the best method based on vitamin A recovery. Medicinal grades are subsequently destearinated by chilling and filtering off the congealed "stearine." The "stearine" fraction contains fatty acids other than stearic acid; therefore, it is not a true stearin.

Chemically, cod-liver oil is a typical marine animal oil. It is a mixture of glycerides of many fatty acids, of which the unsaturated fatty acids oleic acid, gadoleic acid and palmitoleic acid predominate. Since it is high in unsaturated fatty acids, it is subject to oxidation and the development of rancidity and destruction of vitamin A when exposed to air. Deficiencies of vitamins A and E have been observed in animals fed rancid cod-liver oil; this can be counteracted in some instances by feeding vitamin E.

In the 19th century cod-liver oil was a folk remedy for wasting diseases. During the period 1914–22 its medicinal value was clinically established and related to the presence of vitamin A and especially vitamin D. These vitamins comprise only a minute fraction of the oil, and the content is usually expressed in units; average oil contains 1,400 international units (I.U.) of vitamin A and 100 I.U. of vitamin D per gram (0.30 micrograms of crystalline vitamin A alcohol = 1 I.U.; 0.025 micrograms of crystalline vitamin D_3 = 1 I.U.). The vitamin potency varies considerably for different species; it increases with the age and varies inversely with the fatness of the liver.

Cod-liver oil is a specific for rickets and other disorders of calcium metabolism resulting from a lack of vitamin D. Its dietary usefulness is related to both its vitamin D and vitamin A potency, primarily in poultry feeds but also in feeds for other animals. The high content of certain unsaturated fatty acids may become an important aspect in nutrition.

Other fish oils have also been developed as vitamin sources. Halibut, rockfish, dogfish and soup-fin shark liver oils are outstanding sources of vitamin A. Halibut-liver oil has approximately ten times the potency of cod-liver oil, while the liver oils of the percomorph fishes (tunas, mackerels, swordfishes and sea basses) often contain 100 times as much vitamin A and D as cod-liver oil. These oils, and oily solutions of vitamin A, D_2 and D_3, have surpassed cod-liver oil as vitamin sources in human medication.

See H. J. Deuel, Jr., *The Lipids, Their Chemistry and Biochemistry*, vol. i (1951). (B. S. S.)

CODREANU, CORNELIU ZELEA- (1899–1938), founder of the Rumanian terrorist Iron Guard, was born at Iasi on Sept. 13, 1899, his father being of Polish-Ukrainian origin, his mother German. At Iasi university Professor A. C. Cuza inspired him with anti-Semitic ideas, and in 1923 Codreanu founded the anti-Semitic National Christian league, with avowed terrorist aims. He was arrested at Iasi in 1924 and on regaining freedom murdered the police prefect responsible. Tried in 1925 and acquitted amid popular acclaim, he went abroad. Returning to Rumania in 1927, he renamed his organization Legion of the Archangel Michael and made pilgrimages through the countryside in national costume on a white horse. In 1928 he joined his group to M. Stelescu's similar Brothers of the Cross, renaming it the Iron Guard, with himself as captain. The Guard gained five seats in parliament in 1932 but was dissolved in 1933 by the Liberal prime minister I. G. Duca, who was then assassinated by Guardists.

With the rise of Naziism, Codreanu became closely associated with Germany, parting over this issue from Stelescu, who publicly denounced the Guard and was then murdered in hospital (1936). Codreanu's party, now Everything for the Fatherland, secured about 16% of the votes in the 1937 elections but was dissolved on the establishment of King Carol's dictatorship. A. Calinescu, minister of the interior, had Codreanu imprisoned in May 1938, and on Nov. 30 Codreanu and 13 comrades were shot, according to the official version, while trying to escape in transit between two prisons. (B. Br.)

CODRINGTON, SIR EDWARD (1770–1851), British admiral, belonged to a family long settled at Dodington in Gloucestershire. He entered the navy in 1783 and was promoted lieutenant in May 1793. Lord Howe selected him to be signal lieutenant of his flagship, the "Queen Charlotte," at the battle of the Glorious First of June, 1794. He was promoted commander after the action and captain in 1795, in which capacity he commanded the "Babet" frigate in Lord Bridport's action off Lorient. Between 1797 and 1805 he was unemployed and married in 1802 Jane Hall of Kingston, Jamaica. In 1805 he was appointed to the "Orion" (74 guns) and was selected by Nelson to command the rear squadron at the battle of Trafalgar. As this did not materialize, his ship fought in Nelson's column. In 1809 he was captain of the "Blake," flagship on the Walcheren expedition. Thereafter he served on the east coast of Spain and then, in the war of 1812–14, was active in North American waters during the operations against Washington, Baltimore and New Orleans. He became rear admiral in 1814, vice-admiral in 1821 and was appointed to the command of the Mediterranean fleet of 13 sail in 1827, flying his flag in the "Asia" (84 guns). In June 1827 he sailed to the Levant to command the allied fleet which at the battle of Navarino (*q.v.*) on Oct. 20 decided the independence of Greece by the destruction of the Ottoman fleet. During the period of his command the Aegean and the Adriatic were cleared of those pirates who had long been a menace to shipping in those parts. His victory at Navarino was the culminating event of his life, but it was received with mixed feelings in London, where it was officially described as "an untoward event" since it was held that Codrington had exceeded his instructions and that the diplomatic consequences were serious and unwelcome. The lord high admiral, the duke of Clarence, defended Codrington in the protracted correspondence which ensued, but he was recalled in June 1828, shortly before the Morea was finally evacuated by the Egyptians. On his return he published a justification of his conduct and in 1831 was employed again in the channel, serving as commander in chief at Portsmouth from 1839 to 1842. He died on April 28, 1851.

He left two sons who distinguished themselves, Sir William John (1804–84) as a soldier in the Crimea and Sir Henry John (1808–77) as admiral of the fleet.

See Lady Bourchier, *Memoir of the Life of Admiral Sir Edward Codrington*, 2 vol. (1873); C. G. Pitcairn Jones (ed.), *Piracy in the Levant, 1827–28; selected from the papers of . . . Codrington*, Navy Records Society (1934). (C. C. L.)

CODRUS, in Greek legend, the last king of Athens, son of Melanthus, of the Neleid family of Pylos, who came to Athens as a refugee. It was prophesied at the time of the Dorian invasion of the Peloponnesus (11th century B.C.?) that only the death of their king at the enemy's hands could ensure victory to the Athenians. Codrus therefore made his way disguised into the enemy's camp and provoked a quarrel, in which he was killed. The Dorians, on discovering this, retreated. The Athenians thought no one worthy to succeed Codrus and abolished the title of king, substituting that of archon (another version says that his son Medon was the last king). The royal families of Ionia as well as the Medontidae, the ruling family in Athens, claimed descent from Codrus. Codrus had a shrine in Athens, together with Neleus and Basile.

CODY, WILLIAM FREDERICK (1846–1917), U.S. frontiersman and showman, known as "Buffalo Bill," was born on a farm in Scott county, Ia., on Feb. 26, 1846. He had very little schooling but before the end of his teens he had worked as horse wrangler and mounted messenger for a large western wagon-freight firm, as a luckless prospector in the Pikes peak gold rush and as a pony express rider. During the American Civil War, Cody served the Union as scout for the 9th Kansas cavalry in a campaign against Kiowa and Comanche Indians and was a U.S. army scout in Tennessee and Missouri military operations.

He married Louisa Frederici in St. Louis in 1866 and the following year became a buffalo hunter for the firm of Goddard Brothers, then under contract to provide food for Kansas Pacific railroad construction crews. It was for his great success as a hunter that Cody won his lasting nickname "Buffalo Bill." Using a .50-calibre breech-loading Springfield rifle he killed (by his own count) 4,280 buffaloes during a period of 17 months.

During 1868–72, and again in 1876, Cody resumed duties as a U.S. army scout in campaigns against the Indians. While serving George A. Custer against the Sioux and Cheyennes in 1876, Cody killed and scalped Yellow Hand, a Cheyenne chief, in a duel. In this engagement Cody felled Yellow Hand with his rifle and within seconds, in the scout's own words, "I . . . had driven the keen-edged weapon to its hilt in his heart. Jerking his war-bonnet off, I scientifically scalped him in about five seconds." A popular dime-novel press gave varying accounts of this duel which stirred the reading public.

The dime novels, especially those of Ned Buntline (pen name of E. Z. C. Judson) featuring semifictional "Buffalo Bill" exploits, gave Cody a world-wide notoriety. Cody was a superb showman and in 1872 took the leading role in a play based on his exploits. In 1883 he organized a "Wild West" exhibition—a spectacular show that was successfully staged in the United States, Great Britain and on the continent. Among the star performers in this show was Annie Oakley, famed rifle shot; for a brief period Chief Sitting Bull also toured with the troupe.

Cody made a fortune in the show business but invested his money unwisely in various speculative ventures. On Jan. 10, 1917, Cody died and was buried in a tomb blasted from solid rock on Lookout mountain, 20 mi. from Denver, Colo.

BIBLIOGRAPHY.—*The Life of Hon. William F. Cody Known as Buffalo Bill,* an autobiography, has been published in several editions. *See* also Richard J. Walsh, *The Making of Buffalo Bill: A Study in Heroics* (1928); Rupert Croft-Cooke and W. S. Meadmore, *Buffalo Bill: The Legend, the Man of Action, the Showman* (1952); Henry Blackman Sell and Victor Weybright, *Buffalo Bill and the Wild West* (1955). The last-named item is excellent pictorially.

(O. O. W.)

COEDUCATION, the education of girls in the same schools that boys also attend, is a modern phenomenon. Plato favoured a parallel education for men and women and proposed that young children play supervised educational games together, but Athenian girls were generally taught in the household by mothers and nurses and Aristotle's view that the distinctive function of females required a different education became dominant. Sparta trained boys and girls separately. In the age of Hellenism girls were segregated. In Rome coeducation probably existed for the children of the privileged classes only through the early years of primary instruction.

Coeducation was adopted earlier and more widely in the United States than in Europe, where tradition proved a greater obstacle. Many advocates of equality for girls accepted separate schools, especially at the secondary level, so long as the same subjects were taught in the same way and equal opportunities were provided for vocational and university preparation. Antagonism to coeducation in England and on the continent diminished more rapidly in higher education than in secondary. In England Girton (Cambridge) was established for girls in 1869 (*see* DAVIES, (SARAH) EMILY) and the London School of Economics was opened to women in 1874. Germany permitted women to matriculate in 1901 and by 1910 women had been admitted to the universities of Holland, Belgium, Denmark, Sweden, Switzerland, Norway, Austria-Hungary, France and Turkey.

History.—The history of coeducation is, of course, a part of the over-all story of the long struggle to achieve equal rights including equal educational opportunities for women. From the dawn of the middle ages to the late 18th century social usage in western Europe separated the education of the sexes except among a few Protestant groups after the Reformation, when Luther and other leaders urged that girls as well as boys should be taught to read the Bible. The resulting tendency toward coeducation became especially marked in Scotland and the northern parts of England and in colonial New England, where young children of both sexes attended dame schools and, in the latter half of the 18th century, girls were gradually admitted to town schools. In New Netherland, Dutch parochial schools admitted boys and girls "at least until they learned to read." In Quaker settlements boys and girls generally attended school together; the Friends in England as well as in America were pioneer proponents of coeducation as they were of universal education. German communities in North America favoured separate education for boys and girls. After the American Revolution educational reform, based on ideals of democracy, equality and freedom, challenged parochial education, and the new free public elementary, or common, schools, which supplanted church institutions in the late 18th and early 19th centuries, were almost always coeducational. By the end of the 19th century only a few larger common-school systems in cities had separate schools for girls.

At the secondary level, colonial Latin grammar schools had accepted boys only, and the earliest academies and seminaries separated the sexes. The first high schools also segregated the sexes, but the trend toward coeducation became dominant after the Civil War. By 1900 almost all public high schools were coeducational.

Collegiate education followed the same course in regard to coeducation. Oberlin (O.) college admitted women to college classes in 1837. Hillsdale (Mich.) college (founded 1844) gave its first A.B. degree to a woman in 1852. Coeducational from the beginning were Albion (Mich.) college (1850); Antioch college, Yellow Springs, O. (founded 1852), led by Horace Mann; Eureka (Ill.) college (1855); Earlham college, Richmond, Ind. (1859); and Swarthmore (Pa.) college (1864).

State universities, led by those in the middle west, followed the example of private colleges in respect to coeducation. The State University of Iowa, Iowa City, granted a bachelor's degree to a woman in 1863. At the University of Wisconsin, Madison (1850), all departments were declared open to women in 1866. The University of Michigan, Ann Arbor, was opened to women in 1870. Numerous older colleges admitted women during the 1870s; by 1880 more than 50% of U.S. colleges were coeducational, and by the end of the century the proportion exceeded 70%. Tulane, Columbia, Brown and Harvard avoided coeducation but opened affiliated women's colleges between 1887 and 1894.

Professional schools were reluctant to admit women and professional associations opposed women's practice (*see* WOMEN, LEGAL POSITION OF), but resistance crumbled in most professions in the latter half of the 19th century. The Geneva Medical school of western New York (now Hobart college) gave Elizabeth Blackwell an M.D. degree in 1849. Lemma Barkaloo entered the law school of Washington university, St. Louis, Mo., in 1869. At Oberlin, Antoinette Brown Blackwell finished the theological course in 1850, and Hartford Theological seminary was opened to women in 1889. Postgraduate schools, developing after 1876, have been open to both sexes, although few women applied for entrance before the end of the century. Johns Hopkins university, Baltimore, Md., a pioneer in graduate study, did not admit women till 1907.

Roman Catholic Position.—Coeducation was accepted very slowly in Roman Catholic colleges and universities in the United States, but by the late 1920s woman students were accorded full status in many of them. Traditional policy, while approving coeducation for young children, has opposed coeducation for adolescents. Economic and social advantages of coeducation are held to be offset by physiological, vocational and moral considerations. The attitude of the church was expressed in an encyclical of

Pius XI, *Rappresentanti in terra* (1929), Latin text, *Divini illius Magistri* (1930), which described coeducation as "founded upon naturalism and the denial of original sin." In the United States the original position of the church on the separate education of the sexes at all levels was modified somewhat, in part because great waves of immigration made it impossible for the small number of teachers to care for boys and girls in separate schools. By the second half of the 20th century nearly all Catholic parochial primary schools and 54% of Catholic high schools were coeducational.

Support and Opposition.—Supporters of coeducation in public elementary schools in the United States stress the justice it accords both sexes, its economy and convenience, its helpful effect on manners and morals and its stimulus to study. Opponents of coeducation at the elementary level have argued that girls' nature is so different from that of boys that a different kind of education is required, especially from the age of 12. The discussion of the question has been more heated at the secondary and higher levels where opponents argue that to have boys and girls in the same school damages the study habits of both and makes necessary a curriculum that fits neither sex and lowers academic standards. Some have charged that coeducation endangers the health of girls and that the enforced association of young men and women encourages too early marriages. In reply, the advocates of coeducation have claimed that young men and women work together better in later years when they have had the experience of studying together and that women have many legitimate vocational aims which can be served only through study at a coeducational institution.

The growth of coeducation in the United States has been favoured by the movement for women's rights, the rapid growth of the secondary school system, the demand for teachers who could create an educated electorate, the employment of women outside the home and in almost every occupation and profession, a phenomenal rise in the college population, the rising rate of marriage of students still in college and the pronounced preference of young men and women for coeducation.

World Survey.—*Commonwealth of Nations.*—There has never been any official policy about coeducation in England and Wales. In the public system of elementary education which grew up during the 19th century about half the schools were mixed, but this was almost exclusively for reasons of economy or numbers and in many cases it was coinstruction rather than coeducation which was practised, the girls sitting on one side of the room and the boys on the other and separating for play and other activities outside the classroom. Similarly, when the Education act of 1902 introduced a public system of secondary education, many mixed secondary schools were built, again largely for reasons of economy rather than principle. In Wales the proportion of mixed schools has always been much higher than in England, in part at least because of the sparsity of population outside the industrial areas. The general feeling was expressed in 1945 by the ministry of education, which wrote: "It is neither possible nor desirable to lay down a fixed doctrine. . . . In the fields of primary and further education, co-education is to be preferred. It is in the secondary field that the rival advantages of separation make themselves most apparent." The great majority of primary schools are mixed, but secondary schools, whether grammar, modern or technical, exist in each of the three categories: boys', girls' and mixed schools.

The English public schools have always been exclusively for boys. Most private schools and especially private boarding schools are for boys or for girls only. There are a few notable exceptions, such as Bedales, which was founded as a boys' school in 1893 but admitted girls in 1898. Another well-known coeducational boarding venture is Dartington Hall, founded by W. B. Currie. The Society of Friends maintains a sizable group of coeducational boarding schools in England.

Most of the teacher-training colleges of England had been for men or women only but after World War II the policy was to encourage mixed colleges. Other establishments for higher education in the United Kingdom are open to both sexes, although at Oxford and Cambridge women have been admitted only recently and to a limited extent.

The Scottish tradition, as indicated above, is quite different from the English; coeducation has been almost universally practised in Scotland since the 17th century, and most primary and secondary schools in Scotland are mixed. The rule is broken here and there in large cities but rarely elsewhere, except in the handful of public schools on the English model. Private schools are few in number and inconsiderable in influence.

All state-supported primary and secondary schools in Canada, as well as major higher institutions, are coeducational, except those of the Roman Catholic school system of Quebec. In Australia young boys and girls are taught separately only in the largest primary schools. Some states conduct separate high schools for each sex in the capital cities, largely for the purpose of economy, and most academic high schools are one sex. In New Zealand the public primary schools are mixed, but secondary education is given in both mixed and one-sexed schools. Higher education establishments in Australia and New Zealand are open to women without limitation.

Continental Europe.—In western Europe the Scandinavian countries are the extreme exponents of coeducation. Denmark accepted the principle in the 18th century and all its primary and secondary schools are coeducational. In Norway coeducation was adopted by law in 1896; all primary and nearly all secondary schools are coeducational, a few private schools being the only exceptions. Sweden adopted coeducation early in the 20th century and except for a few secondary schools is wholly coeducational. Finland has a rather larger proportion of segregated secondary schools.

In the Netherlands coeducation was permitted in 1871 and by 1886 had become general except in Roman Catholic districts, which still uphold segregation at the secondary stage. In Belgium, on the other hand, two-thirds of the primary schools are single-sex and there are practically no mixed intermediate or secondary schools. In France two-thirds of the 38,000 communes conduct coeducational one-teacher primary schools but larger elementary schools are usually single sex. In Spain the primary schools are mixed but the intermediate and secondary schools are not. In Portugal there are separate primary schools for boys and girls and at the secondary level sexes are taught separately in the main towns but together in the provincial ones. In Switzerland mixed elementary and secondary schools are general, although some cantons maintain separate schools at both levels. The elementary and secondary schools of Italy are coeducational. In Greece the primary and about half of the secondary schools are mixed.

Until the closing decades of the 19th century it was practically impossible for a German girl to get secondary education, and when girls' secondary schools were introduced they were of inferior status to boys'. Hitler increased this inferiority by excluding girls from *Gymnasium* courses. After World War II some *Länder* made coeducation their objective, but the tradition of segregation dies hard and in the Federal Republic of Germany the teaching of boys and girls separately has been the general tradition in primary schools, although coeducation has been the practice in small rural schools. Also, in a number of large municipalities, such as Bremen, Hamburg and West Berlin, coeducation at the primary level is now the rule. Coeducation has made little progress at the secondary level.

U.S.S.R.—In tsarist Russia boys and girls generally were taught separately, at least in cities, but with the establishment of the U.S.S.R. coeducation became the universal practice. In 1943, however, a decree of the central government called for the abolition of coeducation so that schools might "adapt themselves to the special characteristics of boys and girls." In actual practice the majority of schools continued to operate on a coeducational basis. After prolonged public discussion, in which it was claimed that discipline had deteriorated in boys' schools, that in some girls' schools pupils had been discouraged from interest in science, agriculture, economics and industry, and that segregation was estranging boys and girls, in 1954 coeducation was restored for the "uncomplicated and comradely relations between boys and

girls." In communist East Germany, Czechoslovakia, Poland and Rumania and in Yugoslavia the schools also are coeducational.

Asia and Africa.—For many centuries in the orient the belief prevailed that for a woman to assume her proper role in society—that of mother and wife—she required little in the way of schooling. Opportunity for formal education was practically nonexistent for women until about the middle of the 19th century, when Christian missionaries established schools for girls. A trend toward the joint education of the sexes in China had its beginnings in the 1920s, in the early years of the national government, when the meagre opportunities for primary education which existed were opened to boys and girls alike. Joint secondary schools for boys and girls became customary and universities were opened to women. Since the establishment of the communist regime in mainland China in 1949, coeducation has become the rule both in theory and practice at all levels.

In 1872 Japan established a nationwide system of public education and national laws provided for separate schools for the sexes. Coeducation was practised at first only in the primary grades. It was not until 1920 that government universities began to admit women students. The number of women students entering the government universities was limited because no provisions were made to allow girls to enroll in secondary schools of the college preparatory type. The curriculum for Japanese girls was different from that of boys from the third year of elementary school and girls were almost completely prevented from going beyond the primary school, although a few of them attended higher normal schools or private colleges. This attitude was greatly modified during the period of U.S. occupation after World War II when the Japanese adopted the principle of coeducation at all levels and the formerly distinct curricula of the secondary schools were merged. By 1949, 55% of the upper secondary schools were coeducational and the percentage continued to rise. Almost 200 of the private universities became coeducational by the second half of the 20th century.

Since World War II, the United Nations and the United Nations Educational, Scientific and Cultural organization (UNESCO) have provided information about coeducation for nonindustrial countries which shows that the practice of coeducation has gained wide acceptance in the nonwestern world. Except in Muslim societies, elementary schools are partly or wholly mixed almost everywhere and secondary and higher schools are generally conducted for men and women studying together.

In India, where the general practice is to maintain mixed schools for boys and girls at the elementary level and separate ones at the secondary, the second five-year plan provided that education was to be made available to 60% of the children from 6 to 11 years of age who should be educated together so far as might be feasible for the sake of economy. The 1959 "Report of the Commission on National Education" for Pakistan also proposed an expansion of educational facilities, but the equal facilities planned for girls were to be separate in both elementary and secondary schools. The ministries of such Asian nations as Cambodia, Ceylon and Vietnam report that coeducation is seldom practised in the elementary and secondary schools of their countries.

In countries of the middle east, such as Jordan, Saudi Arabia, Egypt, Iraq and Iran, there are virtually no mixed schools. Turkey, however, utilizes coeducation in all primary schools, and Israel, at all levels. The announced policy in Egypt is to encourage coeducation at the primary level.

In Africa the practice regarding coeducation varies greatly. In the former French territories, including Malagasy Republic, in Kenya and in Ghana the elementary schools are mixed. In Ethiopia and in the Republic of the Congo (former Belgian Congo) separate primary schools for boys and girls have been the rule. In Togo larger towns have mixed and the smaller ones separate schools.

In many nonindustrial nations, where coeducation has been adopted at the secondary level, the legal fact of coeducation does not mean that there is equal access to schools. In Nepal only 3% of the pupils in the secondary schools are girls. Failure to implement policies favouring coeducation in African and Asian territories is due to religious scruples, in part, and to the facts that parents are unwilling to send female children to schools taught by men, that the work of girls is needed and that boys are accorded priority. Sometimes initiation ceremonies and the custom of early marriage work against the adoption of coeducation in practice.

Latin America.—Latin-American countries are alike in rejecting coeducation at primary and secondary levels and in accepting it in higher learning institutions. Two factors have militated against coeducation at the lower levels over most of Latin America: (1) industrialization, which intensifies the need for coeducation, is relatively recent even in the most developed countries; and (2) Roman Catholic tradition, speaking broadly, is opposed to coeducation, particularly for adolescents. Peru, however, reports that 27% of its primary schools are coeducational. Costa Rica and the Dominican Republic report that whether schools are mixed depends on the size of the towns in which they are located, and in Bolivia, Brazil, Chile and Uruguay most of the rural schools are coeducational, although when circumstances permit separate schools are preferred.

See also EDUCATION, HISTORY OF.

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(C. A. EG.)

COEFFICIENT. This term was introduced into algebra by François Vieta at the close of the 16th century to denote either of the two rational factors of a monomial. Thus in the expression ab, either a or b is the coefficient of the other. In the case of a product of a constant by a variable, it is usual to call the constant factor the coefficient. Thus the numbers 2, -1, 0, and a are the coefficients of the polynomial $2x^3 - x^2 + a$.

The integer $\binom{n}{r} = \frac{n!}{r!(n-r)!}$ is the coefficient of the term $x^r y^{n-r}$ in the expansion of $(x+y)^n$ by the binomial theorem. Such integers are called binomial coefficients.

If $z=f(x,y)$, then $dz=\frac{\partial f}{\partial x}dx+\frac{\partial f}{\partial y}dy$ so that the partial derivatives $\partial f/\partial x$ and $\partial f/\partial y$ are often called differential coefficients.

In physics and mechanics, the term "coefficient" is applied to a number of constants that have to be determined experimentally. Thus if F is the force due to friction between two surfaces, and if N is the normal pressure between the surfaces, then $F=\mu N$ where μ is a constant depending on the condition and nature of the surfaces in contact, called the coefficient of friction.

A body normally expands when heated, and the change in length of a bar of unit length per degree change in temperature is a constant, called the coefficient of linear expansion of the substance.

The coefficient of pressure of a gas is the ratio of the change in pressure per degree to the pressure at the ice point, the volume remaining constant.

In the division of one polynomial by another, the method of detached coefficients may be used. When the divisor is of the form $x-c$, the method is particularly simple, and is known as synthetic division. Let it be required to divide $3x^4-8x^3-2x+5$ by $x-3$. The coefficients of the dividend are written down in order, 0's being supplied if not all powers of x are present. The first coefficient is brought down unchanged. This is multiplied by

3 and added to the next coefficient. The sum 1 is multiplied by 3 and added to the next coefficient, etc. The partial quotient is

3	−8	0	−2	5	3
	9	3	9	21	
3	1	3	7	26	

$3x^3 + x^2 + 3x + 7$ with the remainder 26. *See* ALGEBRA; POLYNOMIAL. (C. C. M.)

COEHOORN, MENNO, BARON VAN (1641–1704), Dutch soldier and military engineer distinguished as a master of siege warfare, was born at Lettinga-State, Friesland, in March 1641, the son of an infantry officer. A captain at 26, he was wounded at the capture of Maastricht by the French (June 1673). His abilities were first apparent in 1674 at the siege of Grave, when he used to great effect a new type of mortar of his own design. His first book on siege techniques, *Verhandeling over de versterckinge des vyfhoecks met alle syne buytenwerken,* appeared in 1682. The most important of his numerous works, the *Nieuwe Vestingbouw* (1685) was translated into German, French, English and Russian. Coehoorn perfected a system of fortification adapted to level ground, such as in the Netherlands. Also, he advocated a new strategy for the defense of citadels, involving the active deployment of troops instead of relying only on moats and ramparts.

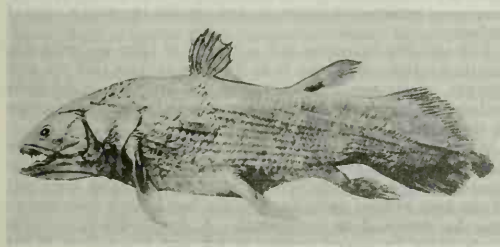
In 1689 Coehoorn greatly assisted Frederick III of Brandenburg at the capture of Bonn, and in 1690 he served as a brigadier at the unsuccessful defense of Fleurus against the French. He was next put in charge of the defense of Namur, whose fortifications he had improved. Nevertheless, in June 1692, Namur fell to the French, and only in 1695 was Coehoorn able to regain it. In this same year he was appointed lieutenant general of the infantry and engineer-general of the fortifications and, in 1697, master general of the artillery. In his new capacities he fortified Groningen, Zwolle, Nijmegen, Breda and Bergen op Zoom. Coehoorn took an active part in the early years of the War of the Spanish Succession, but died of an apoplexy at The Hague on March 17, 1704.

See G. T. van Coehoorn (Menno's son), *Het leven van Menno Baron van Coehoorn,* ed. by J. W. Sypestein (1860). (E. H. K.)

COELACANTH. Coelacanths are fish of the order Coelacanthini, members of which appeared about 350,000,000 years ago and spread over much of the world, leaving numerous fossil remains which apparently ceased 60,000,000 years ago. It was therefore startling when the first living coelacanth (*Latimeria chalumnae*) was trawled in 40 fathoms near East London, U. of S.Af., in 1938. The second was caught by a native on a line in about 40 fathoms near the Comoro Islands in Dec. 1952. This, *Malania anjouanae,* a male, lacked a first dorsal and extra tail but was probably mutilated in early life. So little was known about coelacanths that it was believed further specimens might show the two to be male and female of the same species. The sex of *Latimeria* was unknown as the soft parts were lost.

Modern coelacanths are bigger than most fossil forms. *Latimeria* was 60 in. long and weighed 127 lb., *Malania* 54 in. and 87 lb. In 1953 and 1954 five more coelacanths were captured and preserved at the Comoros, establishing this as their home.

Coelacanths are grouped in four families, three extinct and one existing, Latimeriidae. These fall in the superorder Crossopterygii (fringe-finned), the early forms of whose two related orders, Coelacanthini and Rhipidistia, lived in swamps and probably crawled out of the water at intervals. Rhipidistian descendants colonized the land (some investigators believe that these forms gave rise to the amphibians), but coelacanths remained aquatic, some probably always marine, leaving no fossil remains. Being close links with the remote past, they may shed light on earlier life.



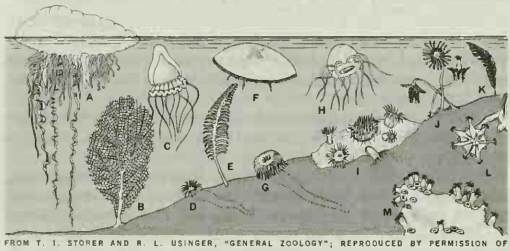
BY COURTESY OF PROFESSOR J. L. B. SMITH

COELACANTH (LATIMERIA)

Almost unchanged in form since their origin, coelacanths have characteristic limblike fins, probably still used today for crawling about in the sea. The tail is large, symmetrical and in most fossil and one recent form there is a small extra tail behind. The skeleton is mostly cartilage, but part of the skull and the basal plates of the fins in the body are bony. The powerful mouth differs from that of most fishes, lacking the "maxillary" bones in the upper jaw. The gill arches are bony, with strong teeth above. Even early coelacanths had scales overlapping like those of modern fishes, with a lateral line.

Coelacanths are robust and powerful flesh eaters, almost certainly dwellers among reefs, where they pounce on prey. The intestines are short and include a spiral valve. Inside *Malania* were the eyeballs of a fish of at least 15 lb. weight. (J. L. B. S.)

COELENTERATA, the phylum of animals that includes such forms as medusae (jellyfish), sea anemones, corals, marine hydroids, fresh-water hydras, sea fans and the Portuguese man-of-war. The name Coelenterata, derived from the Greek meaning hollow-gut, is descriptive of the general organization of the body around the hollow gut or coelenteron. Another name, Cnidaria, is also commonly used for the group, since the name Coelenterata as originally used included the sponges (Porifera) and the comb jellies (Ctenophora) as well as the animals now considered coelenterates.



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1957)

FIG. 1.—MARINE COELENTERATES IN CHARACTERISTIC HABITATS: HYDROZOA (A, H, J, K); ANTHOZOA (B, D, E, G, I, M); SCYPHOZOA (C, F, L)

(A) Portuguese man-of-war (*Physalia*); (B) sea fan (*Gorgonia*); (C) *Periphylla;* (D) sea anemone (*Edwardsia*); (E) sea pen (*Pennatula*); (F) common jellyfish (*Aurelia*); (G) *Cerianthus;* (H) *Gonionemus;* (I) sea anemone (*Epiactis*); (J) *Tubularia;* (K) *Plumularia;* (L) *Haliclystus;* (M) stony coral (*Astrangia*)

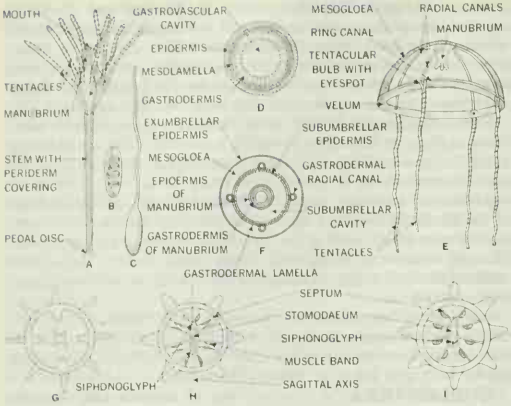
INTRODUCTION AND NATURAL HISTORY

The phylum may be defined as that group of radiate animals (Radiata) that usually bear tentacles and possess intrinsic nematocysts. They may be said to be of the tissue grade of construction and do not possess organs. The radial symmetry of this group is pronounced, although certain forms are better described as biradially or radiobilaterally symmetrical.

Two basic body forms are represented among coelenterates: the *polyp* and *medusa* (fig. 2). In size coelenterates vary from minute stalklike polyps only $\frac{1}{25}$ of an inch long to polyps having a disc three feet in diameter; and from inconspicuous jellyfish to giant forms six feet in diameter.

Polyp and Medusa.—*Polyp.*—The polyp is an upright sessile form, usually of columnar shape. It is attached at its base to the substrate, while the oral end is free and surrounded by tentacles. (*See* POLYP.)

Medusa.—The free-swimming coelenterates popularly known as jellyfish are scientifically known as medusae, the name referring to the resemblance borne by the long mobile tentacles of some of these animals to the snaky tresses of the Gorgon Medusa of Greek mythology. The umbrella-shaped body of a medusa is called the



FROM L. H. HYMAN, "THE INVERTEBRATES" (VOL. I); REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1940)

FIG. 2.—STRUCTURE OF COELENTERATES

(A) Hydroid polyp; (B) unexploded nematocyst; (C) exploded nematocyst; (D) cross section of polyp; (E) hydrozoan medusa; (F) cross section of medusa; (G) hydrozoan, or scyphozoan, medusa showing tetramerous radial symmetry; (H) anthozoan (*anemone*) showing hexamerous biradial symmetry; (I) anthozoan (alcyonarian) showing octomerous radiobilateral symmetry

bell. Hanging down inside the bell, from its midpoint, is a tubular structure, the manubrium, that carries the mouth at its free end. The tentacles of the medusa are located at the margin of the bell. (*See* JELLYFISH.)

Alternation of Generations.—One of the striking features of the Coelenterata is that within the life history of a single individual both the polyp and medusa may occur.

In many coelenterates of the classes Hydrozoa and Scyphozoa, sexual reproduction leads to the development of a larval stage (fig. 3), the planula (see *Reproduction and Development*), which later attaches and develops into a polyp. This polyp may remain single or, by asexually reproducing itself, may become colonial. The polypoid phase may be regarded as a juvenile stage, specialized to live an attached life. Later, by asexual means, the polyp buds off free-swimming medusae that become the sexually adult forms of the species. Alternation of generations, therefore, as it is used here, refers to the alternation, within the life history of a species, of an asexually reproductive stage, the polyp, with a sexually reproductive stage, the medusa.

Colonies and Polymorphism.—No colonial medusae are known, but colonies of polyps occur in all classes of Coelenterata. In all cases colony formation is the product of asexual reproduction by the polyp. Secondary individuals are formed as buds from the base or sides of existing polyps, or from the ends of stolons sent out by polyps. In most colonies the body cavities of the several constituent polyps are connected by tubular passages, so that food obtained by one individual may serve as nourishment for all.

The existence within a species of several types of individuals is cited as an example of polymorphism. Not uncommonly various polyps in a colony become specialized for some particular function. For example, in certain hydrozoan colonies one can identify polyps specialized for protection, feeding and reproduction. The medusae produced by some hydrozoan colonies can be looked upon as specializations for sexual reproduction and locomotion.

Food and Feeding.—The coelenterates are primarily carnivores that depend on stinging capsules called nematocysts (*see* below) to sting and subdue (by paralysis) prey such as marine worms, other coelenterates, larval animals of many different sorts and small fishes. However, some coelenterates, such as certain scyphozoan jellyfish and some corals, do not seem to use nematocysts for food gathering; instead, they collect minute organisms and organic debris by means of ciliary-mucous mechanisms. Small particles entrapped in mucus are carried to the mouth by ciliary currents, sometimes aided by movements of the tentacles.

Food is ingested in the following manner. The tentacles carry the food toward the mouth, and the latter in some cases rises to receive it. The mouth then opens and the oral lips grasp the food. Swallowing is accomplished by muscular action alone or by a combination of muscular and ciliary movements. Many polypoidal coelenterates can ingest prey as big as themselves, or even bigger (fig. 4).

A long argument has been carried out in the literature dealing with the nutrition and feeding of reef-forming corals and other coelenterates that possess masses of unicellular algae in their gastrodermal cells. One school of thought maintained that reef-corals are restricted to shallow, well illuminated waters that are poor in food for corals and that the algae in the animals' tissues serves as food.

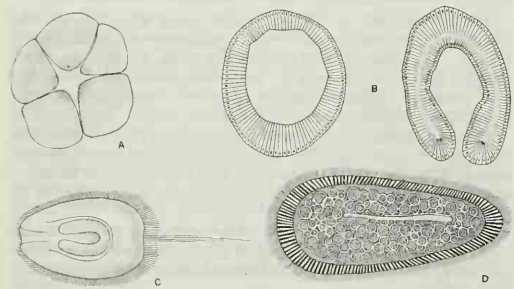
An opposing view maintained that corals feed exclusively on animal matter and that they cannot digest algal cells. In furtherance of the latter view it has also been shown that corals (with algal symbionts) that normally grow in light can grow and be kept healthy for at least six months in the dark. The argument seemed stalemated until it was shown, by using radioactive labeled carbon compounds, that the algal cells gave off, as biproducts of photosynthesis, organic substances that subsequently diffuse into the tissues of the host coelenterate. The degree to which corals or other coelenterates are actually dependent upon their algal symbionts has not yet been established.

Coelenterates and Other Animals.—Coelenterates are related to other animals in a wide variety of ways. One can generalize that coelenterates are predaceous carnivores that may be placed close to the top of ecological food chains.

Intimate associations of coelenterates with a number of animals are well known. For example, small fish are common companions of many large jellyfish and the Portuguese man-of-war. These fish find protection from possible predators among the tentacles of their hosts, and they seem not to cause discharge of the hosts' nematocysts. However, if such a fish is injured, its exposed tissue does cause nematocyst discharge, and the fish becomes a prey of its host.

Fish also live intimately with a number of large sea anemones, and their relationships seem to be the same as those that live with jellyfish. Some anemones are known that live only on the shells occupied by hermit crabs; others live only on the stalks of sponges or the branches of sea fans.

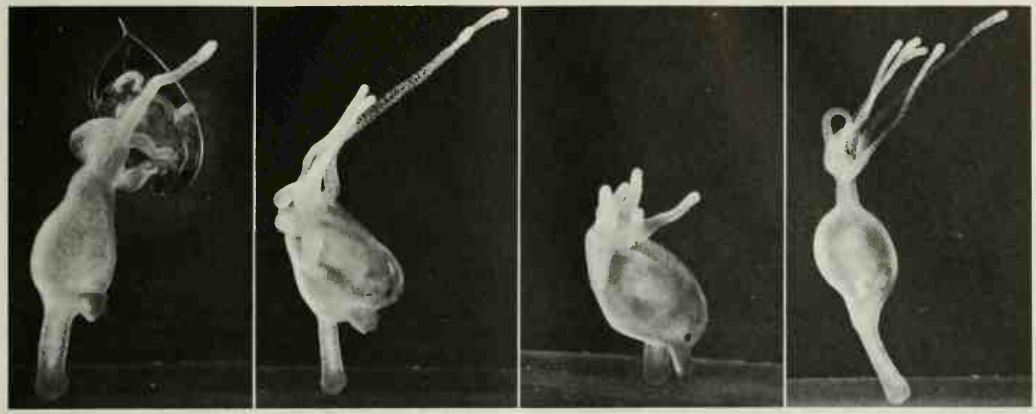
A number of hydroids are known that have close associations with such diverse hosts as fish, worms and clams. In most instances the hydroids have become adapted to living on some part of the host without doing harm to the host. Such relationships may be described as commensal. A few hydroids, such as *Hydrichthys* on several species of fish and *Polypodium* in the ovarian eggs of the sturgeon, seem to be true parasites.



AFTER CARLGREN & GEMMILL, FROM STEPHENSON, "THE BRITISH SEA ANEMONES", BY COURTESY OF THE RAY SOCIETY, WITH AN ADDITION

FIG. 3.—COELENTERATE DEVELOPMENT

(A) Section through early stage in cleavage of the egg of a sea anemone (*Metridium*); (B) later stages, (left) blastula, (right) gastrula; (C) later larva of sea anemone; (D) hydrozoan planula



CHARLES WALCOTT

FIG 4.—HYDRA INGESTING WATER FLEA (DAPHNIA)

(Left) Hydra tentacles carry the prey toward the mouth as the latter rises to receive it; (left centre) digestion begins as the prey passes down into the body cavity; (right centre) tentacles and body cavity contract as digestion proceeds; (right) digestion almost completed, the hydra extends its tentacles to await new prey

FORM AND FUNCTION

Structure of a Coelenterate.—The body of a coelenterate may be analogized to a sac with a single opening. This opening is the mouth or stomodaeum, which serves both for the ingestion of food and the egestion of undigestible substances. The mouth is surrounded at a greater or lesser distance by tentacles that are used in food gathering and in defense against other organisms. Both the food gathering and defensive qualities of these tentacles are aided by the possession of nematocysts.

The outer surfaces of the body are covered by a single tissue layer, the epidermis or ectoderm. This tissue layer possesses cells of many types (fig. 5), notably those which form nematocysts (cnidoblasts), sensory cells, nervous cells (neurons), glandular cells, undifferentiated interstitial cells and epidermal cells. Epidermal cells may possess cilia and may have their bases specialized as contractile or muscular structures.

The inner surfaces of the body are likewise covered by a single tissue layer, the gastrodermis or endoderm. Here again essentially the same cell types will be found. The gastrodermis is specialized as a digestive layer. Food material that enters the coelenteron is soon broken down to a particulate mass as a result of the action of strong protein-splitting enzymes released by the gastrodermis. The particulate material is then ingested by the cells lining the coelenteron. It is within these cells that final digestion occurs. The useful products of digestion either are diffused throughout the organism or are carried by wandering cells (amoebocytes).

The coelenteron may be a simple sac or one complexly subdivided by partitions and canal systems.

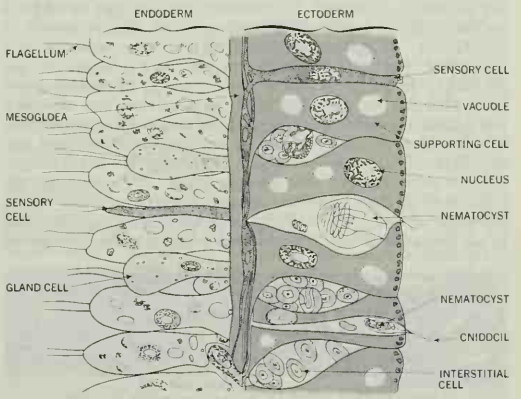
A third body layer, the mesogloea, occurs between the epidermis and gastrodermis. This layer may be so thin as to be nearly indistinguishable or very thick, with many cells and fibres as well as large quantities of a gelatinous ground substance. The mesogloea, when well developed as in jellyfish, serves as an internal elastic skeleton against which muscles may work. In many polyps, on the other hand, the thin mesogloea seems to be little more than a cementing layer between the epidermis and gastrodermis.

Muscles and Motion.—In the morphologically simplest coelenterates, such as hydrozoan polyps, there are no discrete muscles, or even muscle cells. Instead there are found in the epidermis and gastrodermis certain epithelial cells, better described as musculoepithelial cells. The muscular, basal portion of these cells is attached to the mesogloea. In the epidermis of the polyp these cells have their muscular bases arranged longitudinally, whereas, in the gastrodermis their bases are arranged transversely in a circular sheath that limits the coelenteron. Elongation is accomplished by constriction of the circular muscles, and shortening or bending by contraction of the longitudinal muscles.

In larger and more complex polyps, such as sea anemones, discrete muscle cells are not found, but special areas of the epithelium are set aside as primarily muscular in function. The longitudinal, external muscle layer is largely lost, being replaced by longitudinal muscles running along the faces of the mesenteries that subdivide the coelenteron. The mesogloea of these polyps is in general more elastic and thicker than that of smaller polyps, and the coelenteron is larger and contains more water. The contained water may be regarded as a "hydraulic skeleton" against which the muscles act. Even though special muscles are present, they are still maintained as a single layer. Space is provided for an increased number of units by a folding of the mesogloea rather than a piling up in layers of muscle cells.

In medusae the muscles are represented by epithelial cells on the concave inner or subumbrellar surface only. They are arranged in circular and radial groups, and their contractions cause the pulsing movements of the bell. These muscles act entirely against the gelatinous, much thickened elastic mesogloea. Medusae swim by forcing or jetting the subumbrellar water out of the bell. After each contraction the elasticity of the mesogloea returns the bell to the normal resting shape.

The movements of most coelenterates are restricted to extensions, contractions and bendings of the tentacles and body. Medu-



FROM KUKENTHAL, "HANDBUCH DER ZOOLOGIE" (WALTER DE GRUYTER & CO.)

FIG. 5.—LONGITUDINAL SECTION OF BODY WALL OF HYDRA (ENLARGED)

sae, as noted above, are free-swimming, and two anemones also are known to swim. Swimming in anemones, however, is restricted to writhing movements of the column and undulating and flapping movements of the oral disc and tentacles. Some hydrozoans occur as free-floating individuals or colonies. One group of colonial hydroids, the Siphonophora, have attached medusae in their colonies and use them as locomotory structures. Some polyps are capable of a limited creeping by means of the ameboid movement of cells on the attachment disc; a few move by a more rapid "somersaulting," end-for-end (fig. 6).

Skeletal Structures.—Two functionally different sorts of skeletal systems occur in coelenterates. The first type, already referred to, is of an internal nature and is either the mesogloea or the "hydraulic skeleton" described for most polyps. Of a different sort are the exoskeletons.

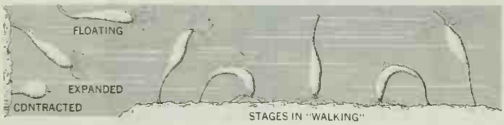
In most hydrozoan polyps, and in a few scyphozoans, there is a tubular, external, secreted sheath, more or less completely encompassing the whole individual or colony. Such skeletons are flexible enough to allow bending but rigid enough to support large colonies in an upright position. In a group of hydrozoans called hydrocorals, and in the true corals, there is an exoskeleton of limestone; the polyps live in cups on the surface of such skeletons. A few hydroids and a number of anthozoans have small calcareous spicules that aid in the support of the polyps.

Still another, and different, skeleton is found in sea fans and sea pens: an axial, tough, but flexible, skeleton upon which the fleshy colony of polyps grows. An interesting modification of the skeleton to form a float from which the colony hangs is found in such coelenterates as the hydroid *Velella* and the Portuguese man-of-war.

Perhaps the most phenomenal matter relating to skeletons is the way in which for eons the skeletons of corals have accumulated to form islands and reefs such as the atolls of the Pacific and the Great Barrier Reef of Australia. (*See* ANTHOZOA; CORAL; CORAL REEF.)

Respiration, Circulation and Excretion.—These functions generally are carried out without benefit of special structures. Respiration and excretion occur through simple diffusion, a direct exchange between the tissue and the external environment or the water contained in the coelenteron. Circulation is perhaps aided by the movements of fluids in the coelenteron due to cilia and muscular movements of the body. A few coelenterate polyps, notably some anemones, have curious systems of channels in the body wall which may aid in circulation. Medusae typically have the coelenteron divided into canals that act as distributional structures. There is no vascular system or blood in the usual sense of these words.

Nervous System.—The nervous system of coelenterates has been called primitive because in most parts of the system there are no definable nerves. Furthermore, the direction in which a nervous impulse travels is unregulated; that is, the system is unpolarized. It consists of identifiable neurons, frequently of a multipolar type (fig. 7), which are organized into one or two networks. In polyps in general there seems to be a single nerve net. Medusae, on the other hand, seem to have two networks, one related to swimming movements and one to other movements. Various sensory structures such as light-sensitive ocelli and balance organs (statocysts) are present in medusae, but not in polyps, and are richly supplied with nervous tissue. Nervelike aggregations occur as rings round the margins of some medusae. From the point of input, a stimulus usually spreads nervous impulses in all directions from its origin, and commonly the distance of spread is related to the frequency of repetition of the stimulus. Thus a single stimulus may have little or no visible effect, but a repetition of this stimulus may intensify the impulses, spreading them for some distance or even throughout the whole nervous system. This phenomenon is called facilitation.

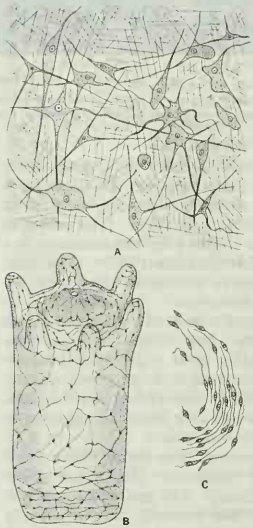


FROM G. WAGNER, "QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE 48" (1905)

FIG. 6.—HYDRA IN VARIOUS RESTING AND "WALKING" POSITIONS (ENLARGED)

In some colonial coelenterates there may be no interconnections of the nervous systems of the constituent polyps; in others there may be well-developed interconnections. The nervous system is most richly represented by a subepidermal plexus of neurons, although in some forms there is a subgastrodermal net as well. No connections of the inner and outer net, other than in the region of the stomodaeum, are known.

Nematocysts.—These minute (5–100 microns) and intracellular capsules function in food gathering, adhesion to foreign objects and protection. They are one of the main reasons for the success that the coelenterates have attained as a group. There are about 20 morphologically distinct types of nematocysts, some of which are illustrated in fig. 8. Nematocysts are formed in special cells called cnidoblasts; these nematocyst-forming cells may move some distance through the tissues before reaching their final location.



BY COURTESY OF UNIVERSITAT WIEN

FIG. 7.—COELENTERATE NERVOUS SYSTEMS

(A) Nervous tissue of an anemone, showing the epidermal ganglion-cell layer from the oral disc as seen from the inner surface of the epidermis (microscopic view); (B) nervous system of hydra (enlarged); (C) ring arrangement of epidermal nerve cells in the pedal disc of hydra (microscopic view)

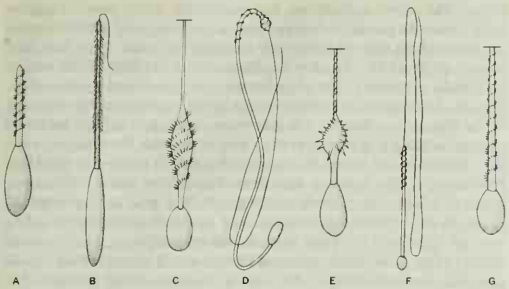
Nematocysts have double walled capsules that contain a hollow, usually spined thread. Before the nematocyst is triggered off the thread is inside out, with the spines facing the central hollow of the tube. On contact with foreign objects, the nematocyst "explodes." A lid, which is usually present, pops aside, and the contained thread everts with a twisting motion. As eversion and twisting proceeds, the spines act like a drill tip, penetrating and pulling the thread into the foreign object. Poisons, which act as paralytic agents, are contained in the nematocyst and pass outward through the hollow thread into the foreign object. There is an active uptake of water and a shrinkage of the capsule when a nematocyst explodes. The precise forces involved are not well understood. Nematocysts are not under nervous control. Experimentally, they will not explode on contact with clean, chemically inert objects. However, contact is required for explosion in the natural situation.

Some nematocysts do not possess spines and are adhesive in function, whereas other spineless types act as lassos and entangle setae and bristles of small prey (fig. 9). Once a nematocyst has exploded it soon pulls free from the surrounding cell and is discarded. Nematocysts that penetrate prey help to hold the object and also cause paralysis of the prey. After ingestion the prey may be further stung by nematocysts in the coelenteron.

The toxin in nematocysts has not been positively identified. For man a sting by a Portuguese man-of-war or many other coelenterates such as large medusae or stinging corals is very painful and may cause temporary paralysis or even anaphylactic shock and death in an extreme case.

REPRODUCTION AND DEVELOPMENT

All known coelenterates reproduce sexually at some stage in their lives. The sexes are usually found in separate individuals, and although hermaphroditism is not unknown, it is rare. Most commonly, eggs and sperm are released to the external environ-



BY COURTESY OF ROBERT WEILL

FIG. 8.—DISCHARGED NEMATOCYSTS OF ANEMONE (A, B); ANTHOMEDUSAN (C, D); COLONIAL HYDROIDS (E, F, G) (A LINE AT THE TOP OF A TUBE INDICATES THAT ONLY PART OF IT IS SHOWN)

ment, where fertilization occurs. However, in some hydroids, medusae and anthozoans fertilization occurs at the point where the eggs are produced and the developmental stages occur in the parent organism.

The details of development of an anemone to the larval stage, the *planula*, are illustrated in fig. 3. Perhaps more typically the gastrula is solid rather than hollow, and the mode of development of the gastrula from the hollow blastula is highly variable. The planula larva, with its heavy coat of cilia, is free-swimming as a rule. The planula of an animal having a polypoid phase eventually attaches by the anterior or forward-moving end. The anterior end gives rise to the base and the attachment structures of the polyp, while the posterior end gives rise to the mouth and tentacles. The planula of a medusa that has no true polypoid stage commonly will sprout tentacles at about its midpoint. Such a stage is somewhat polyplike and is known as an actinula. The posterior end of the actinula will become the manubrium, bearing the mouth, and the aboral half of the actinula will grow into the bell of the medusa.

RELATIONSHIPS AND EVOLUTION

Relationships Among Coelenterates.—Among themselves, the three classes of coelenterates—Hydrozoa, Scyphozoa and Anthozoa—seem closely related. The Hydrozoa are at once the morphologically simplest but, at the same time, the most diverse. Their simplicity suggests that they may be the ancestral coelenterates, while their diversity suggests a highly advanced group.

The Scyphozoa seem intermediate between the Hydrozoa and Anthozoa. Their medusae are like those of the Hydrozoa, whereas their internal complexity suggests affinities to the Anthozoa. Various schemes of evolution have been suggested that have placed either the Hydrozoa or Anthozoa at the stem of the group. The fossil record offers little help in resolving the question.

Evolutionary Ancestry.—The relationships of Coelenterata to other phyla of animals is not clear. Suggestions have been made that the coelenterates represent an evolution from colonial protozoans, on the one hand, and from early flatwormlike ancestors, on the other. There is very little evidence to support either of these views.

If one accepts a protozoan ancestry, one can look to the coelenterates as organisms of early metazoan vintage. Only two well-developed cell layers are present in many coelenterates; these layers may be analogized and homologized with the developing ectoderm and endoderm of more highly evolved groups. On theoretical grounds the organization of the coelenterate body can be compared to the developmental stage called gastrula.

Those people who support the theory that coelenterates are derived from early flatworms consider the somewhat obscured bilateral symmetry of the Anthozoa as a point of evidence. The claim is then made that with the development of a sessile way of life the inherent bilaterality evolved toward the radial. (As a point of interest, this same line of argument is well accepted as part of the interpretation of echinoderm ancestry from bilateral ancestral forms.) The nematocysts of coelenterates may be compared to such intracellular structures as the rhabdites of flatworms. There is no embryological evidence to support the view that either protozoans or flatworms are ancestral to coelenterates. Against the hypothesis of flatworm ancestry: the coelenterates, which possess the best developed mesogloea (possible mesoderm or third tissue layer), develop this tissue from ectodermal rather than endodermal tissue as do the flatworms.

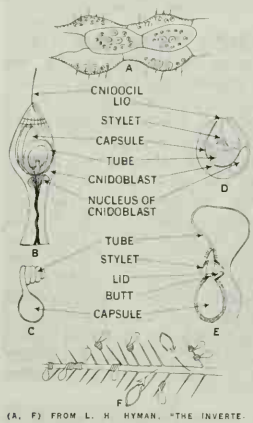
In view of the present state of knowledge of coelenterate phylogeny, it seems best not to accept any particular group as ancestral to the coelenterates and to leave to further inquiry the question of whether polyp, medusa or planula represent the ancestral coelenterate.

CLASSIFICATION

The coelenterates are divided into three major groups or classes, based in part on the complexity of the coelenteron, as follows:

Class Hydrozoa.—This group includes marine hydroids, hydromedusae (hydrozoan jellyfish), fresh-water hydras (fig. 4) and the Portuguese man-of-war. As stated earlier the Hydrozoa are morphologically the simplest of all coelenterates. They are marine organisms except for the hydras and a fresh-water jellyfish, *Craspedacusta*. The coelenteron of the Hydrozoa, a simple cavity without compartments or nematocysts, may extend into the tentacles. In the hydrozoan jellyfish the coelenteron becomes ramified into four or more canals that radiate from a central stomach. A ring canal usually courses round the margin of the bell and unites the radial canals. Hydrozoan jellyfish possess a diaphragm-like structure, the velum, which reduces the size of the subumbrellar opening. In some Hydrozoa the hydroid is the sexually mature form; in others the hydroid is only a juvenile stage, budding off jellyfish that become the sexually mature stage. Some hydrozoan jellyfish, however, have no hydroid stage. Many colonial marine hydroids are polymorphic. (*See* HYDROZOA.)

Class Scyphozoa.—These are large jellyfish common in shallow waters of all oceans and seas of the world, although one group (the Coronatae) occurs in deep waters. There are no fresh-water Scyphozoa. The coelenteron is divided into four chambers by inward projections of the body wall. Commonly there are small groups of internal (gastric) tentacles on the sides of these projections. The coelenteron possesses nematocysts. A characteristic feature of the scyphozoan jellyfish is the possession of eight (rarely four) or more complex marginal sensory structures called rhopalia. No velum is present, and the bell margin is usually scalloped. A complex system of radial canals runs from each of the stomach pouches out to the margin of the bell, where they are joined by a ring canal. The radial canals usually are much branched and commonly join one another in a network. Almost all scyphozoans are free-swimming, or at least are capable of free movement. Only one group (the Stauromedusae or Lucernariida) live as attached polyplike animals. The life history of many of the Scyphozoa involves a polypoid juvenile stage, a scyphistoma, that buds off the adult form. (*See* SCYPHOZOA.)



(A, F) FROM L. H. HYMAN, "THE INVERTEBRATES" (VOL. I), REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1940); (B) AFTER J. VON GELEI, "ZTSCHR. ZELLFORSCH MIKROS. ANAT I" (1924); (C–E) BY COURTESY OF ROBERT WEILL

FIG. 9.—NEMATOCYSTS OF HYDRA

(A) Portion of hydra tentacle showing epidermal cells with batteries containing nematocysts; (B) undischarged desmoneme in cnidoblast; (C) side view of discharged desmoneme; (D) undischarged stenotele in cnidoblast; (E) discharged stenotele; (F) tail bristle of a *Cyclops* showing desmonemes wound around hairs and two stenoteles puncturing the bristle (A, F, enlarged; B–E, greatly enlarged)

Class Anthozoa.—This group includes sea anemones, true corals, sea fans, sea feathers, sea

pansies and soft corals. They are all polypoid animals, occurring on and in the bottom in all marine habitats from shallow waters to the greatest depths. The coelenteron bears nematocysts and is compartmented into six, eight or more divisions by mesenteries arranged radially or radiobilaterally round the coelenteron. Anthozoans are generally characterized by their sessility, locomotion usually being limited to a very slow creeping by means of a pedal disc. However, one species of anemone is planktonic and at least two anemones are capable of limited, undirected, swimming movements. The great majority of anthozoans are free-swimming only during their larval stages. Many anthozoans form colonial masses composed of similar individuals budded from an original sexually produced polyp. Some colonies exhibit polymorphism among the members. Skeletons of lime characterize the corals, whereas other anthozoans, such as sea fans, produce tough but flexible proteinaceous skeletons. (*See* ANTHOZOA.)

For further information on the Coelenterata *see* JELLYFISH; POLYP; articles on various coelenterates including CORAL; PORTUGUESE MAN-OF-WAR; SEA ANEMONE, etc.; *see* also references under "Coelenterata" in the Index volume.

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COELHO, JOSÉ FRANCISCO TRINDADE (1861–1908), Portuguese writer, best known for his short stories, was born in Mogadouro in the Trás os Montes region on June 18, 1861. He entered the University of Coimbra but, unexpectedly, failed his first-year examination. Nevertheless, Coelho remained at the university, paying his way by taking private pupils and writing for various newspapers. He graduated in 1885 and then entered the government's legal service, but also continued with his journalistic work and his own writing. He retired from the legal service in 1907 and committed suicide on June 9, 1908. It is on the stories published under the title *Os Meus Amores* (1891; enlarged 3rd ed., 1901) that his fame rests. Of unequal merit, they have a rural setting, and the characters are drawn almost exclusively from a simple, primitive world. Coelho is less successful in the contriving of a satisfactory plot than in the description of natural scenery and the evocation of his own childhood experiences. Besides some writings on legal topics, he produced a volume of memoirs of his student days in Coimbra, *In Illo Tempore* (1902).

See F. Ramos, *Trindade Coelho, homem de letras* (1947); B. da Fonseca, "Trindade Coelho," in *Perspectiva da Literatura Portuguesa do Século XIX*, vol. II (1948). (N. J. L.)

COELLO, ALONSO SÁNCHEZ: *see* SÁNCHEZ COELLO, ALONSO.

COELLO, CLAUDIO (*c.* 1635–1693), Spanish painter, the last important master of the great Madrid school of the 17th century, was born at Madrid, son of Faustino Coelho, a well-known Portuguese worker in bronze. He studied under Francisco Rizi, and was dominated at first by an overcharged, exaggerated style, which was then beginning to be admired in Madrid. He then studied works in the royal collections, to which he secured access through his friendship with the court painter Juan Carreño. He also profited by his friendship with Josef Donoso, from whom he probably learned fresco painting, and with whom he co-operated in the painting of frescoes in some churches and palaces of Madrid. In 1671 he decorated the ceiling of the vestry in Toledo cathedral. In 1683 he was commissioned by the archbishop of Saragossa to paint frescoes in the cupola and the transept of the Augustine church. On his return to Madrid he became court painter to King Charles II (1684) and undertook the altarpiece for the sacristy in the Escorial, representing the "Transfer of the Holy Eucharist." The scene is represented as taking place in the same room in which the picture is hung. It is a fine arrangement of space in the baroque style containing some 50 portraits including that of Charles II. This work is his masterpiece. It is nearly allied to the art of Velázquez and Carreño, and shows strong colour and fine draftsmanship. He seems to have tried to stem the decadence that was engulfing Spanish art, and his work was greatly admired. Then Luca Giordano arrived in 1692, and, according to tradition, the preference shown by the court to the Italian painter hurt Coello and hastened his death. His last work was the "Martyrdom of St. Stephen," painted for the Dominican church at Salamanca. He died on April 20, 1693, at Madrid, and was buried in the Church of San Andrés.

His works are to be seen in the churches of Madrid and other cities of Spain, at Munich, Budapest, Frankfurt and London.

COELOM AND SEROUS MEMBRANES are the body cavity and the membranes that line it. The coelom was originally a space within the body of lower animals in which nitrogenous wastes collected before being voided. When the apparatus for filtering and discharging urinary products was combined and separated from the coelom, this cavity became a huge, fluid-filled bursa which permitted the visceral organs to move about in a nearly frictionless manner when adjusting to movements of the body as a whole. In mammalian anatomy this coelom is divided into a pericardial cavity (containing the heart), two pleural cavities (containing the lungs), a peritoneal cavity (containing the abdominal and pelvic organs) and two vaginal processes (containing the testicles). The lining of the coelomic cavities is known as the tunica serosa, or serous membrane. This layer is also reflected over any organs that protrude into the coelom and is wrapped about those parts that traverse it. In the latter instance it suspends these parts by a system of mesenteries or ligaments. The portion of the serosa that underlies and lines the body wall is called the parietal layer. Portions that serve as mesenteries and reflect over or envelop organs in or near the midplane belong to the visceral layer. In mammals the linings of the several body cavities are named the pericardium, pleurae and peritoneum.

A serous membrane is simple in structure. Its glistening surface is a single layer of flat epithelial cells that have been given the distinctive name of mesothelium. Beneath this superficial sheet of epithelium there is a layer of local connective tissue that varies in thickness regionally and harbours a cell population that is, in most regions, scanty. Among the cells represented are fibre formers, scavengers and fat storers. Still deeper, in locations where the membrane is freely movable, there is a subserous layer of fibrous (and sometimes fatty) tissue that binds the serous membrane to underlying structures. The membrane secretes the watery serous fluid which contains a variety of free cells. The amount of exudate is normally small, but it can increase enormously in diseased conditions. A mesentery results from a folding of a visceral serous membrane about the digestive tube. The greater extents of the two participating membranes fuse by their fibrous components; hence both free surfaces are covered with mesothelium. The omentum of the stomach is the most complicated and physiologically important part of the mesenterial system. In this membrane there are regions beset with innumerable perforations; in certain other areas scavenger cells accumulate along vessels, forming so-called milky spots visible to the naked eye.

Pericardium.—The pericardium is a closed sac in the chest that contains the heart. Like all the serous membranes it has a visceral and a parietal layer, the former being closely applied to the heart; to it is due the glossy appearance of a freshly removed heart. The parietal layer is reflected where the great vessels

enter and leave, and there becomes continuous with the visceral layer. Hence everywhere the two layers of the membrane are in contact except for a trace of fluid secreted by the serous walls.

Pleurae.—The pleurae, covering the lungs and lining the chest cavity, resemble the pericardium except that the fibrous outer coat of the parietal layer is not nearly so strong. It is closely attached to the inner surface of the chest walls and to the outer layer of the pericardium; above, it is thickened by a fibrous contribution from the scalene muscles and forms the dome of the pleura, which fits into the concavity of the first rib and contains the apex of the lung. The reflection of the serous pleural membrane, from the parietal to the visceral part, takes place at the root of the lung. The upper limit of the pleural cavity reaches about one-half inch above the inner third of the collarbone, while, below, it may be marked out by a line drawn from the 12th thoracic spine to the 10th rib in the midaxillary line, the 8th in the nipple line and the 6th at its junction with the breastbone.

Peritoneum.—The peritoneum is a more extensive and complicated membrane. It surrounds the organs of the abdomen and pelvis and, like the other sacs, has a parietal and visceral layer. The line of reflection of these, though continuous, is very tortuous. The peritoneum consists of a greater and lesser sac that communicate through an opening (epiploic foramen, *i.e.*, foramen of Winslow), and the best way of understanding these is to follow the reflections first in a vertical median (sagittal) section and then in a horizontal one.

If a median sagittal section is studied first, and a start made at the umbilicus (*see* fig. 1), the parietal peritoneum is seen to run upward, lining the anterior abdominal wall, and then to pass along the undersurface of the diaphragm until its posterior third is reached. Here there is a reflection onto the liver, forming the anterior layer of the coronary ligament of that organ, while the membrane now becomes visceral and envelops the front of the liver as far back as the transverse fissure on its lower surface. It continues toward the stomach, forming the anterior layer of the lesser omentum, which in this particular region is known as the hepatogastric ligament. It next covers the front of the stomach, and at the lower border runs down as the anterior layer of an apronlike fold, the great omentum, which sometimes reaches as low as the pubes. Then it turns up again as the posterior or fourth layer of the great omentum until the transverse colon is reached, the posterior surface of which it covers and is reflected, as the posterior layer of the transverse mesocolon, to the lower part of the pancreas. After this it turns down and covers the anterior surface of the third part of the duodenum until it reaches the posterior wall of the abdomen, from which it is reflected onto the small intestine as the anterior layer of the mesentery, a fold varying from 5 to 8 in. between its attachments. After surrounding the small intestine it becomes the posterior layer of the mesentery and so again reaches the posterior abdominal wall, down which it runs until it reaches the rectum. The anterior surface of the rectum is covered by peritoneum to a point about three inches from the anus, from which in the female it is reflected onto the uterus and vagina and then onto the bladder; in the male, on the other hand, the reflection is directly from the rectum to the bladder. At the apex of the bladder, after covering the upper surface of that organ, it is lifted off by the urachus and runs up the anterior abdominal wall to the umbilicus, from which the start was made. All this is the greater sac.

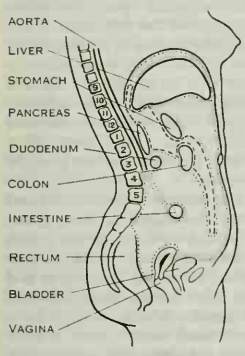


FIG 1.—VERTICAL MEDIAN SECTION OF TRUNK TO SHOW ARRANGEMENT OF THE PERITONEUM
The peritoneum is indicated by a dotted line for the greater sac and a broken line for the lesser sac

The tracing of the lesser sac may be conveniently started at the transverse fissure of the liver, whence the membrane runs down to the stomach as the posterior layer of the lesser omentum, covers the posterior surface of the stomach, passes down as the second layer of the great omentum and up again as the third layer, covers the anterior surface of the transverse colon and then reaches the pancreas as the anterior layer of the transverse mesocolon. After this it covers the front of the pancreas and in the middle line of the body runs up below the diaphragm to within an inch of the anterior layer of the coronary ligament of the liver. Here it is reflected onto the top of the caudate lobe of the liver to form the posterior layer of the coronary ligament, covers the whole caudate lobe and so reaches the transverse fissure.

This section, therefore, shows two completely closed sacs without any visible communication. In the female, however, the great sac is not absolutely closed, for the upper ends of the uterine (Fallopian) tubes open into it by their minute ostia abdominalia, while the lower ends communicate with the cavity of the uterus and so with the vagina and exterior.

A horizontal section through the upper part of the first lumbar vertebra will, if a fortunate one (*see* fig. 2), pass through the epiploic foramen and show the communication of the two sacs. A starting point may be made from the midabdominal line and the parietal peritoneum traced around the left side of the body wall until the outer edge of the left kidney is reached. Here it passes in front of the kidney and is soon reflected off onto the spleen, which it nearly surrounds. Just before it reaches the hilum of that organ where the vessels enter, it is reflected toward the front of the stomach, forming the anterior layer of the great omentum. Continuing, it soon reaches the lesser curvature of the stomach and then becomes the anterior layer of the lesser omentum, which continues until the bile duct and portal vein are reached at its right free extremity. Here it turns completely around these structures and runs to the left again, as the posterior layer of the lesser omentum, behind the stomach and then to the spleen again as the posterior layer of the great omentum. From the spleen it runs to the right once more, in front of the pancreas, until the inferior vena cava is reached. This point is just behind the portal vein and is the place where the lesser and greater sacs communicate, known as the epiploic foramen. From this opening the lesser sac runs to the left, while all the rest of the peritoneal cavity in the section is the greater sac. From the front of the vena cava the parietal peritoneum passes in front of the right kidney and around the right abdominal wall to the midabdominal line. The right part of this section is filled by the liver, which is completely surrounded by a visceral layer of peritoneum, and no reflection is usually seen at this level between it and the parietal layer. Some of the viscera, such as the kidneys and pancreas, are located behind the peritoneum. Others, such as the small intestines and transverse colon, are surrounded, except at one point where they are attached to the dorsal wall by a mesentery or mesocolon, as the reflections are called. Others again are completely surrounded, and of these the caecum is an example. Some, like the liver and bladder, have larger uncovered areas, and here the reflections of the membrane form ligaments that allow considerable freedom of movement.

Each vaginal process is the remains of a peritoneal pocket that

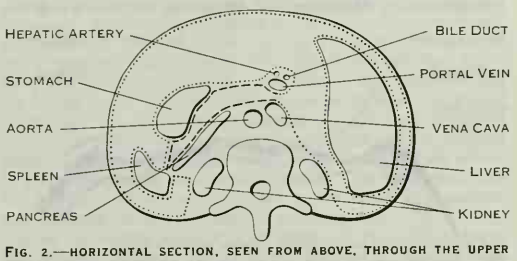


FIG. 2.—HORIZONTAL SECTION, SEEN FROM ABOVE, THROUGH THE UPPER PART OF THE FIRST LUMBAR VERTEBRA, SHOWING ARRANGEMENT OF THE PERITONEUM

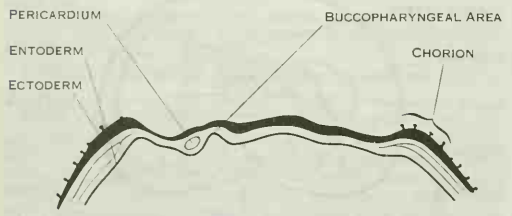
descends into the scrotum during fetal life before the testis itself descends. After the descent of the testis the upper part usually becomes obliterated, while the lower part forms a serous sac that nearly surrounds the testis. The parietal layer lines the inner wall of its own side of the scrotum.

Embryology.—The middle germ layer (mesoderm) eventually splits into two layers, the outer of which (somatic) then lines the parietal or ectodermal wall, while the inner (splanchnic) overlies the entoderm; between the two is the coelom. The pericardial area is early distinguished from the rest of the coelom since it first lies in front of the neural and buccopharyngeal area; here the mesoderm stretches right across the midline, which it does not do in front and behind. As the head of the embryo is formed the pericardium is gradually turned under, so that the dorsal side becomes the ventral and the anterior limit the posterior (*see* fig. 3 and 4).

The primitive heart lies at first in the ventral wall of the pericardium, but with the folding under it comes to lie in the dorsal wall and gradually bulges into the coelom (pericardial cavity); in doing this it draws down a fold of the membrane called the dorsal mesocardium. In mammals no ventral mesocardium exists, though in more lowly vertebrates it is present. Caudally the pericardial cavity communicates with the general cavity of the coelom, but with the growth of the Cuvierian ducts (*see* VEINS: *Embryology*) these communications disappear. Originally the mesocardium runs the whole length of the pericardium from before backward, but later on the middle part becomes obliterated.

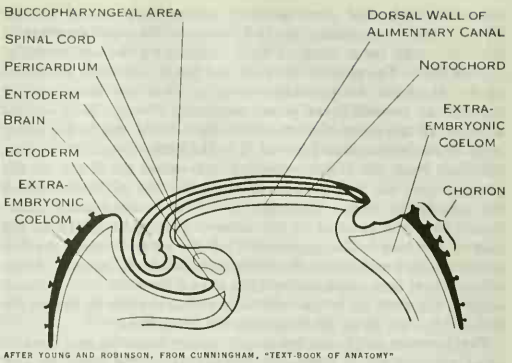
Just behind the pericardium the mesoderm forms a mass into which the developing lungs push, thereby protruding into the coelom. These spaces lose connection with the rest of the coelom, as the diaphragm develops, and become the pleural cavities. The rest of the coelom persists as the peritoneal cavity. At first the stomach and intestine form a straight tube, connected to the dorsum of the embryo by a dorsal mesentery and to the mid-ventral wall, cranial to the umbilicus, by a ventral mesentery. Into the ventral mesentery the liver grows as an outgrowth from the duodenum, so that some of the mesentery remains as the falciform ligament of the liver and some as the lesser omentum. Into the dorsal mesentery the pancreas grows, as two diverticula from the duodenum, while the spleen is developed from the mesoderm contained in the same fold. As the stomach turns over and its left side becomes ventral, the dorsal mesentery attached to it is pulled out, so that it forms the great omentum including the gastrosplenic ligament. The duodenal loop is thrown to the right, so that the right side of its mesentery becomes pressed against the dorsal wall of the abdomen and obliterated. This accounts for the fact that the pancreas and duodenum are covered by peritoneum only on their anterior surfaces in man. The formation of the lesser sac is partly due to the turning of the stomach to the right, with the result that a cave is formed behind it. Originally the whole colon had a dorsal mesocolon continuous with the mesentery, but in the region of the ascending and descending colon this usually disappears and these parts of the gut are uncovered by peritoneum posteriorly. The transverse mesocolon persists and at first is quite free from the great omentum, but later, in man, the fourth layer of the great omentum becomes continuous with the posterior layer of the transverse mesocolon.

Comparative Anatomy.—In Amphioxus the coelom is developed in the embryo as a series of bilateral pouches from the sides of the alimentary canal; these are therefore entodermal in their origin, as in *sagitta* and the Echinodermata (*see* ECHINODERMATA) among the invertebrates. In the adult the coelom is represented by two dorsal canals communicating with a ventral canal by means of branchial canals which run down the outer side of the primary gill bars. Into the dorsal canals the nephridia open. In the intestinal region the coelom is present only on the left side.



FROM CUNNINGHAM, "TEXT-BOOK OF ANATOMY" (OXFORD UNIVERSITY PRESS)

FIG. 3.—LONGITUDINAL SECTION SHOWING THE DIFFERENT AREAS OF THE BLASTOCYST IN EARLY DEVELOPMENT OF THE MAMMALIAN EMBRYO



AFTER YOUNG AND ROBINSON, FROM CUNNINGHAM, "TEXT-BOOK OF ANATOMY"

FIG. 4.—LONGITUDINAL SECTION SHOWING RELATION OF PARTS TO SEROUS MEMBRANES IN THE EARLY DEVELOPING EMBRYO OF MAMMALS

In the higher chordates (Craniata) the coelom is developed by a splitting of the mesoderm into two layers, and a pericardium is partitioned off from the general cavity. In all groups the ova burst into the coelom before making their way to the exterior, and in some—*e.g.*, Amphioxus, lamprey (Cyclostomata), eels and lungfish (Dipnoi)—the sperm cells do so too. The Cyclostomata have a pair of genital pores which lead from the coelom into the urinogenital sinus, and so to the exterior.

In the Elasmobranch fishes there is a pericardio-peritoneal canal forming a communication between these two parts of the coelom; also a large common opening for the two oviducts in the region of the liver, and two openings (abdominal pores) on the surface close to the cloacal aperture. In the Teleostomi (teleostean and ganoid fishes) abdominal pores are rare, but in most Teleostei (bony fishes) the ova pass directly down oviducts, as they do in arthropods, without entering the peritoneal cavity; there is little doubt, however, that these oviducts are originally coelomic in origin. In the Dipnoi (lungfish) abdominal pores are found, and probably serve as a passage for the sperm cells, since there are no deferent ducts.

In fishes a complete dorsal mesentery is seldom found in the adult; in many cases it only remains as a tube surrounding the vessels passing to the alimentary canal.

In the Amphibia, reptiles and birds a common cavity contains lungs and abdominal organs, and even in birds the lungs are not completely isolated from the others. In many lizards the comparatively straight intestine, with its continuous dorsal mesentery and ventral mesentery in the anterior part of the abdomen, is very like a stage in the development of the human and other mammalian embryos. In the Mammalia the diaphragm is complete (*see* DIAPHRAGM) and divides the pleuroperitoneal cavity into its two constituent parts. In the lower mammals the derivatives of the original dorsal mesentery do not undergo as much fusion and obliteration as they do in adult man; the ascending and descending mesocolon are retained, and the transverse mesocolon contracts no adhesion to the great omentum. It is common, however, to find a fenestrated arrangement of the great omentum, which shows that its layers have been completely obliterated in many places. In those animals, such as the rabbit, in which the testes are sometimes in the scrotum and sometimes in the abdomen, the communication between the peritoneal cavity and vaginal process remains throughout life. *See* also ENDOTHELIUM.

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COELOMATA, a zoological term denoting those animals that have a true coelom; *i.e.,* a membrane (peritoneum)-lined body cavity or space between the body wall and the internal organs. Animals having no such space, as the flatworms (*Platyhelminthes*), are termed Acoelomata, and those in which this space is not a true coelom are called Pseudocoelomata.

COELOSTAT, in astronomy, a mirror driven by clockwork so as to reflect continually the same region of the sky into the field of view of a fixed telescope. The mirror is mounted so as to rotate about an axis in its own plane, which points to the pole of the heavens, and is driven at the rate of one revolution in 48 (sidereal) hours. The image of a star seen in the mirror is then stationary. The device is particularly useful in eclipse expeditions when elaborate equatorial mounting of the telescopes is impossible. Other instruments for somewhat similar purposes are the heliostat and siderostat (*q.v.*).

COEN, JAN PIETERSZOON (1587–1629), fourth governor general of the Dutch East Indies, was born at Hoorn on Jan. 8, 1587. From 1601 to 1607 he was employed in Rome in the house of the Pescatori, merchants of Dutch origin. In 1607 he was sent to the East Indies as second commercial agent for the Dutch East India company and remained away four years. Sent out in 1612 at the head of a trading expedition, he became a councilor and director-general of the East Indian trade in 1613 and later president at Bantam. In Oct. 1617 he was promoted in succession to Laurens Reaal to the post of governor general, in which capacity, through his vigour and intrepidity, he laid the firm foundation of the Dutch empire in the east. In addition to contending with the declining power of the Portuguese, he was in constant conflict with English merchants fighting for a share in the spice trade. Meanwhile the native rulers sought to play off one power against the other, but Coen reduced them to submission—sometimes, as at Banda (1621), with cruelty. He took and destroyed the original city of Jakarta in 1619 and founded on its ruins the capital of the Dutch East Indies, to which he gave the name of Batavia (now Jakarta, capital of the Republic of Indonesia). Coen resigned his post in 1623 and returned to Holland, but in his absence further difficulties arose with the English, and in 1627, under pressure from the directors of the company, he returned as governor general to Batavia. In 1629 he beat off a formidable attack from the sultan of Mataram upon Batavia, but died, during a second siege, on Sept. 21.

(K. H. D. H.)

COENWULF (d. 821), Anglo-Saxon king of the Mercians from 796 to 821, succeeded King Offa's son Egfrith. He managed by 798 to suppress a revolt in Kent against Mercian supremacy and made his brother Cuthred king there, ruling the kingdom himself after Cuthred's death in 807. His harbouring of the enemies of Eardwulf of Northumbria led to an invasion of Mercia in 801. Coenwulf abolished in 802 the archbishopric established (787) in Offa's reign at Lichfield. When Kent was in revolt, he had tried to get the primacy removed from Canterbury to London, but abandoned this scheme after his recovery of Kent. He had a long quarrel with Archbishop Wulfred of Canterbury, which resulted in the latter being debarred from his functions from 817 until a reconciliation with the king in 821. Coenwulf advanced against Wales; the Mercians raided deep into north Wales in 816, and Coenwulf himself took an army into Dyfed in 818. He was at Basingwerk, Flintshire, no doubt campaigning against Wales, when he died in 821.

See F. M. Stenton, *Anglo-Saxon England,* 2nd ed. (1947); *English Historical Documents,* vol. i, ed. by D. Whitelock, pp. 168, 170, 249 ff., 788–794 (1955). (D. Wk.)

COESITE is a high-pressure modification of silicon dioxide, or silica (SiO_2), polymorphic with quartz, tridymite and cristobalite. It is named after its discoverer, Loring Coes, Jr., who first produced it in 1953. It is stable only in the region above the pressure-temperature curve between the points at 0° C. at 20 kilobars and 1,800° C. at 40 kilobars. For this reason, it would not be expected to be found as a normal mineral in the crust of the earth, for crustal rocks would have to be buried to depths of approximately 100 km. (over 60 mi.) to attain the necessary pressure. In 1960, however, coesite was found in nature as an abundant mineral in the Coconino sandstone of the floor of Meteor crater, near Winslow, Ariz. It is apparent that the coesite was formed from quartz under the elevated temperature and high-pressure conditions induced by the impact of the large meteorite that produced the crater. Since this discovery, coesite has also been found associated with the Rieskessel caldera in Bavaria, a depression that is 13 by 15 mi. across at its bottom, and in several other similar occurrences. The impact origin of these craters thus appears highly probable.

Reported measurements of the specific gravity range between 2.93 and 3.01. It is monoclinic, with $\alpha = 1.593$, $\gamma = 1.597$ and near 8 in hardness. Unlike the other forms of SiO_2, it is insoluble in 5% hydrofluoric acid at room temperature.

See also Silica. (J. R. Go.)

COEUR, JACQUES (*c.* 1395–1456), French trader and businessman, who became immensely rich and correspondingly powerful, was born at Bourges, a town of drapers and merchants, where his father was a skinner. About 1429 he formed a commercial partnership with two brothers named Godart; but he was compromised by a fraudulent speculation in coinage, in the contracting for which he had taken a share. In 1432 he initiated himself into the Levant trade, sailing from Narbonne on a ship belonging to merchants of Montpellier; Bertrandon de la Broquière, equerry of Philip the Good, duke of Burgundy, met him at Damascus. After his return he quickly rose to prominence. He was master of the mint in Paris in 1436 and *argentier du roi* (steward of the royal expenditure and banker of the court) three years later. He became a member of the king's council (1442), then commissioner to the estates of Languedoc (1441–51) and inspector general of taxes (*visiteur général des gabelles*) for Languedoc (1447). He inspired the *ordonnances* issued between 1435 and 1451 to withdraw the money that had been stamped with rival French and English superscriptions during the war. Charles VII entrusted him with diplomatic missions: in 1447, Jean de Villages, his nephew, obtained from the sultan of Egypt certain privileges for French merchants and also the right to consular representation; and Jacques Coeur himself managed to maintain good relations with Genoa and won the favour of Pope Nicholas V by his zeal to promote the abdication of the antipope Felix V. In 1449 he lent the king the money necessary for the recovery of Normandy and entered Rouen with him appareled no less magnificently than he. He was then at the height of his glory. Ennobled in 1441, he managed the marriage of his daughter with a nobleman, got his brother made bishop of Luçon and saw his son archbishop of Bourges. He possessed about 40 manors and built a palace at Bourges which remains one of the finest monuments of Gothic domestic architecture in France.

Jacques Coeur's businesses were various but connected. Their basis was Levantine trade; the pope had authorized him to trade with the infidels. At Montpellier, the heart of his activity, he built a house to which were delivered the spices brought by his seven galleys in exchange for scarlet cloth sold to the Levantines. All the chief cities of western Europe supplied and consumed his wares. At Barcelona, Avignon, Lyons, Paris, Limoges, Rouen and Bruges, he had his factors; at Tours was the warehouse of the "Argenterie"; and the end of the Hundred Years' War facilitated relations with England and Scotland. He competed with the Italian ports. At the end of his career he used the port of Marseilles. To sustain his enterprises, Jacques Coeur acquired much land and property, used his connections and his political position and received gratifications from the towns and the estates of Languedoc, whose interests he defended. The silver necessary for trading in Levant was provided by the mines of Beaujolais and the Lyonnais that the king had granted to him.

Other merchants, however, were jealous of his quick progress. His debtors, numerous at the court, resolved to disgrace him. He was accused of having poisoned Agnès Sorel, the king's mistress

who had died in 1450; and he was charged with speculation and extortion. Arrested in July 1451 and confined for two years, he was condemned to do public penance for his fault and to remain a prisoner until he should have paid a very heavy sum; and all his possessions were confiscated. He would have remained a prisoner if Jean de Villages had not arranged his escape to Beaucaire and thence to Marseilles, Nice, Pisa and Rome, where the pope received him in 1455. On Nov. 25, 1456, he died at Chios, whither he had gone in command of the fleet sent by Pope Calixtus III to relieve Rhodes. Louis XI, in reaction against his father, considered Jacques Coeur's rehabilitation, returned some of his property to his family and, by taking his agents into his service, revived the enterprises that he had initiated.

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(MI. M.)

COEUR D'ALENE, a tribe of American Indians whose territory included the forested and partially mountainous area around Coeur d'Alene lake, Ida., and the open grasslands of immediately adjacent Washington. They spoke a Salishan language and belonged culturally to the Plateau. Adjoining tribes were: west, the Spokane; north, the Kalispel; east, the Flathead; south, the Nez Percé. All were culturally akin to the Coeur d'Alene and all were Salishan except the Sahaptin-speaking Nez Percé. However, the Coeur d'Alene were clearly distinguished from their neighbours in dialect and in many specialized aspects of their cultural life.

The general Plateau principles of democracy in political organization and of devotion to the guardian spirit in religion were strongly exemplified. They lived peacefully with all their neighbours. Occasional small-scale raids occurred, but no warfare had taken place from time immemorial.

The origin of the French name for the tribe is uncertain. In the early literature English translations were sometimes used, such as "pointed hearts" or "awl hearts." The untranslatable native name has been commonly rendered as "Skitswish." The form used by the explorers Lewis and Clark was "Skeet-so-mish."

These explorers did not visit the tribe but, on information obtained from the Nez Percé, accurately mapped their location and estimated the population at 2,000. By 1873, when a reservation was established by executive order, the population had dropped to well under 1,000. No treaty was ever made with these Indians, but the loss of the bulk of their tribal lands was recognized in 1887 in an agreement with the United States. In 1955 the U.S. Indian Claims commission affirmed aboriginal Indian title to the lands claimed by the survivors of the tribe. The precise number of survivors is uncertain, but the Indians living on the Coeur d'Alene reservation in 1950 officially numbered 630. (V. F. R.)

COFFEE, a beverage made from the roasted seeds (beans) of the coffee plant, a tropical evergreen shrub or small tree of the genus *Coffea* of the family Rubiaceae (*q.v.*). Coffee is consumed, as either a hot or cold drink, by about one-third of the world's population in an amount believed larger than that for any other beverage. In the early 1960s, the U.S. was consuming about 50% and Brazil was producing about 50% of the world's coffee crop.

The popularity of coffee can be attributed at least in part to its invigorating effect. This effect is produced by caffeine, an alkaloid that is present in ground coffee in amounts between 0.75 and 1.5% by weight. In this amount, caffeine functions as a stimulant and diuretic through its actions on the central nervous system, heart, blood vessels and kidneys. Because these effects generally are beneficial, coffee or caffeine may be prescribed in the treatment of heart disease, dropsy, migraine, chronic asthma and barbiturate poisoning. Excessive amounts of coffee or caffeine may produce excessive gastric acidity, nervousness and heightened cardiac action, but fatal results from overdoses of coffee or caffeine have never been reported in humans, although lethal overdoses can be demonstrated in laboratory animals.

History.—Coffee probably derives its name from the Arabic *qahwah,* although some etymologists connect it with the name Kaffa (*q.v.*), a province in southwest Ethiopa (*Abyssinia*) reputed to be the birthplace of coffee. Coffee plants that are believed to have been growing wild in Kaffa were taken to southern Arabia and placed under cultivation there about 500 years ago. The original name is reflected by the words adopted for coffee in various languages; for example: Chinese, *kai-fey*; Danish and Swedish, *kaffe*; Dutch, *koffie*; Finnish, *kahvi*; French, Spanish and Portuguese, *café*; German, *Kaffee*; Greek, *kaféo*; Hungarian, *kavé*; Italian, *caffè*; Japanese, *kéhi*; Latin (scientific), *coffea*; Persian, *qéhvé*; Polish, *kawa*; Rumanian, *cafea*; Russian, *kophe*; Turkish, *kahveh.*

The history of coffee, although vague and obscure, is rich in legend. One of the tales surrounding the discovery of coffee is that of Kaldi, a goatherd. Bewildered by the queer antics of his flock, Kaldi is supposed (about A.D. 850) to have eaten berries of the evergreen bush on which the goats were feeding and, overjoyed at the feeling of exhilaration that he experienced, has been pictured as dashing off in excitement to proclaim his great find to the world.

The stimulating effect of coffee was soon discovered and taken advantage of in connection with the long religious service of the Muslims, but the strictly orthodox or conservative section of the priesthood claimed that it was an intoxicating beverage and, therefore, prohibited by the Koran. Severe penalties were threatened those disposed to its use. Nevertheless, coffee drinking spread rapidly among Arabian Muslims, and its growth and use became general in Arabia.

The early record of coffee in Europe, where it was introduced into one country after another during the 16th and 17th centuries, is filled with accounts of its use as a religious, political and medical potion, its rises and falls in favour, and its prohibition or approval. Coffee gained its first real popularity as a beverage in the coffeehouses of London, which became centres of political, social, literary and eventually business influence (*see* LLOYD'S). The first London coffeehouse was established in (or about) 1652 "at St. Michael's Alley in Cornhill" by one Pasqua Rosée and a "quarreling partner" named Bowman, from whom Rosée soon parted.

In the first-known coffee advertisement, a handbill produced in 1652 (original in the British museum), Rosée proclaimed that coffee "quickens the spirits, and makes the heart lightsome . . . is good against sore eyes . . . excellent to prevent and cure the dropsy, gout, and scurvy . . . neither laxative nor restringent."

Continental Europe, too, became well implanted with the idea of coffee, and the coffeehouse flourished in most of these countries later in the 17th century. In the major cities of North America (Boston, New York and Philadelphia), coffeehouses also became popular, starting about 1689. The first licence to sell coffee in the United States was issued to a Dorothy Jones of Boston in 1670. The Merchants' Coffeehouse, established in New York in 1737, is claimed by some authorities to have been the "birthplace of the American Union."

Until the close of the 17th century, the world's rather limited supply of coffee was obtained almost entirely from the province of Yemen in southern Arabia. But, with the increasing popularity of the beverage, the propagation of the plant spread rapidly from southern Arabia to Ceylon (1658), to Java and other islands of the Netherlands Indies starting about 1696, Haiti and Santo Domingo in 1715, Dutch Guiana (Surinam) in 1718, Martinique in 1723, Brazil 1727, Jamaica 1730, Cuba 1748, Puerto Rico 1755, Costa Rica 1779, Venezuela 1784, Mexico 1790, Colombia late 18th century, El Salvador 1840. Coffee cultivation was started in the Hawaiian Islands (Kona district, island of Hawaii) in 1825.

One of the most dramatic stories that explain how coffee was brought to the new world is that of Gabriel Mathieu de Clieu, a

Flowers of coffee tree

Coffee cherries. Each cherry contains two beans

Young trees growing on a Kenya plantation. The taller trees are used to provide shade for the coffee plants while they are small

Open plantation in South America. Seedlings have been transplanted in wide rows to allow for future growth

Harvesting coffee cherries in Angola. Picking is selective and must be done by hand

Picking wild coffee in Ethiopia. Kaffa, Ethiopia, is considered the birthplace of coffee, and its name in various spellings is used for the beverage in most languages

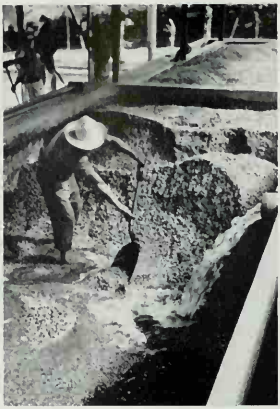
Shaded nursery for the cultivation of seedlings at São Paulo, Brazil

COFFEE GROWING, CULTIVATION AND HARVESTING

BY COURTESY OF (TOP LEFT, BELOW) PAN-AMERICAN COFFEE BUREAU, (TOP RIGHT) MINISTRY OF INFORMATION, NAIROBI, (CENTRE RIGHT) SERVIÇOS DE ECONOMIA, ANGOLA, (BOTTOM LEFT) UNITED NATIONS; PHOTOGRAPHS, (TOP LEFT, ABOVE) RADIO TIMES HULTON PICTURE LIBRARY, (CENTRE LEFT) ZYGMUNT HAAR FROM BLACK STAR, (BOTTOM RIGHT) H. ARMSTRONG ROBERTS

COFFEE

Washing and pulping coffee cherries at a small coffee co-operative on the Kenya-Tanganyika border



Shoveling husked beans into fermentation vats at a plantation in Costa Rica

Moving the beans from storage vats along canals to concrete beds where the beans are placed in the sun to dry (Costa Rica)

Raking the beans on a drying platform. The beans must be turned regularly to insure even drying (Brazil)

Drying by placing the beans in mesh-bottom flats so that air can circulate over top and bottom of beans (Kenya)

Drying by mechanical means. Warm air is circulated through rotating, perforated drums (Jamaica)

Hand sorting of dried beans before they are packed in bags for shipment

PREPARATION OF COFFEE FOR SHIPMENT

BY COURTESY OF (BOTTOM LEFT) BRAZILIAN MINISTRY OF FOREIGN AFFAIRS, (CENTRE RIGHT, TOP) MINISTRY OF INFORMATION, NAIROBI, (CENTRE RIGHT, MIDDLE) THE COMMISSION IN THE UNITED KINGDOM FOR THE WEST INDIES, BRITISH GUIANA AND BRITISH HONDURAS, (CENTRE RIGHT, BOTTOM) HILLS BROS. COFFEE, INC., PHOTOGRAPHS, (TOP LEFT) HASSNER FROM BLACK STAR, (TOP CENTRE, TOP RIGHT) MAX HUNN

young French naval officer assigned as captain of infantry at Martinique. In 1723 (some authorities set the date as 1720), De Clieu, while on a visit to France, heard that the Dutch had succeeded in transplanting coffee from Arabia to the East Indies; he became determined to carry the cultivation to Martinique, where the climate resembled that of the East Indies. The few coffee plants then being cultivated in Paris were guarded in the royal hothouse of Louis XV. De Clieu obtained one (some writers say two or three) of the precious plants. During his return trip across the Atlantic, De Clieu recorded that for more than a month he was obliged to share his scanty ration of water with his tiny coffee plant (he refers to only one) "upon which my happiest hopes were founded and which was the source of my delight." De Clieu's little tree was finally planted in Martinique and carefully nursed to its first harvest of coffee cherries, from whose seeds a big majority of the coffee plants in the Americas are said to be descended. By 1777, three years after the death of De Clieu, there were nearly 19,000,000 coffee trees in Martinique.

By the 20th century, coffee had become responsible for much of the income of many countries lying between the Tropic of Capricorn and the Tropic of Cancer. Although practically every country within this area produces some coffee, the greatest concentration of production became centred in the western hemisphere.

Botany of Coffee.—The genus *Coffea*, to which the common coffee tree belongs, contains 25 or more species, most of which grow wild in the tropics of the old world.

Of the various species, *Coffea arabica* accounts for the bulk of world production. Other species grown commercially are *C. robusta* and *C. liberica*, although production of the latter is very limited in quantity. *C. stenophylla* is not known to have been produced commercially.

The common Arabian coffee shrub (*C. arabica*) is an evergreen plant that under natural conditions may grow to a height of 30 ft. or more. But for commercial purposes, particularly in countries where the coffee cherries are picked by hand, the trees are usually topped to keep heights under 15 ft. so as to make harvesting easier. Leaves of the coffee tree resemble laurel in form (elliptic, 4 to 6 in. in length, 1½ to 2½ in. wide) and have a deep rich-green colour and a glossy surface. The white flowers of the coffee tree, which are produced in dense clusters in the axils of the leaves, have a five-toothed calyx, a tubular five-part corolla, five stamens and a single bifid style. Coffee trees in blossom are things of beauty, but the flowers last only a few days. The flowers are replaced by clusters of green cherries that advance in colour through various shades of green and golden brown until fully ripe, when they are bright red and are similar in shape to ordinary fruit cherries, although somewhat less plump and slightly elongated.

The red outside covering of the coffee cherry is a thick pulpy skin. Under the skin is a layer of yellowish jellylike substance that completely surrounds the two beans or berries, which lie with their flat faces together like the two halves of a peanut. Each bean (also called seed or berry) is enclosed in a membranous endocarp, commonly called the "parchment," which is brittle when dried. Inside the endocarp and completely surrounding each individual coffee bean is a delicate spermoderm (seed skin) commercially called the "silver skin." Malformation frequently produces a single bean called a "pea-berry" that is completely circular and not flat on one side. The coffee bean (seed) is blue-green in colour and has a tough, hard texture.

Cultivation and Processing of Green Coffee.—Primitive methods were used in the production of coffee for many years, but by the 20th century the large commercial producers were using intensive cultivation and mechanical processing methods.

Growth Enemies.—The coffee tree is susceptible to damage by insect pests and plant diseases. The Ceylon coffee-leaf disease (*Hemileia vastatrix*), a fungoid growth that appeared in Ceylon in 1869 and spread to almost every coffee-producing country, is at least partially to blame for having once destroyed the coffee industry of the old world. The *Stephanodores* (coffee-bean borer, referred to in Brazil as the "coffee plague" or *broca*), coffee "leaf-miner," Mediterranean fruit fly and various forms of root disease are other common pests. They are kept under control by rigorous and continuous use of insecticides. Research laboratories and technical stations have been established in the larger producing countries to further the science of coffeegrowing by increasing the yield per tree, creating new and improved techniques for fighting leaf rust and other forms of infestation and attempting to develop a frost-resistant coffee tree.

Cultivation.—Cultivation of the coffee plant for several hundred years has brought about considerable variations in local types. The colour of coffee beans after harvesting and processing may differ considerably as to shade, and variations in size and shape of the beans make it possible to differentiate commercial types by appearance, although these characteristics are not always indicative of quality "in the cup." In general, it may be said that the greatest differences in the drinking quality of coffee are produced by altitude—the higher the altitude, up to the limit of cultivability, the milder the product. This mildness is believed to be produced by aromatic substances that also contribute to the pleasurable aroma and taste of the beverage.

Coffee is grown under varying weather conditions at altitudes from 1,500 to 6,000 ft., but it is more or less generally conceded that the finest coffees usually come from the higher elevations—3,000 to 6,000 ft. Coffee requires a warm and humid climate, preferably with the sun on the plant only part of the day, which explains why hilly or mountainous countries are preferred for planting trees. The most desirable temperature averages 65° to 75° F. the year around, although coffee grows well in some places where greater variations occur (over 80° or under 60° F.). It should be noted that in tropical countries elevations of 6,000 ft. and above are not accompanied by the extreme low temperatures found at such elevations outside the tropics, although frost-producing temperatures have been recorded in some coffee countries at infrequent intervals and have caused serious damage to the coffee crop.

Coffee trees are planted according to precise plans for spacing but become so dense after a few years that they almost appear to be growing wild. Trees have to be pruned closely to create passageways and permit access at time of picking. The coffee tree begins to produce a small number of cherries when it is three years old but usually does not come into full bearing until its fifth year. A tree may continue to yield profitably for 50 to 60 years, although 25 to 30 years is average, and many growers prefer to replace trees after 12 to 15 years in order to maintain quality and high yield.

The steps involved in the cultivation of coffee differ somewhat from country to country and from locality to locality, but the over-all procedure is generally as follows: coffee trees are propagated either from seeds or from slips. In the latter case, the lower branches of the tree are bent down and the ends are buried in the earth. After about four months, roots form and the new growth starts.

Seeds are usually propagated in carefully prepared nursery beds that are shaded to protect the tender shoots from too much sun as they come through the ground. When seedlings are four to six months old they are transplanted to allow room for development. At about 18 months, when the plants are approximately 20 in. high, they are transplanted for the last time to whatever permanent planting spot has been selected. As the coffee trees continue to grow and begin to reach maturity they require more and more sunshine for proper development and ripening of the cherries; for this reason, the shade trees among which the coffee trees are planted must be pruned frequently.

In some producing countries, coffee cherries are allowed to ripen to a point where they shrivel and begin to dry on the trees and are then shaken off onto large sheets of canvas. The higher grades of coffee, however, are picked by hand when the cherries are at the desired stage of ripeness. Trees are not stripped. Only the ripe cherries are removed, and it takes several pickings before a crop is completely harvested. In some countries the harvesting is entirely seasonal, while in others it is almost a year-round process, several crops being produced each year. Under good

conditions, a fair day's pick per person is from 100 to 125 lb. of coffee cherries. It takes about 5 lb. of cherries to make 1 lb. of green coffee beans, so, in terms of usable coffee, it might be said that a picker's capacity is from 25 to 30 lb. a day. On the average, a coffee tree will produce from 1½ to 2 lb. of green coffee beans a season; thus a plantation must be of rather extensive size to produce tonnage of any great consequence.

Processing.—Coffee may be prepared by either a "dry" or a "wash" process. In the "dry" process, sometimes called the "unwashed" or "natural" process, the coffee cherries are thoroughly rinsed in water and then spread out on cement patios in the open air and sun to dry. After drying, the coffee is repeatedly run through fanning and hulling machines to remove the hulls, dried pulp and parchment, and then is subjected to further cleaning by machines that remove portions of the silver skin.

The "wash" process is quite different. The cherries are first put through a pulping machine that breaks them open and virtually squeezes the beans out of the pulpy skin. Then the beans go into large tanks where they are left for about 24 hours. Slight fermentation takes place in the jellylike substance, which the coffee grower calls "honey." This fermentation loosens the honey so it can be removed easily by thorough washing back and forth through several hundred feet of washing canals. After washing, the coffee is spread out in patios to dry. It takes two to three weeks in the sun for the coffee to become thoroughly dried, and during this time it must be continuously turned over so that every bean will be dried. When climatic conditions do not permit drying in the sun, drying machines are employed. Warm air is circulated through the coffee as it revolves in a large perforated drum. When the desired stage of drying has been reached, the coffee beans are put through hulling and polishing machines that crack and remove the brittle parchment and silver skin.

In the case of the highest quality coffees, there is then a careful hand inspection to remove imperfect beans, which is the final step before packing the coffee in bags for shipment to the coffee ports of the world. (In Brazil, coffee is sacked in 60-kg. bags—132.276 lb. In other countries, the shipping unit may vary from about 150 to 165 lb., and in a few instances may run as high as 200 lb. However, the 60-kg. bag is the accepted statistical unit is almost all computations of world production, exports or imports that are expressed in terms of "bags.")

Tasting and Blending.—In European countries, where coffee has been sold to a great extent in the whole bean, importers used to make their purchases largely on the basis of the size, colour and other physical characteristics of the bean, although after 1946 this practice became less general. In the U.S., a more selective manner of purchasing was established; coffees are bought primarily on the basis of cup tests for taste and quality. Persons who work as coffee testers must train for years before becoming proficient. Most testers start training at an early age and continue studying almost without interruption, for they must depend entirely upon taste and smell; they devote great attention to the development of those senses. Coffee defies all known chemical tests for evaluation of quality and can be evaluated only by the senses of taste and smell.

Varieties of Coffee.—Coffees grown in the various countries differ by types and kind, as well as by grades. In fact, coffees from different plantations in one producing section nearly always show a variety of characteristics. In the parlance of the trade, the terms "Brazils," "milds" and "robustas" are used to describe the three major types of coffee. Brazils apply generally to coffees grown in Brazil. All those grown elsewhere in Central and South America, and most of those grown in Asia and Oceania, are called milds. Most of the Brazils and milds are produced by the *C. arabica* species of tree. The *C. robusta* species, which produces robusta coffee, is a native of the Congo and is more resistant to disease than is *C. arabica*; however, the beverage produced by *C. robusta* is regarded as inferior to *C. arabica*. Much of the increase in coffee production that took place in Africa during and after the late 1940s was produced by plantings of *C. robusta* trees; by the early 1960s the production of *C. robusta* in Africa was four times that of *C. arabica*.

Broadly speaking, the mild coffees are regarded as superior in characteristics to Brazils, although this is not a strictly true differentiation, for a great deal of the product of Brazil is of finer quality than some of the coffees that come from "mild"-producing countries. This is also true with African growths. The mild coffees from British East Africa and some parts of the Congo compare with the best.

Coffee also is described according to characteristics referred to by growers and buyers as hardness or softness, washed or unwashed, high-grown, naturals, etc. The task of the coffee tester is to combine these characteristics, which are obtained from many different lots of coffee, in a way that produces a satisfactory blend.

Roasting.—Until coffee is roasted it has none of the flavour or taste generally associated with coffee. Roasting creates the brown colour and transforms the natural chemical constituents into others that give coffee its splendid aromatic qualities and pleasing taste. Full development of the flavour depends to a great degree on the avoidance of underroasting or overroasting. Skill and experience are required to avoid the slight variations that might yield an undesirable result. Green coffee loses about 16% of its weight in the roasting process. Therefore, approximately 1.19 lb. of green coffee is required to produce 1 lb. of roasted coffee; and 1 lb. of green coffee is equivalent to .84 lb. of roasted coffee.

Grinding.—Coffees packaged in ground form by the manufacturer go through the grinding process immediately after roasting. In most modern roasting plants, the grinding is accomplished by feeding the coffee through steel rollers that first crack it and then cut it to the desired degree of fineness. Some coffees are left in the whole bean to be ground in the grocery store at time of purchase, or in some cases ground in the home.

Ideas with respect to granulation vary. Some roasters offer their product in several different degrees of grind, each identified as being especially suited for certain types of coffee-brewing devices. Others produce what is referred to as an "all-purpose grind," composed of certain proportions of coarse, medium and fine particles intended to permit proper extraction of the taste and strength elements so that the beverage will be balanced in aroma, flavour and strength no matter what method of preparation is used.

Early in 1948 the national bureau of standards of the United States department of commerce, in co-operation with the National Coffee association of the U.S., issued a Simplified Practice recommendation stipulating three degrees of fineness for standard grinds of coffee (with reasonable tolerances) identified as regular grind, drip grind and fine grind. Adherence to these standards is not mandatory, but they have been followed fairly generally by U.S. roasters who market their product in more than one grind. Regardless of the type of grind, uniformity of granulation is important and various methods of checking, principally with wire screen sieves and sieve shakers, are used to make sure that the proportions of the various-sized grains run uniformly throughout all production.

Packaging.—Generally speaking, roasted coffee is sold in bulk, in paper packages or in rigid containers that are either vacuum-packed or pressure-packed. Bulk coffee, distributed through retail outlets in sacks or wooden drums (like the old cracker barrel), is weighed out to the purchaser; this type of marketing had almost disappeared in the United States by the early 1960s. Coffee sold in special types of paper bags or cartons is usually packaged by the manufacturer and distributed over reasonably small geographic areas from central roasting points. Most roasters operating over large areas (and this is particularly true in the United States) pack coffee by the vacuum process either in metal cans or in glass jars. This is done immediately after roasting and grinding.

Ground coffee begins to lose freshness when exposed to the air because of oxidation of the chemical ingredients that provide the flavour and aroma. The vacuum-packing process, first applied to the packaging of coffee in 1900 by a firm in San Francisco, Calif., protects the quality of coffee over a long period of time and enables the manufacturer to preserve the flavour and freshness of coffee

ground in his plant immediately after roasting. After the can or jar is filled with ground coffee, the air is withdrawn from the container, which is then hermetically sealed, thereby preventing the entrance of air until the container is opened. The same result is achieved by pressure packing, the main difference being the introduction of an inert gas into the can after the air is withdrawn and before the can is sealed. By the early 1960s, approximately two-thirds of all the home-consumed ground coffee in the United States was vacuum-packed, mostly in metal cans.

Soluble Coffee.—Soluble coffee is a powdered or liquid form of brewed coffee concentrate to which water is added to produce the beverage. There are three types of soluble coffee: (1) dried or dehydrated; (2) liquid extract; (3) frozen concentrate. Liquid coffee extract (packaged either in jars, cans or pressurized aerosol dispensers) had not, by the early 1960s, proved very practical or successful, largely because it required refrigeration during distribution and exhibited a tendency to deteriorate. Frozen concentrate likewise had not made any notable progress. Most soluble coffee consumed in the early 1960s was of the dried type.

Although patents on powdered or liquid coffee concentrate or essence were first issued in the early 19th century (mostly in Europe), such a product did not become a commercial reality until G. Washington, an American chemist residing temporarily in Guatemala city, invented a "refined soluble coffee" in 1906 that was first sold in the United States in 1909. Prior to World War II, soluble coffee was a relatively neglible factor in the coffee industry. Its popularity, however, was considerably enhanced in the U.S. when it was used by the U.S. armed forces in field rations; after the war several companies that had begun to produce such a product for military supply began to market commercial brands of "instant coffee," so-called because it could be prepared as the beverage simply by adding hot water. Soluble coffee advanced from a relatively modest position in 1946 until by the early 1960s between $\frac{1}{4}$ and $\frac{1}{3}$ of all coffee prepared in U.S. homes was of the soluble type. During this time, most roasters of national or regional importance, and including some with only localized distribution, had either developed their own facilities for producing soluble coffee or acquired such a product from a producer for the trade (private-label packer).

In its early period of rapid growth, soluble coffee in dry form (referred to as powdered or granular) was either all coffee or what is known as product or filled type (coffee with carbohydrates added). With continuing improvement in the quality of soluble coffee, a distinct consumer preference began to be evidenced in favour of the all-coffee type and by the mid-1950s the product type had practically disappeared from the U.S. market.

The manufacturing of soluble coffee is an intricate process that varies considerably from company to company according to their process and equipment. Generally speaking, however, soluble coffee is produced by first blending, roasting and grinding as in the case of regular ground coffee. Then follow extraction, evaporation and drying (for powdered instant coffee) by one of several methods, the two systems most commonly used being spray drying and drum (or belt) drying in vacuum. Varying percentages of extraction and differences in methods of evaporation and drying produce instant coffees that differ in colour, type and fineness of particles, and density. The finished product is packaged by automatic machinery either in glass jars or cans, glass containers being in common use in the early 1960s.

Decaffeinated Coffee.—A process was developed in Germany about 1900 by Ludwig Roselius, a coffee merchant, for removing a large percentage of the caffeine from coffee. His technique was later improved by manufacturers in the United States. Although the processes for decaffeination remain more or less secret, it may be said that the result is attained by steaming the green coffee and then soaking it in a chlorinated organic solvent. During the 1950s, preference in decaffeinated coffee shifted markedly from the ground to the soluble (instant) product, and in the early 1960s about $\frac{1}{8}$ of all soluble coffee consumed in homes was decaffeinated. Ground and instant decaffeinated coffee together accounted for about $\frac{1}{20}$ of the coffee used in U.S. homes.

World Production.—In the first half of the 20th century, after the centre of coffee production shifted away from Arabia and other sections of the old world, the countries of the western hemisphere grew up to nearly 90% of all the coffee produced in the world. After 1950, the western hemisphere's share of world production dropped to approximately 75%, chiefly because of the increased rate of coffee growing in Africa. Brazil continued to rank, however, as the world's largest producer of coffee, growing about 40,000,000 bags annually (1 bag = 132.3 lb., or 60 kg.). Other leading producers were Colombia, Ivory Coast, Togo, Mexico, Angola, Guatemala, El Salvador, Indonesia, Costa Rica and India. World production of coffee averages about 77,000,000 bags a year; about 80% of the crop is exported. The United States accounts for about 55% of the world imports; other major importing countries are France, Germany, Italy, Sweden, Canada and Great Britain.

Inter-American and International Coffee Agreements.—Early in World War II (May 1940) almost all of the European coffee market was cut off, and it became necessary for producers to attempt to sell their entire output to the United States. In the wake of enormous overproduction, there followed a price disruption that threatened the economic stability of the producing countries. The purpose of the Inter-American Coffee agreement, drawn up between the governments of the United States and 14 Latin-American coffee-producing countries on Nov. 28, 1940, was to make possible the orderly marketing of coffee under the conditions then existing. The agreement provided for equitable allocation of the United States coffee market among the participating countries through limitation of exports by the Latin-American signatories according to a basic annual quota. The agreement expired Sept. 30, 1948. Thereafter, the Special Commission on Coffee was established within the Inter-American Economic and Social council in order that the United States and representatives of producing countries of the western hemisphere might continue to have the opportunity to discuss problems of mutual concern affecting coffee.

A new imbalance between production and consumption appeared in the late 1950s when crops began to be produced by the extensive new plantings that had been made in 1953–54, the year of crop damage and record high prices. In an effort to forestall a new price disruption, a Latin-American Coffee agreement was entered into by 15 western hemisphere producing countries in Oct. 1958. In Sept. 1959, these same countries joined with some of the African producers to create the International Coffee agreement, which was renewable on a year-to-year basis but aimed at eventually becoming a long-term arrangement that would include all producing countries. The objective was to stabilize the world coffee market through self-imposed export quotas and renewed efforts to increase consumption. These objectives were to be reached through more aggressive propaganda in the United States and active development of "new markets" as distinguished from "traditional" coffee-consuming countries.

How to Make Coffee.—The Coffee Brewing Institute, Inc., a nonprofit membership corporation formed in 1952 by the Pan-American Coffee bureau and the National Coffee association of U.S., recommends observance of the following simple rules in making coffee: (1) Start with a thoroughly clean coffee maker. Rinse with hot water before using. Wash thoroughly after each use. Rinse with hot water and dry. (2) Use fresh coffee. Buy coffee in the size of can or package that will be used within a week after opening. (3) For best results start with freshly drawn cold water. (4) Use the full capacity of the coffee maker. For lesser quantities, it is best to use a smaller coffee maker. Never, in any case, brew less than three-fourths of the coffee maker's capacity. (5) Measure both coffee and water accurately. Standard recommendation for full-strength beverage is two level tablespoons of coffee to each $\frac{3}{4}$ measuring cup (6 oz.) of water. (6) After finding the exact timing that produces the desired results with a specific coffee maker, stick to it in order to get a uniform beverage. (7) Coffee should never be boiled. When coffee is boiled, an undesirable flavour change takes place. (8) Serve coffee as soon as possible after brewing. Freshly brewed coffee always tastes best. If necessary to let coffee stand for any length of time after

making, hold at serving temperature by placing the utensil in a pan of hot water over very low heat. Electrical devices usually have a "warm" unit for maintaining temperature.

Making Soluble (Instant) Coffee.—Soluble coffee can be prepared for individual servings right in the cup, or several cups at a time in any clean utensil, simply by adding the desired amount of boiling water to a measured amount of instant coffee and stirring. It is preferable to pour the water onto the coffee rather than measure the coffee into the water.

Most directions for preparing instant coffee call for "about 1 teaspoon to each cup of water." The exact amount depends on the size of cup, individual strength preference and the coffee itself. The degree of concentration is not the same in various soluble coffees, so larger or smaller measurements of one product may be required than of another to produce equivalent strength.

To prepare iced coffee, place the instant coffee in a glass, half fill with cold water, stir, and fill with ice. Quantities can be made similarly in a larger utensil.

See also references under "Coffee" in the Index volume.

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For figures on coffee production *see* the *Britannica Book of the Year*.

(T. C. W.)

COFFERDAM, a temporary dam formed to enable foundations to be laid or other construction operations to be undertaken on a site which is under water. The engineer surrounds the site with an enclosure in such a fashion as to make possible its dewatering.

When the depth of the water is small and the current slight, simple clay dams may be used, but in general cofferdams are somewhat more complicated structures. One type consists of two rows of continuous wooden piles tied together at the top and filled between with clay puddle. Another frequently used type consists of adjacent cells whose continuous outside walls consist of interlocking vertical sheet steel piling. They are also often filled with packed clay puddle. These cells join one another in such a way as to surround the site of the structure to be erected. The enclosed space may then be pumped dry. A cofferdam must be sufficiently strong to withstand the exterior pressures which arise under these circumstances. *See* also FOUNDATIONS; TUNNEL. (W. E. HD.)

COFFEYVILLE, a city of Montgomery county in southeastern Kansas, U.S., on the Verdigris river, about 150 mi. S. of Topeka, near the southern boundary of the state. Founded in 1869 and incorporated in 1872, it was named for James A. Coffey, a pioneer settler. During the early 1870s, following the completion of a railroad, Coffeyville became a major shipping point for Texas cattle and later developed into an important trading and industrial centre.

The city is located in the mid-continent gas and oil field (natural gas was discovered in 1892) and numbers among its industries a refinery, a pipeline terminal and several manufacturers of oil-field equipment. Its industries include tile and pottery manufacture, railroad car repair, flour and soybean milling and preparation of paint pigments and zinc sulfate. The city supports Coffeyville college, a public two-year college. For comparative population figures *see* table in KANSAS: *Population*. (R. W. RI.)

COFFIN, HENRY SLOANE (1877–1954), U.S. clergyman, author and educator, a leader in the movement for liberal evangelicalism in the Protestant churches, was born in New York city on Jan. 5, 1877. Graduating from Yale in 1897, he studied theology at New college, Edinburgh, Scot. (1897–99), at Marburg, Ger. (1899), and at Union Theological seminary, New York city (1899–1900). After serving as minister of Bedford Park Presbyterian church (1900–05) and Madison Avenue Presbyterian church (1905–06), he became in 1926 president of Union Theological seminary, holding this office till 1945. A many-sided man of great intellectual power and unusual charm, in great demand as a preacher in college and university chapels, Coffin was an advocate of the application of Christian ethics to social problems, an interpreter of the Reformed tradition of dignity and intellectual integrity in worship, a promoter of higher standards of theological education, a supporter of the League of Nations and of the United Nations, and a tireless worker and negotiator in the cause of Christian unity.

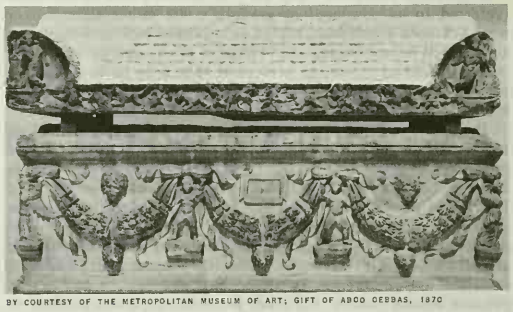
From 1922 until 1945 he served as a fellow of the Corporation of Yale university. He was moderator of the Presbyterian Church in the U.S.A. during 1943–44. He held many distinguished lectureships and was the author of more than 20 volumes in the field of theology and religion, *The Meaning of the Cross* (1931) in particular having been widely recognized as a fine statement of Christian theology for the general reader. He died at Lakeville, Conn., on Nov. 25, 1954.

See Reinhold Niebuhr (ed.), *This Ministry: the Contribution of Henry Sloane Coffin* (1945); and Walter Russell Bowie (ed.), *Joy in Believing: Selections From the Spoken and Written Words and the Prayers of Henry Sloane Coffin* (1956).

(M. P. No.)

COFFIN, the receptacle in which a corpse is confined (Lat. *cophinus*, a coffer, chest or basket, but not "coffin" in its present sense). The Greeks and Romans disposed of their dead both by burial and by cremation. Greek coffins varied in shape, being in the form of an urn, hexagonal or like modern coffins, or triangular, the body being in a sitting posture. The material used was generally burnt clay, and in some cases this obviously had been molded around the body and baked. In the Christian era stone coffins came into use. Examples of these have frequently been dug up in England. Those Romans who were rich enough had their coffins made of a limestone brought from Assus, in Asia Minor, which was commonly believed to "eat" the body; hence arose the name sarcophagus (*q.v.*).

The coffins of the Chaldeans were generally clay urns with the top left open, thus resembling immense jars; these were molded around the body, since the size of the mouth would prevent insertion after the clay was baked. The Egyptian coffins, or sarcophagi, as they have been incorrectly called, were the largest stone coffins known and were generally highly polished and covered with hieroglyphics, usually a history of the deceased. Mummy chests shaped

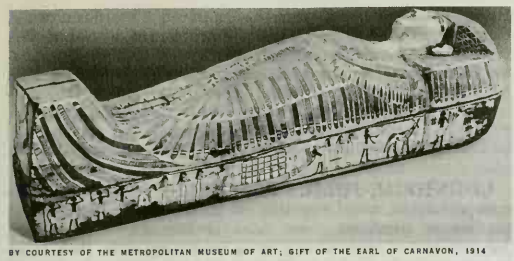


BY COURTESY OF THE METROPOLITAN MUSEUM OF ART; GIFT OF ABCO GEBBAS, 1870

FIG. 1.—ROMAN MARBLE SARCOPHAGUS DECORATED IN RELIEF FOUND AT TARSUS, ABOUT 3RD CENTURY A.D.

to the form of the body were also used, being made of hardwood or painted papier-mâché, and bore hieroglyphics (*see* MUMMY). Unhewn flat stones were sometimes used by early European peoples to line the grave. One was placed at the bottom, others were stood on edge to form the sides, and a large slab was put on top, thus forming a rude cist. In England after the Roman invasion these rude cists gave place to the stone coffin, which was used until the 16th century.

Primitive wooden coffins were formed of a tree trunk that had been split down the centre and hollowed out—a type still in use among aboriginal peoples. The earliest specimen of this type is in the Copenhagen museum, the implements found in it proving that it belonged to the Bronze Age. This type of coffin, modified by planing, was used in medieval Britain by those who could not



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART; GIFT OF THE EARL OF CARNAVON, 1914

FIG. 2.—WOODEN MUMMY CHEST COVERED WITH STUCCO FOUND AT DRAH ABU'L NAGGA, THEBES, EGYPT. ABOUT 13TH CENTURY B.C.

afford stone, while the poor were buried without coffins, wrapped simply in cloth or even covered only with hay and flowers. Toward the end of the 17th century, coffins became usual for all classes.

Among the American Indians some tribes, *e.g.*, the Sauk, Fox and Sioux, used roughhewn wooden coffins; others, such as the Seri, sometimes enclosed the corpse between the upper and lower shells of a turtle. The Seminoles of Florida used no coffins, while at Santa Barbara, Calif., canoes containing corpses have been found buried, though they may have been intended for the dead warrior's use in the next world. Rough stone cists, too, have been found in Illinois and Kentucky. In their tree and scaffold burial the Indians sometimes used wooden coffins or travois baskets, or simply wrapped the bodies in blankets. Canoes, mounted on a scaffold near a river, were used as coffins by some tribes, while others placed the corpse in a canoe or wicker basket and floated it out into the stream or lake. The aborigines of Australia generally used coffins of bark, but some tribes employed baskets of wickerwork.

Lead coffins were used in Europe in the middle ages, shaped like the mummy chests of ancient Egypt. Iron coffins were certainly used in England and Scotland as late as the 17th century.

The coffins used in England are generally hexagonal in shape, of elm or oak lined with lead, or with a leaden shell. In the United States glass is sometimes used for the lids, and the inside is lined with copper or zinc. The coffins of France and Germany and the continent in general usually have sides and ends parallel. Coffins used in cremation throughout the civilized world are of some light material easily consumed and yielding little ash. Ordinary thin deal and papier-mâché are the favourite materials. Coffins for what is known as earth-to-earth burial (*i.e.*, burial in which earth comes into contact with the corpse) are made of wickerwork covered with a thin layer of papier-mâché over cloth.

See also FUNERARY RITES AND CUSTOMS.

COGGESHALL, RALPH OF (d. after 1227), English monastic chronicler, was a monk of the Cistercian abbey at Coggeshall in Essex. He was elected abbot in 1207, but resigned his office on grounds of ill health in 1218. The abbey already possessed its own *Chronicon Anglicanum*, beginning at 1066; Ralph wrote the entries between the years 1187 and 1224. He wrote a continuation of Ralph Niger's chronicle, extending from 1162 to 1178, and some short annals from 1066 to 1223.

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COGIDUMNUS (COGIDUBNUS), a native prince in Roman Britain who flourished in the third quarter of the 1st century A.D. His capital was at Chichester (Noviomagus Regnensium or Regnum), the tribal centre of a people known as Regni or Regnenses, that is, the people of the *regnum* or "kingdom." This comprised, according to Tacitus in *Agricola*, ch. 14, more than one canton. Chichester boasts a famous inscription, set up *ex auctoritate Ti(beri) Claud (i) Cogidubni r(egis) legati Aug(usti) in Brit(annia)*; and this not only indicates his kingship and Roman citizenship but also his special position in the counsels of the province as an imperial legate. His fidelity to Rome is emphasized by Tacitus. (I. A. RD.)

COGNAC, a town of western France, *département* of Charente (*q.v.*), is situated on the left bank of the Charente river, 37 km. (23 mi.) W.N.W. of Angoulême. Pop. (1954) 16,843. The 12th-century church of St. Léger has a Romanesque façade and a 15th-century tower. The château, dating from the 15th and 16th centuries, is the former residence of the counts of Angoulême. Cognac is on the main railway from Angoulême to Saintes, Rochefort and La Rochelle. The most important industry is the distilling of cognac, to which the town gives its name and which is exported by rail or through the nearby port of Tonnay-Charente (*see* BRANDY). Casks and bottles for cognac are manufactured, and there is much trade in grain and cattle.

In 1526 Cognac gave its name to a treaty drawn up in opposition to Charles V by Francis I, the pope, Venice and Milan. Its possession was contested during the wars of religion, and in 1570 it became a Huguenot stronghold. In 1651 it withstood successfully a siege against Louis II, prince of Condé, leader of the Fronde. In World War II the town was in German hands from June 1940 to Aug. 1944.

COGNITION means "knowing," in the widest sense of the term. In psychology it is used to denote one of the three ultimate functions or processes of consciousness, the others being feeling and conation (or willing). Cognition includes every mental process that can be described as an experience of knowing as distinguished from an experience of feeling or of willing; it includes, in short, all processes of consciousness by which knowledge is built up. In its most familiar and fully developed form it is known as judgment, in which a certain object (known logically and grammatically as a "subject") is discriminated from other objects and characterized by some concept or concepts. Although cognition is readily distinguishable from feeling and conation, yet in the actual flow of mental life the three types of experience are always found together, not separate, but one of them is usually predominant in one total experience, another in another, and this fact facilitates their mutual discrimination. Psychology, as a descriptive science, is not concerned with the epistemological question, how external objects can be revealed in subjective experiences; it simply takes at their face value these cognitive experiences in which objects appear to be known somehow, and leaves the critical problems to epistemology and logic.

See PSYCHOLOGY, and KNOWLEDGE, THEORY OF, and authorities there quoted.

COHAN, GEORGE M(ICHAEL) (1878–1942), U.S. actor, popular song writer, playwright and producer became famous as the "Yankee Doodle Dandy." Though he was born in Providence, R.I., on July 3, 1878, his father foresightedly gave it as July 4. His parents were of the theatrical profession, and at an early age he appeared with them in juvenile parts, subsequently taking comedy roles in vaudeville and on the legitimate stage. Also at an early age he began writing plays and popular songs. A description of his early experiments and the stage career of the "Four Cohans" is in his autobiography, *Twenty Years on Broadway and the Years It Took to Get There* (1925).

Among Cohan's productions may be mentioned *The Governor's Son* (1901); *Forty-five Minutes From Broadway* (1905); *The Talk of New York* (1907); *Get-Rich-Quick Wallingford* (1910); *Broadway Jones* (1912); *Seven Keys to Baldpate* (1913); *The Tavern* (1921); *The Song and Dance Man* (1923); *American Born* (1925). Among his best-known appearances were those in *Ah Wilderness!* (1933) and *I'd Rather Be Right* (1937). He composed numerous songs, including "Mary's a Grand Old Name," "You're a Grand Old Flag" and the famous "Over There" of World War I, for which congress authorized him a special medal in 1940. Cohan died in New York city on Nov. 5, 1942. His career was the subject of a motion picture, *Yankee Doodle Dandy* (1942).

See Ward Morehouse, *George M. Cohan: Prince of the American Theatre* (1943).

COHEN, ERNST JULIUS (1869–1944), Dutch chemist, whose most important work was on the allotropy of metals, par-

ticularly tin. Born at Amsterdam, Neth., on March 7, 1869, he studied chemistry under Svante Arrhenius at Stockholm, Swed., Henri Moissan at Paris, and Jacobus van't Hoff at Amsterdam. He became assistant to the latter in the university chemical laboratories at Amsterdam in 1893, and in 1902 professor of physical chemistry at the University of Utrecht. Cohen headed the Van't Hoff laboratory founded there in 1904. He published a large number of works on piezochemistry and electrochemical thermodynamics, particularly in relation to the study of standard galvanic cells; he also wrote widely on the history of science. During World War II he was arrested by the Germans because of his Jewish descent and died in the gas chamber at the concentration camp of Auschwitz, Ger., on or about March 15, 1944. Cohen's writings include: *Physical Chemistry for Biologists, Inorganic Chemistry for Medical Students* (1907); *Jacobus Henricus van't Hoff, Sein Leben und Werken* (1912); *Physico-Chemical Metamorphosis and Some Problems in Piezochemistry* (1928).

COHEN, HERMANN (1842–1918), German-Jewish philosopher, founder of the Marburg school of Neo-Kantianism, was born at Coswig, Anhalt, on July 4, 1842, and educated at Breslau and Berlin. In 1876 he succeeded F. A. Lange (*q.v.*) as professor at Marburg university. Between 1902 and 1912 he published the three parts of his philosophical system (*Logik der reinen Erkenntnis, Ethik des reinen Willens, Ästhetik des reinen Gefühls*). As a reaction to both metaphysics and materialism, Neo-Kantianism restored the sovereignty of "pure" thought: existence is rooted in reason. The concept of the "thing in itself" (*Ding an sich*), Kant's concession to metaphysics, is to be discarded as being outside human knowledge. In his ethics, Cohen maintained man's absolute freedom. The state aims at the moral perfection of society. God is the "idea," expressing the correspondence between the realms of nature and morality. The realization that philosophical ethics deals with mankind as a whole, not with the individual, caused Cohen's radical turn to religion and to his ancestral Jewish faith. In *Religion der Vernunft aus den Quellen des Judentums* (1918) a systematic presentation of Judaism, he concentrated on the "correlation" between God and the individual, divine love and messianic humanity. After retiring from Marburg (1912), Cohen taught Jewish philosophy at the liberal Institute for the Science of Judaism in Berlin. He died at Berlin, April 4, 1918. *See* also JEWISH PHILOSOPHY: *Modern Jewish Philosophy;* NEO-KANTIANISM.

See the introduction by Franz Rosenzweig to Cohen's *Jüdische Schriften* (1924); S. H. Bergman, "Hermann Cohen," *Between East and West* (1958). (N. N. G.)

COHEN (Hebrew for "priest"), a Jewish family name, implying descent from Aaron and the Hebrew priests. Many families claiming such descent are, however, not named Cohen. Other forms of the name are Cohn, Cowen, Kahn, etc.

COHESION: *see* SOLID STATE PHYSICS; SURFACE TENSION.

COHN, FERDINAND JULIUS (1828–1898), German botanist whose studies on microscopic forms of plant life entitle him to rank with Louis Pasteur and Robert Koch as one of the founders of the science of bacteriology. He was born in Breslau on Jan. 24, 1828, completed his higher education at the University of Berlin and then returned to his native city, where he ultimately became director of the Institute of Plant Physiology in the University of Breslau.

Chief among his contributions are his system of classification of microorganisms (1872, 1875), his discovery of bacterial spores (1876) and the bearing of bacterial spores on the problem of spontaneous generation. From his accurate morphologic studies Cohn concluded that it should be possible to arrange bacteria into genera and species. Nevertheless, he pointed out that morphology alone was an insufficient basis for classification. Indeed he was perhaps the first to recognize that organisms of similar form can and do differ from each other in their physiological and biochemical characteristics. During his lifetime Cohn was recognized as the foremost systematic student of bacteria of his day. It was in his laboratory in 1876 that Robert Koch, then unknown, demonstrated his proofs that *Bacillus anthracis* was the causative agent of splenic fever or anthrax, a disease of cattle, sheep and sometimes men. Through Cohn, Koch was appointed to the Imperial Health office in Berlin, where he continued his brilliant work. Cohn was an outstanding teacher and popularizer of science. He received many honours, among them election as a foreign member of the Royal society of London. Cohn died in Breslau on June 25, 1898.

See Pauline Cohn, *Ferdinand Cohn, Blätter der Erinnerung* (1901); F. J. Cohn, *Bacteria: the Smallest of Living Organisms* (1872), trans. by C. S. Dolley (1881), with bibliography of Cohn's writings in 1939 ed. (M. C. L.)

COHNHEIM, JULIUS FRIEDRICH (1839–1884), German pathologist, noted especially for his study of inflammation of the serous membranes, was born at Demmin, Pomorze, on July 20, 1839. After serving as an army surgeon in 1864–65 he became an assistant in the Pathological institute in Berlin and was the most distinguished of Rudolf Virchow's pupils. He was subsequently professor of pathology at Kiel (1868), Breslau (1872) and Leipzig (1878), where he was also director of the Pathological institute. Paul Ehrlich was among his pupils at Breslau. Cohnheim's first important dissertation on inflammation of serous membranes appeared in 1861, and was followed by other important papers on that subject from 1869 to 1873. On this question his teaching was opposed to that of Virchow. He showed that inflammation is caused by the passage of white corpuscles through the walls of the capillaries and that pus is formed largely of these corpuscles in a disintegrated state. Cohnheim made many useful innovations in the method of microscopical work. His most important book is his *Vorlesungen über allgemeine Pathologie* (1878). He died on Aug. 15, 1884, at Leipzig.

COHOES, a city of Albany county, N.Y., U.S., part of the Albany-Schenectady-Troy standard metropolitan statistical area, located on the Mohawk river where it tumbles down the "Great Falls" into the Hudson. The history of the city has been determined largely by its location on these falls. Established by settlers from Rensselaerwyck during the early 18th century, Cohoes developed into a small, thriving manufacturing city producing a variety of products, particularly textiles. These enterprises developed because a dam had been built at the falls and because the Erie and Champlain canals had been joined just outside the city by 1825. Capitalists were quick to take advantage of this opportunity for transportation and water power and Cohoes was incorporated as a village in 1848 and as a city in 1869. The old colonial military road from Albany to Ft. Edward and Lake George runs through the city.

In 1866 construction workers found an almost perfect skeleton of a mastodon buried in rock alongside the falls.

For comparative population figures *see* table in NEW YORK: *Population.* (H. S. PR.)

CO-HONG. This pidgin-English term is generally used to designate the group of Chinese merchant firms authorized by the government to trade with western merchants at Canton before the first Opium War of 1839–42 opened China to more extensive contact with the west. Such firms were called "foreign-trade firms" (*yang-hang*) and the merchants who headed them "hong merchants" (*hang-shang*). These officially sponsored merchants, in existence in the second half of the 17th century, were theoretically 13 in number, but actually there were fewer, sometimes no more than 4. In the 1740s a system was established requiring each foreign ship arriving at Canton to have a hong merchant serve as security, guaranteeing to the Chinese government all duties and the good behaviour of the foreign traders. By 1760, when Canton had become the only Chinese port where foreigners were permitted to trade, the hong merchants were designated as the only merchants in Canton who could sell tea and silk to westerners. A few, like the famous Howqua (Wu Ping-chien; 1769–1843), attained great wealth; but hong merchants were subject to heavy exactions from officials and many failed financially.

The Co-hong has often been compared with a merchant guild. However, while the hong merchants collectively enjoyed the monopoly of the foreign trade at Canton, each merchant was independent in his dealings. As early as 1720 the hong merchants were known to have agreed upon a system of collective price fixing, having taken a blood oath in a manner reminiscent of

Chinese merchant guilds. That arrangement was abandoned in 1722. It was not until 1760 that, under the leadership of an ambitious Hoppo (the official who headed the Canton maritime customs), the hong merchants formed an association called the "collective firm" (*kung-hang*). That association was abolished, however, in 1771 and subsequent attempts to revive it never succeeded. The Chinese term *kung-hang* carried a sense of a price-fixing association; but its pidgin-English corruption, the Co-hong, came to be used by the western merchants in a broader sense, without the connotation of an association. (K.-C. L.)

COHORT (Lat. *cohors,* an "enclosure"), the tactical infantry unit of the Roman legion (*q.v.*), which numbered ten cohorts. The cohort corresponded to the modern infantry battalion; it was divided into three maniples (companies), each of which was in turn divided into two centuries (platoons). The size of a cohort varied with the strength of the legion, which in theory had 6,000 men. During the republic, however, a legion of 4,200 men had ten cohorts of 420 men each; during the empire the cohort regained its full strength of 600 men. The organization of the Roman legion into cohorts greatly increased its tactical flexibility over the Greek phalanx. Unlike the phalanx, the legion, because of its cohorts, was able to fight in an open, checkerboard formation readily adaptable to rough terrain and to changes in the tactical situation. The cohort was also the organizational unit of Rome's fire brigade (*vigiles*) and of the city's military garrison, the praetorian guard. *See* also TACTICS: *Tactics of the Ancient World.* (DO. A.)

COHOSH, a common name applied to several plants, including the species of *Actaea* that are better known as baneberry (*q.v.*), the summer cohosh (*Cimicifuga americana*), the black cohosh (*C. racemosa*), all of the crowfoot family, and the blue cohosh (*Caulophyllum thalictroides*) of the barberry family. All occur in eastern North America, with the species of *Actaea* occurring as far west as Utah and Oregon. (J. M. BL.)

COIMBATORE, a municipality and district headquarters in Madras state, India, and one of the most important industrial and trading centres in south India. Pop. (1961) 286,305. Located on the edge of a cotton area, it commands the famous Palghat gap, about 20 mi. wide, between the Nilgiris hills to the north and the Anaimalai hills to the south. It is an important textile centre, and its other industries include leather tanning, the manufacture of soap and agricultural implements, and coffee and sugar processing. It has a degree-granting college, an agricultural college and a school of forestry, affiliated with Madras university. Coimbatore is an important railway junction of the Southern railway, providing access through the Palghat gap with the western coast, and is also an important bus terminus, with services to Mysore city. Three miles from the town is the temple of Perur, dating partly from Chola times and partly from the early 18th century.

COIMBATORE DISTRICT (area 6,018 sq.mi.; pop. [1961] 3,557,471) comprises a hilly region on the west, north and south; the eastern part is a fertile plain, lying at an altitude of about 900 ft. The climate is subhumid and hot. Droughts are not uncommon, and during periods of severe drought the small rivers become dry. The hilly west and north is devoted to coffee and tea plantations, and the forest yields good sandalwood and timber. In the plain region rice is an irrigated crop, and cotton, the most important cash crop, is extensively grown. The district, with parts of modern Salem district of Madras state, was formerly named Kongu Nadu and in the 9th century was under the Chola dynasty (*q.v.*). In the 11th century the Hoysala (*q.v.*) kings of Mysore ruled it, and it later formed part of the great 14th-century kingdom of Vijayanagar (*q.v.*). It was conquered by Haidar Ali in 1761 and merged with his Mysore kingdom. After the fall of his son and successor Tipu Sahib (1799) the district became a part of British India and was incorporated in Madras state. In 1956, upon the reorganization of the state boundaries in the republic of India, the taluk of Kollegal was transferred to Mysore state. (G. K. GH.)

COIMBRA, the university city of Portugal, is situated in the centre of the country in the province of Beira Litoral, on the right bank of the Mondego river. It is 224 km. (139 mi.) N.N.E. of Lisbon by road, on the main Oporto-Lisbon railroad. Pop. (1960) 50,168. Founded in 1290 in Lisbon, the university, after being moved several times, was finally settled at Coimbra in 1537. Its chapel has a beautiful door (1517–22) and the richly decorated baroque library (1716–23) possesses 1,000,000 volumes and 3,000 manuscripts, among them a first edition of Luís de Camões' *Os Lusiades* (1572). In the old part of the city, on a hill above the river, are the old Romanesque cathedral (1170); the church of São Salvador (12th century); the architecturally uninteresting new cathedral, begun in 1598; the Machado de Castro museum in the old episcopal palace, restored in 1592; Santa Cruz church, built in the reign of Afonso I and rebuilt in 1520; the aqueduct of São Sebastião (1568–70), rebuilt on Roman foundations; the botanical gardens; the 12th-century monastery of Celas, built by Princess Sancha, daughter of King Sancho I; and Santo António church, remarkable for the pottery sculptures in its chapels. On the right bank of the Mondego near Santa Clara bridge is Dr. Manuel Braga park. On the other side are the old and new convents of Santa Clara, 13th and 17th century respectively, in whose church is the tomb of St. Elizabeth of Portugal, patroness of Coimbra; the Quinta das Lágrimas where Inês de Castro, beloved of King Pedro I, was supposed to have been murdered; and the Lapa dos Esteios. The main industries are the making of pottery, fabrics, foodstuffs, beer, wine and paper. Tanning is carried on. Oil is found and maize, rice and fruits are grown in the district.

A 4th-century Latin inscription identifies Coimbra with Aeminium, while Condeixa, 13 km. (8 mi.) S.S.W., was the ancient Conimbriga or Conimbrica. Aeminium was for more than a century a Moorish stronghold, but in 878 it was recaptured by Afonso III and peopled by Galicians from the north. When the see of Conimbriga was transferred there, the bishop kept the old name and Aeminium became known as Coimbra. After many vicissitudes, it was captured by Ferdinand I of Castile in 1064 and for more than a century was the centre from which the reconquest of Portugal from the Moors was carried on. Six kings—Sancho I and II, Afonso II and III, Pedro and Ferdinand—were born there, as was the poet Francisco de Sá de Miranda (1481–1558). In 1755 Coimbra suffered considerably from an earthquake and in 1810 it was sacked by the French. Dom Miguel made the city his headquarters in 1834 and in 1846 it was the scene of a Miguelist insurrection. (M. C. CA.; A. C. DA S.)

COIN: *see* MINT; NUMISMATICS.

COINAGE OFFENSES: *see* COUNTERFEIT MONEY.

COIR is the fibre obtained from the shell of the coconut. It can be processed by machinery but is considered to be of superior quality when processed by hand. After steeping in sea water, washing in fresh water and drying, the reddish-brown mass of fibre is opened up into fibres five to ten inches long, which are graded according to the end use. Coir is employed extensively in rope, brush and mat manufacture. It is resistant to rot, and its other valuable features include lightness coupled with elasticity and resistance to mechanical wear and abrasion. Considerable quantities are exported from the Pacific, and cultivation and preparation of coir also play a major part in Ceylon's economy. Great Britain imports substantial quantities of coir, largely for re-export after manufacture. The German Federal Republic, the Netherlands, the United States, France and Italy also import and manufacture considerable amounts. (A. DR.)

COITER (COYTER, KOYTER), **VOLCHER** (1534–1590?), Dutch physician and surgeon who established the study of comparative osteology and first described cerebrospinal meningitis, was born in Groningen, in the Netherlands. He was awarded a grant by his native city that enabled him to study for five years at the principal universities of Italy and France under such masters as Fallopius, Eustachius, Aranzi and Rondelet. In 1569 he was appointed city physician of Nürnberg. Shortly afterward he entered military service as field surgeon to the palatine prince Johann Casimir. The time of his death is variously given, ranging from 1576 to 1600.

Coiter was a brilliant investigator whose interests covered the full range of the medical sciences of his time. He corrected some of the errors of Vesalius, and concerned himself with the finer

structures of the sense organs and the nervous system. He described embryology, particularly the development of the human fetus, as well as the comparative osteology of animals and illustrated the descriptions with his own drawings. He performed human autopsies whenever the opportunity presented, and described many disease processes, including cerebrospinal meningitis (1573). (L. M. Z.)

COJEDES in northern Venezuela is regarded as one of the most typical llanos (grassland) states. Area 5,714 sq.mi., pop. (1961) 72,181. Since colonial days cattle raising has completely dominated the economy. The area is drained by secondary tributaries of the Orinoco. The climate is wet and dry tropical with about 48 in. of rain falling during the rainy season (May to September or October). Rains bring much hardship to the *llaneros* ("cattlemen"). In the capital, San Carlos, the temperature ranges between 63° F. in the rainy season and 102° F. in the dry season. No point in Cojedes rises above 700 ft. Coffee is grown in the hills to the north and corn, cotton, sugar cane and yuca (cassava) to the south where irrigation is possible. San Carlos and Tinaquillo are the principal market centres. (L. We.)

COKE, SIR EDWARD (1552–1634), English lawyer and parliamentarian whose defense of the supremacy of the common law against the claims of the royal prerogative had a profound influence on the development of English law and the constitution, was born at Mileham in Norfolk on Feb. 1, 1552. He was educated at Norwich grammar school and Trinity college, Cambridge, and entered the Inner Temple in 1572. Called to the bar in 1578, he soon acquired a reputation, his early cases including the Cromwell libel case (4 Rep. 13) and *Shelley's Case* (1 Rep. 94). Under the patronage of Lord Burghley, Elizabeth I's first minister, he entered the public service and rose rapidly, becoming member of parliament for Aldeburgh in 1589 and solicitor general and recorder of London in 1592. A year later he was elected speaker of the house of commons, showing considerable skill in carrying out Queen Elizabeth's policy of curbing the commons' passion for discussing ecclesiastical matters. In 1593 he first crossed the path of Francis Bacon (*q.v.*). The attorney generalship fell vacant, and Bacon, supported by the earl of Essex, became Coke's rival for the post. Coke got it in 1594 and then kept Bacon out of the office of solicitor general as well, or so Bacon thought. Coke's first wife, Bridget Paston, died in 1598 and four months later Bacon was again his unsuccessful rival when he married Lady Elizabeth Hatton; it was a tempestuous and unhappy union.

As attorney general Coke was the champion of the crown and its prerogative powers. He started a series of state prosecutions for libel and conducted the great treason trials of the day, prosecuting the earls of Essex and Southampton in 1601, Sir Walter Raleigh in 1603 and the Gunpowder plot conspirators in 1605. His methods in these trials, especially in that of Raleigh, were brutal even by the standards of his age.

In 1606 Coke was made chief justice of the common pleas, and there then began the series of conflicts which eventually broke his judicial career. At the time of Coke's appointment Archbishop Richard Bancroft had already started his attempt to shake off the control which the common-law courts exercised over the ecclesiastical courts by writ of prohibition. This matter came to a head in *Fuller's Case* (1607–08) when Coke, summoned to a disputation on the king's power to withdraw a case from the courts, earned James I's fury by his assertions that the common law was the supreme law and that "the king in his own person cannot adjudge any case. . . ." In 1610 Coke again crossed the king when he gave his celebrated opinion on proclamations before the council, stating that the king cannot change any part of the common law nor create any offense by proclamation which was not an offense before. The same year he disputed the claim of the court of high commission to imprison for adultery and when, in 1611, James attempted to put him on the commission he refused.

Coke's position was strong. Incorruptible and respected, he was the embodiment of the common law. A last attempt was made to "buy" him when in Aug. 1613 James, on Bacon's advice, appointed him chief justice of the king's bench where it was hoped he would look after the royal interests. He was also made a privy councilor and was the first to be called lord chief justice of England. At the king's bench he retained his predominance and continued to maintain the supremacy of the common law over all persons and institutions except parliament. In *Peacham's Case* he protested against the practice of consulting the judges individually and separately, which James, abetted by Bacon, was more or less driven to follow when the whole bench, if consulted together, merely echoed Coke. In 1615, however, he tried his strength too high, for the court of king's bench started a dispute with Lord Chancellor Ellesmere (*see* Brackley, Thomas Egerton) over the right of the court of chancery to interfere with, and indirectly nullify, a common-law decision. Coke was also believed to be at the bottom of the abortive attempt to make some who had been suitors in a case of this sort liable to the penalties of a praemunire. Meanwhile he had further endangered his position by throwing out from the bench in the Overbury murder trials dark hints of scandal in high places ("God knows what became of that sweet babe, Prince Henry, but I know somewhat"). Finally he came into collision with James I over the king's right to grant commendams (permission to hold livings in plurality). Coke and the other judges ignored a royal injunction that they should take no action upon a case involving this right until the king's pleasure was known. They were called before the king and council and ordered to obey the injunction. The other judges submitted, but Coke merely said that he would do what an honest and just judge ought to do.

In June 1616 the privy council, with Bacon behind it, formulated three charges against him. One was a trumpery matter, never proved, about a bond that had passed through his hands. The other two were charges of interference with the court of chancery and of disrespect to the king in the matter of commendams. Coke was forbidden to go on circuit, ordered to revise the "errors" in his *Reports* and on Nov. 14, 1616, he was dismissed. Thereupon, presumably in search of an influential friend, he offered his daughter in marriage to Sir John Villiers, brother of the duke of Buckingham. His wife, supported by Bacon, objected and hid the child, who was then only 14. Coke abducted her violently and had her married, strongly against her will, to Villiers. Coke made a gradual return to public life, and by 1617 was back in the privy council and in the Star Chamber.

In 1620 Coke entered parliament again as member for a Cornish borough, in theory as a supporter of the king. Yet for the rest of his career he was a leading member of the popular party. He opposed Prince Charles's proposed Spanish marriage, took a part in drawing up the charges against Bacon and spoke in the great debate on the liberties of parliament (1621), spending nine months in prison as a result, but nothing was found that could incriminate him. In 1628 it was his bill of liberties that ultimately took the form of the Petition of Right. This was his greatest parliamentary hour. Admitting his changed views, Coke, at the age of 76, molded the ancient precedents, including Magna Carta, into a charter of liberty limiting the royal prerogative. He retired at the end of the session and died at Stoke Poges, Buckinghamshire, on Sept. 3, 1634. His papers were instantly seized and some, including his will, were never recovered.

It is true that Coke was inclined to be overbearing and impatient both at the bar and on the bench, that he was undoubtedly rather narrow and that he was not always logical. However, his knowledge of law was unequaled, though he "read the Year Books as a Tudor, not as a medieval lawyer." Coke manipulated medieval "precedents" and used them to support his 17th-century view of the common law. He successfully upheld this common law in the courts and in parliament, against the church, the admiralty and the dangerous claims of the royal prerogative. He only failed in trying to uphold it against the chancery, which was too strong for him. While he was issuing his *Reports* no others came out. They are not so much reports in the modern sense as compendiums of the law bearing on a particular case, with personal comments on points raised or general remarks. A balanced estimate of his importance as a legal authority is that of Chief Justice William Best: "The fact is that Lord Coke had [often] no authority for what he states, but I am afraid we should get rid of a great

deal of what is considered law in Westminster Hall if what Lord Coke says without authority is not law. He was one of the most eminent lawyers that every presided as a judge in any court of Justice. . . ." Among his other publications are four volumes of *Institutes,* of which vol. i is known as *Coke Upon Littleton* (1628).

As a man, he evokes admiration more readily than sympathy. More learned a lawyer than Bacon but without his philosophical genius, proud, ambitious and domineering, a just judge but a savage prosecutor, obstinate in his opposition to illegal exercise of authority, resolute in his faith in the supremacy of the common law even to the extent of challenging the equity of the chancellor, he could cringe before the king even in the act of defying the crown.

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COKE, SIR JOHN (1563–1644), English royalist, who gave valuable service to Charles I, especially during the "11 years' tyranny," was born on March 5, 1563, and was educated at Trinity college, Cambridge. After leaving the university he entered public life as a servant of William Cecil, Lord Burghley, becoming deputy treasurer and then a commissioner of the navy. He became M. P. for Warwick in 1621 and was knighted in 1624, afterward representing the University of Cambridge. In the parliament of 1625 Coke acted as secretary of state (he was permanently appointed in Sept. 1625). In this and later parliaments he introduced the royal requests for money and defended the foreign policy of Charles I and other actions of the king. Disliked by the leaders in the house of commons, his speeches did not improve the king's position, but when Charles ruled without a parliament he found Coke's industry very useful. However, in 1639, when a scapegoat was required for the humiliating treaty of Berwick with the Scots, Coke was dismissed. He died at Tottenham on Sept. 8, 1644. Coke's son, Sir John Coke, sided with the parliament in its struggle with the king, and it is possible that in later life Coke's own sympathies were with this party, although in his earlier years he had been a defender of absolute monarchy. (S. R. Bt.)

COKE, THOMAS (1747–1814), the first Methodist bishop and founder of Methodist missions, was born at Brecon, Wales, on Sept. 9, 1747. He was educated at Jesus college, Oxford, and ordained in the Church of England in 1772. From 1772 to 1776 he was curate at South Petherton in Somerset, but he was dismissed for adopting the open-air and cottage services suggested by John Wesley, with whom he had become acquainted. After serving on the London Wesleyan circuit he was in 1782 appointed president of the first conference in Ireland. In 1784 he presented to Wesley his *Plan for Missions* and on Sept. 2 he was ordained by him as "superintendent" of the Methodist societies in the new world and left on the first of his many visits to America. In 1787 the American conference changed his title to "bishop," a nomenclature which he tried in vain to introduce into the English conference, of which he was president in 1797 and 1805. Failing this, he asked the prime minister, Lord Liverpool, to make him a bishop in India. Refused, he raised funds to establish his own mission and was on his way there when he died at sea on May 3, 1814. Coke was always a missionary enthusiast, and the pioneer of such enterprise within the Methodist movement. He was an ardent opponent of slavery, and endeavoured also to heal the breach between the Methodist and Anglican communions. He published a *History of the West Indies* (1808–11), several volumes of sermons and, with Henry Moore, a *Life of John Wesley* (1792).

COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION. Coke is the solid residue which remains when certain types of bituminous coals are heated to a high temperature out of contact with air until practically all of the volatile matter has been driven off. The residue consists principally of carbon, with minor proportions of hydrogen, nitrogen, sulfur and oxygen (which together constitute the so-called fixed carbon), plus the mineral matter present in the original coal, which has undergone alteration during the coking process.

The process of heating bituminous coal in this manner is referred to as carbonization or coking. The properties of coke depend on the type of coal or coal mixture from which it is made and the process and temperature used in its manufacture. In high-temperature carbonization, with which this article is concerned, the final temperature of the coke discharged from the ovens is about 900° C. (1,652° F.) or slightly higher. The primary purpose usually is to produce a coke having the requisite properties for metallurgical use, as in blast furnaces or in foundry cupolas, although the gas, tar and light oils recovered are also valuable products. In Great Britain and Europe, but no longer in the United States because of the availability of natural gas, processes of carbonization employing special retorts are used for the primary purpose of making city gas (coal gas), with coke production a secondary objective. Such processes produce a coke suitable for varied industrial, commercial and residential uses, but not the type required for blast furnaces and foundry cupolas. (The making of coal gas is described in GAS INDUSTRY; *see* also FUELS: *Gaseous Fuels: Coal Gas.*) Coal carbonization may also be accomplished at lower temperatures of about 500° to 600° C. (932°–1,112° F.). The coke is higher in volatile-matter content, is much more reactive and therefore suitable for use in residential heating equipment, but is not of metallurgical quality. (*See* CARBONIZATION, LOW-TEMPERATURE.)

THE NATURE OF COKE

Coke is a hard, cellular mass of carbonaceous material ranging in colour from silvery gray to a dull black. Oven coke is of irregular shape and size, with the maximum dimension of from six to ten inches, which is one-half the width of an oven. Coke made in beehive ovens occurs in blocks or columns of irregular length, which may be as long as two feet, depending upon the depth to which coal has been charged on the floor of the oven. Beehive coke is more silvery and uniform in appearance than oven coke. The end of a piece of oven coke which has been at the wall of the oven has a cauliflower appearance, a more silvery colour, and has been more thoroughly coked than the end at the centre of the oven. Wide differences in size, appearance, colour, hardness, porosity and other properties are shown by cokes from different sources. These differences result for various reasons including the oven wall temperature, coking time, type of coal mixture, and other material and operating factors.

Coke is essentially a partially graphitized and cellular form of carbon; its true specific gravity is about 1.85 to 1.9, or about midway between the specific gravities of coal and graphite. Because of its cellular structure and high porosity, however, coke has a lower bulk density than coal; that is, coke requires about 40% more storage space than an equal weight of coal. It is the combination of high graphitization and porosity that gives coke its chief value in the smelting of iron. For this purpose a fuel is required which will burn rapidly in the lower regions of the blast furnace, furnishing a high temperature for the melting of the iron and slag. Also required is a high mechanical strength to withstand rough treatment. Resistance to reaction with carbon dioxide in the higher levels of the furnace is also required.

The undesired constituents of coke are mineral matter (evidenced by the ash content), excessive moisture, volatile matter, sulfur and phosphorus. Except for the moisture, these are constituents which were part of the coal charged to the ovens, although in altered form because of the treatment at high temperatures. Reduction of these constituents in the coke is a problem of coal selection, cleaning and preparation. Sulfur and phosphorus are undesirable in metallurgical coke because they enter into the iron and must be removed when the iron is converted into steel.

HISTORY OF COKE MAKING

The early history of the manufacture and use of coke made from coal for the smelting of iron ore is somewhat obscure. Because of the ravages caused in timber supplies by the expansion of the charcoal-using iron industry in England during the 16th century, a number of acts of parliament were passed in the last half of the century severely restricting the number and location of ironworks. The attention of ironmasters was thus directed to the desirability of finding substitute fuels, and a number of patents

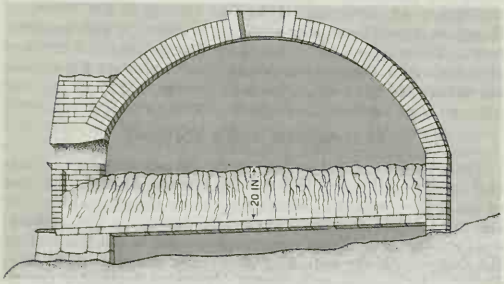
were granted from 1589 onward covering the use of coal for the manufacture of iron. In spite of the granting of patents, these early attempts to smelt iron ore using coal or coke were unsuccessful in practice. In many instances it is impossible to discover whether coke or the raw coal was used. In 1621, Lord Dudley was granted a patent on a process developed by his son, Dud Dudley, who, in his *Metallum Martis* (1665) put forward exaggerated claims that the iron produced was superior to that smelted and refined by charcoal. It is doubtful whether it would have been possible to produce iron of acceptable quality with raw coal in the equipment and plant available at that time but the use of coke is not mentioned. The first recognized success in the substitution of coke made from coal for wood charcoal in the smelting of iron was the result of the persistent efforts of the Abraham Darbys, father and son, of Shropshire, Eng., during the early 1700s.

As might be expected, the early process for the manufacture of coke closely followed that applied to the production of wood charcoal (*q.v.*). The coal was built up in piles and set on fire, care being taken that only part of the coal was burned; the remainder carbonized to form coke. The method was exceedingly wasteful; yields were low, gas and tar were lost, and it was impossible to secure uniform carbonization. Later, some control of the process was obtained by building the pile around a brick chimney with gaps in it through which gases could enter. This was closed at the top, when necessary, by a damper. A still later development was to carry out the carbonization in long piles enclosed by two brick walls provided with holes for the controlled admission of air.

By about 1850 the beehive process had almost completely displaced the foregoing. In this process, small charges of coal were coked by the heat released from combustion of practically all the volatile matter and about one-sixth of the theoretical yield of coke. The ovens used were round in shape with domed roofs and were constructed of firebrick and stone. Although still highly inefficient, the beehive process produced excellent coke from coals having strong coking properties. Various improvements in the beehive oven were introduced in the last half of the 1800s, but those still in use are relatively unchanged in their principal features of construction.

Fig. 1 is a cross-sectional view of a standard beehive oven showing a residue of coke before removal. Coal is charged to the floor of the oven through an opening in the roof and is leveled through the opening in the side. Heat remaining in the brickwork from the previous run starts the distillation of volatile matter. Air admitted at the top of the side door mixes with the volatile matter and combustion occurs chiefly above the coal charge. The progress of coking is downward. It is important that the air admitted be controlled to avoid loss of coke, and the amount of air admitted is reduced as coking proceeds. From five to six tons of coal are charged to an oven, and the time of coking may run from 48 to 73 hours, depending upon the type of coal charged and the coke properties desired.

In the operation of a beehive oven all of the gaseous and liquid chemical products, which represent about 40% of the heat content of the coal charged, are lost. Numerous efforts were made in the last half of the 1800s to reduce this heat loss and to recover tar, ammonia and surplus gas. Waste heat boilers were added to the beehive oven to aid in heat recovery from the combustion products. Improved ovens, rectangular in cross-section, were devised, with separate flues on the sides for combustion of the volatile gases liberated and transmission of heat to the charge through the walls of the oven. By-product recovery systems were added and provision was made to remove tars and light oils from the raw gas before it was directed to the heating flues. An important advance was made when Henry Simon, of Manchester, Eng., introduced a recuperative system whereby part of the heat of the burned gases from the heating flues was used to preheat the air which was supplied to the flues. As a result higher temperatures were obtainable in the ovens, and some surplus gas became available.



BY COURTESY OF U.S. BUREAU OF MINES, DEPARTMENT OF THE INTERIOR

FIG. 1.—CROSS SECTION THROUGH A BEEHIVE COKE OVEN

During these developmental years, ovens were narrowed to furnish coke of more uniform properties, and heating flues were redesigned to give more uniform heating throughout the length of the oven. More elaborate systems for recovery of chemical products were devised. The names of Simon-Carvès, Coppée, Piette, Otto, Semet-Solvay, Koppers, and Wilputte, who were coke oven designers and builders, are still familiar to coke-oven operators.

The first by-product coke ovens built in the United States were installed in 1893 at the plant of the Solvay Process company, Syracuse, N.Y. These were designed by Louis Semet and their primary purpose was to produce ammonia for use in the Solvay ammonia-soda process. The coke and gas obtained were used as fuels. Within the next few years, the quality of coke produced in by-product ovens was demonstrated to the satisfaction of blast-furnace operators and other oven installations were made by Semet-Solvay, Otto-Hoffman and others. Ovens designed by Heinrich Koppers, of Germany, were installed in 1906 at the plant of the Illinois Steel company, Joliet, Ill. The first real impetus to coke oven construction resulted from demands for ammonia, benzene and toluene for explosives and tars for dyes during World War I when imports of these coal-derived chemical products from Germany ceased. By 1919 more coke was produced in the United States from by-product ovens than from beehive ovens, and ten years later over 90% of the coke was produced in the new ovens. For many years beehive ovens have been operated chiefly to supply peak demands for metallurgical coke.

THE COKE-OVEN PLANT

The modern coke-oven plant consists of an area for receiving coal by rail or barge, with provision for handling, storage, blending and handling several types of coal, one or more batteries of coke ovens, a plant for recovery of the gas and chemical products, and equipment for the discharge and quenching of the coke and for screening the coke and delivering it to storage, rail cars or the blast furnace. All operations are integrated and continuous.

Chemical-Recovery Coke Ovens.—In the United States the term by-product was being replaced in the second half of the 20th century by the term coal chemicals, and the coke ovens from which coal chemicals are recovered were being referred to as chemical-recovery coke ovens. A typical modern chemical-recovery coke oven in the United States and other countries is a rectangular chamber constructed of refractory materials. Each oven is about 40 ft. long and 12 to 13 ft. high, with an average width of 17 to 20 in. The width is tapered 2 to 4 in. from front to back, with the wider dimension at the back to facilitate discharge of the coke by a pusher. For convenience in operation, a group of about 50 or 60 ovens are built closely side by side in a single structure known as a battery.

Rows of heating flues separate the ovens, each row serving to heat two ovens except for the flues at each end of the battery. The flues connect into the regenerators which are located immediately below each oven and which supply preheated air for combustion and receive the hot products of combustion. The heating gas is directed into the flues by a separate duct when the ovens are heated with coke-oven gas. Many of the coke ovens of the combination type are designed to be heated with either coke-oven gas or blast-furnace gas (also producer gas) in which case the blast-furnace gas (or producer gas) as well as the air is preheated in regenerators. Heating is carried out in half the number of flues

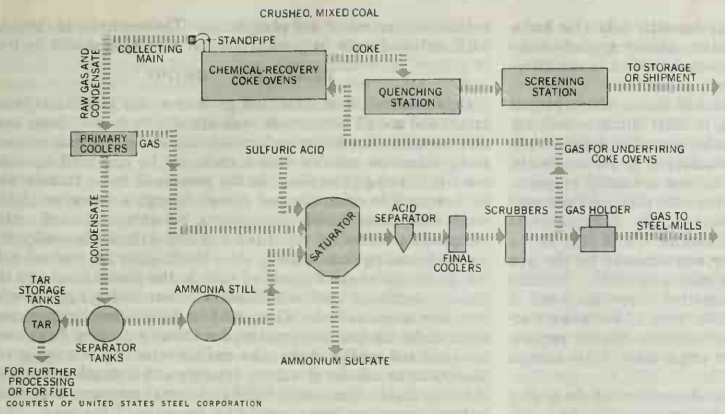


FIG. 2.—FLOW SHEET SHOWING THE OPERATION OF COKE AND COKE CHEMICALS PRODUCTION

for 20 to 30 minutes; then the system is reversed and heating is carried out in the other half. The oven structure is built almost entirely of silica brick. This refractory, because of its rigidity under load, permits the use of higher temperatures in the flues and thus secures more rapid working and greater oven capacity than is attainable with fire-clay brick. Flue temperatures of 1,370° to 1,455° C. (2,500° to 2,650° F.) are commonly used in modern U.S. ovens, but temperatures vary depending on the rate of production or quality of coke required.

A popular type of chemical-recovery oven in the United States is the Becker modification of the Koppers oven, the distinguishing feature of which is its provision for conducting the gases of combustion from the top of a row of vertical flues across and over the oven and down the row of flues on the other side (*see* fig. 2). The crossover flues, of an inverted-U shape, are in the upper part of the oven battery structure. They pass over alternate ovens only, and are usually six to eight in number, distributed across the length of the oven. Each crossover flue handles the waste gases from four to six vertical flues in the heating walls beneath, and each set of vertical flues is separated from each other set. The heating gases burn in all of the flues in one-half of the number of walls, and when reversal takes place for the purpose of regeneration the heating gases burn in the remaining half. This procedure is in contrast with the system where heating gases burn in one-half of the flues in each wall on each reversal. This construction and flow pattern results in more uniform heating, end to end, of the oven walls, and a stronger flue and oven structure.

Operation of Coke Ovens.—Modern chemical-recovery coke ovens have a capacity of from 15 to 20 net tons of finely crushed coal having a bulk density of about 50 lb. per cubic foot in the oven. At normal rates of operation, each oven has a daily capacity of about 20 to 24 tons of coal. Coal is charged into the hot ovens from a car that runs on top of the ovens and is filled from central mixing bins. Before being charged, doors at each end of the oven are closed and sealed. After the charge is dropped in the oven, the top of the coal is leveled, the lids on the charging doors are closed, and the volatile gases which have started to evolve are directed into the collecting main. The charging and leveling operation is done rapidly, usually requiring only 1½ to 2 minutes. The time required to carbonize the coal is dependent chiefly upon the width of the oven and the temperature of the adjacent flues. At normal rates of operation the coking time is about one hour for each inch of oven width. When foundry coke is being made the period is slightly longer. At the end of the coking period, the oven doors are removed and the hot coke, at a temperature of about 980° C. (1,800° F.), is pushed mechanically into a car at the rear of the furnace. To prevent loss by combustion in the air, the incandescent coke in the car is taken immediately to a quenching station at one end of the battery where it is cooled with a controlled amount of water. A dry quenching process to recover the sensible heat of the hot coke is sometimes used. The quenched coke is dumped on an inclined wharf where it cools further and is then transported by belt conveyer to a screening station and separated into sizes before storage or shipment.

Recovery of Coal Chemicals.—Methods for the recovery of coal chemicals from the raw gas leaving the coke ovens vary somewhat according to the way the ammonia is recovered. Three methods have been used—the so-called direct, semidirect and indirect processes. Ammonia is recovered as ammonium sulfate in the direct and semidirect processes. A dilute ammonia liquor is produced in the indirect process. Ammonia stripped from this liquor is either converted to ammonium sulfate or concentrated in solution. The direct process is not used in the United States and seldom is used in Europe. The great majority of plants in the United States employ the semidirect process with production of ammonium sulfate.

In the recovery of coal chemicals, the volatile products leaving the ovens enter a standpipe leading to a collecting main where the gas is first cooled and initial condensation of the tar takes place. After the gas is further cooled in the primary coolers and more tar is extracted, the ammonia is recovered by the semidirect process in which the gases are passed through a weak solution of sulfuric acid either in specially designed low-differential saturators or spray-type ammonia absorbers. The ammonia is thus converted into solid, crystalline ammonium sulfate. Light oil containing benzene, toluene, xylenes and higher boiling hydrocarbons is scrubbed from the gas by a petroleum-type absorbent oil after which the light oil is steam distilled from the scrubbing oil. The gas, which has a heating value of about 530 B.T.U. per cubic foot, requires no further treatment when used for underfiring the ovens or in the steel-mill furnaces, but removal of hydrogen sulfide and naphthalene is necessary for distribution in city mains.

The approximate average yields of products obtained from the carbonization of 2,000 lb. of coal in the United States is as follows:

Coke, total, including breeze, lb.	1,410.00
Tar, gal.	8.32
Ammonium sulfate or equivalent, lb.	19.56
Crude light oils, gal.	2.94
Gas, total, cu.ft.	10,400.00

Of the total gas produced about one-third is used to underfire coke ovens, and almost two-thirds is sold to gas utility systems or used in associated steel plants and allied industries. Only a small proportion, about 5%, of the coke oven gas produced is sold for distribution in city mains. In the years up to 1946 as much as 20% was used for this purpose. The availability of relatively inexpensive natural gas by pipeline in virtually all areas of the United States has led to a rapid conversion of city distribution systems from manufactured and coke-oven gas to natural gas.

Mention of the broad categories of coal chemicals produced by carbonization—tar, light oils and gas—gives no hint of the hundreds of important chemicals, pharmaceutical and industrial compounds, dyestuffs and explosives derived from these basic materials. The organic chemical products obtained from coal by carbonization constitute an indispensable source of materials for the chemical industry. (*See* COAL AND COAL MINING: *Preparation and Uses of Coal: By-products of Coal*).

UTILIZATION OF COKE

Coke is designated by its method of manufacture, such as oven coke, beehive coke or retort coke. It is also designated by the use to which it is put, as blast-furnace coke (or simply furnace

coke), foundry coke, water-gas coke, or domestic coke (for house heating). Another method of designation, chiefly applied to domestic coke, is by size. The usual size classification is egg (largest), stove, nut, range, pea and breeze.

Of the total coke produced in the United States, about 94% is used in metallurgical processes—91% in blast furnaces and 3% in foundries. The remainder of the coke is used as follows: 1% for producer-gas and water-gas manufacture; 1% for residential heating; 1% for export and 3% for various industrial purposes. In the late 1930s as much as 23% of the coke produced was used for residential heating, but this market rapidly disappeared as natural gas became widely available following World War II. A notable improvement in fuel efficiency was achieved by the iron and steel industry during the decade ending in 1957. Whereas an average of 1,937 lb. of coke were required to produce a ton of metal (pig iron and ferroalloys) in 1948, only 1,703 lb. were required in 1957. Contributing to this reduction in coke requirements were improvements in iron ore preparation, blast furnace operation and coke quality.

Qualities of Metallurgical Coke.—Assessment of the quality of metallurgical coke other than by full-scale use involves consideration of chemical and physical properties which can be determined by standard laboratory tests. Those of a chemical nature apply chiefly to quantitative analytical determinations involving impurities (moisture, sulfur, ash and phosphorus). Because coke is the chief source in pig iron of sulfur, an undesirable constituent, the sulfur content should be low, preferably 1% or less. The phosphorus content should also be low, 0.01% to 0.02%, especially for the production of bessemer and basic open-hearth metal. Over the years cokes ranging in ash content from 8% to 16% have been used in blast furnaces but a good coke should not contain more than 12%. Under most conditions, higher rates of iron production are obtained when the ash content is low. A good coke contains no more than 2% volatile matter, and the moisture content should not exceed about 5%. Above all, uniformity is essential, with elimination of day-to-day variations.

Physical and strength qualities are even more important. Strength to resist breakage is demanded since from the time coke is pushed from the oven to the time it is dropped on the stock line of the blast furnace or cupola it is subjected to impact and abrasion by falls and slides on wharfs, conveyers, screens, weighing hoppers and crossbelts. Within the furnace it must resist the abrasive action of walls and the other charge materials and, in the lower layers of the charge, it must have sufficient strength to withstand the heavy weight of the materials above it at the prevailing high temperatures. Standard tests are designed to evaluate coke strength by carefully defined impact and abrasive actions in laboratory-scale equipment. Size is an important criterion, particularly uniformity of size. A maximum size of about 4 in. is desirable for blast-furnace use, with exclusion of fines smaller than about $\frac{3}{4}$ in. which would otherwise fill up voids in the charge and interfere with the uniform upward flow of gases throughout the cross section. Better results are obtained by charging separately the smaller sizes of coke, about $\frac{3}{4}$ in. by 2 in., rather than including these sizes with the larger pieces.

No common agreement exists on what constitutes the optimum quality of metallurgical coke. Coke suitable for one furnace and the corresponding operating conditions may not be suitable for others. Discussion of coke quality can be controversial because of substantial differences between blast furnaces, types of burden and conditions of operation. Most of the physical tests are empirical in nature, and the results, to be significant, must be correlated with experience in practice. Attempts have been made to formulate an over-all index of quality for evaluating and correlating coke properties with blast furnace operation. Several have been developed by individual iron and steel companies and used with some success, but agreement on a single formula has not been reached.

Operators of foundry cupolas require a coke that is large in size, dense in structure, with small cells and thick cell walls, and having high values for strength, hardness, heating value and carbon content. Again, the coke should be low in moisture, ash, volatile matter, sulfur and phosphorus. The reactivity of the coke with carbon dioxide to produce carbon monoxide should be low.

COALS FOR COKING

Only coals of bituminous rank produce a coke of suitable properties, and not all bituminous coals are able to do so. Some contain too many impurities such as ash and sulfur. In this respect, many otherwise suitable coking coals can be upgraded by commercial cleaning processes. In the process of being transformed by heating into coke, the coal passes through a fusion or plastic stage with some fusible components becoming softened, other components becoming vaporized and still others, thermally less stable, becoming decomposed. As a result, gases are evolved with the formation of small gas-filled cells in the plastic mass and the process continues until solidification occurs and a rigid cellular structure is maintained. When and how these interacting processes occur under the time-temperature conditions prevailing determines the yield and quality of the coke and the attending tars and gases. Variations in cellular structure, fracture and strength result with different coals. Some coals build up internal pressures that result in heavy pressures being exerted on the walls of the oven.

Because it is difficult to find a single coal having all the requisite properties, it is general practice to blend two or more coals into a mix which will perform satisfactorily in the oven and produce a quality coke. For example, some high-volatile coals are highly fusible and tend to produce a frothy coke of low strength. Coals of low-volatile matter content exert high pressures against the walls of the oven with the attendant possibility of damage to the refractory structure. By blending these coals in suitable proportions (70% to 85% high-volatile type, 15% to 30% low-volatile types), the quality of the coke can be improved and the danger of excessive pressure minimized. Blending also furnishes an opportunity to include less desirable but locally available low-cost coals and still produce a satisfactory coke.

Because of the varied qualities and coking propensities of coals, it has been necessary to devise laboratory tests to give preliminary evaluation of their probable behaviour in commercial ovens. In addition to the usual analytical tests for ash, sulfur, moisture and volatile matter, empirical physical tests have been developed to assess such properties as plasticity and expansion pressure. Moisture content, bulk density, degree of fineness and size distribution, and petrographic composition of the coals used also affect the resultant properties and quality of the coke. Pilot-scale test ovens and related facilities for carbonization research have been developed in several countries.

To a limited extent it is possible to enhance the quality of coke made from marginal coals by methods involving adjustment of particle size by such procedures as grinding, changing the bulk density of charged blends by tamping or compressing the charge as it is placed in the oven, concentration of petrographic constituents, or addition of pitch or similar substances to the blend.

Although coal is widely distributed throughout the world, the reserves of good coking coals are limited and many countries are without adequate supplies and must import all or a portion of the coals used for coking operations.

See COAL AND COAL MINING; *see* also references under "Coke, Coking and High-Temperature Carbonization" in the Index volume.

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COKE OF NORFOLK: *see* LEICESTER OF HOLKHAM, THOMAS WILLIAM COKE, EARL OF.

COLBERT, JEAN BAPTISTE (1619–1683), French statesman and minister of finance to Louis XIV, was born on Aug. 29, 1619, at Reims, where his father, son of a merchant and a merchant himself, had already bought some official appointments.

In 1651, when Cardinal Mazarin had to leave Paris during the Fronde, Colbert became his agent there. He kept the cardinal abreast of the news and looked after his personal affairs. Mazarin,

on his return to power, made Colbert his intendant and helped him purchase profitable appointments for his family and for himself. Quickly enriched, Colbert also acquired the barony of Seignelay, which was subsequently raised to a marquisate for him. On his deathbed, Mazarin recommended him to Louis XIV, who soon gave Colbert his confidence. Thenceforth Colbert dedicated his enormous capacity for work to serving the king both in his private affairs and in the general administration of the kingdom.

Financial and Economic Affairs.—For 25 years Colbert was to be concerned with the economic reconstruction of France. The first necessity was to bring order into the chaotic methods of financial administration. He caused the fall of the all-powerful *surintendant des finances,* Nicolas Fouquet (*q.v.*), who had rendered great services to the state by using his personal credit, but who made no distinction between his own fortune and public money. Fouquet's trial (1661–64), mysterious in many ways, was conducted without equity, and pressure was brought to bear on his judges. The *surintendance* was replaced by a council of finance, of which Colbert was to be the dominant member, with the title of intendant until, in 1665, he became controller general.

Financiers and tax farmers had made enormous profits from loans and advances to the state treasury, and Colbert established tribunals (*chambres de justice*) to make them give back some of their gains. Well received by public opinion, which held the financiers responsible for all difficulties, these measures alleviated the public debt, which was further reduced by the repudiation of some government bonds and the cancellation of others by paying back the principal less the interest already paid. Many private fortunes suffered, but no disturbances ensued, and the king's credit was restored. Colbert would have liked to avoid further public borrowing but was obliged to have recourse to loans during the Dutch War of 1672–79. On the conclusion of peace, loans at advantageous rates of interest helped cancel old debts.

France under the monarchy was divided between (1) *pays d'états,* where the representatives of the province voted the tax; and (2) *pays d'élection,* which paid the taille (*q.v.*), a distributory tax levied only on *roturiers.* Colbert intended to levy the taille on all who were properly liable for it and so initiated a review of titles of nobility in order to expose all those who were claiming exemption falsely, but he also wanted to make the tax less oppressive by a fairer distribution. He reduced the total amount of it but insisted on payment in full over a reasonable period of time. Furthermore, he took care to suppress many abuses of collection (confiscation of defaulters' property, seizure of peasants' livestock or bedding, imprisonment of collectors who had not been able to produce the due sums in time). These reforms and the close supervision of the officials concerned brought large sums into the treasury. Indirect taxes moreover were increased, and the tariff system was revised in 1664 as part of a system of protection. The special dues which existed in the various provinces could not be swept away, but a measure of uniformity was obtained in central France.

Colbert sought to organize industry and commerce on the principles of mercantilism, according to which a country could not prosper unless it exported much and imported little, thus increasing its gold reserve. This necessitated not only the production of high-quality goods which could compete with foreign products abroad but also the building up of a merchant fleet to carry them. Colbert attracted foreign workers who brought their trade skills to France. He gave privileges to a number of private industries and founded state manufactures. To guarantee the standard of workmanship, he made regulations for every sort of manufacture and imposed severe punishments (fines and the pillory) for counterfeiting and shortcomings. He encouraged the formation of companies to build ships and tried to obtain monopolies for French commerce abroad through the formation of trading companies. The French East India and West India companies, founded in 1664, were followed by others for trade with the eastern Mediterranean and with northern Europe, but Colbert's propaganda for them, though cleverly conducted, failed to attract sufficient capital, and their existence was precarious. The protection of national industry demanded tariffs against foreign produce, and other countries replied with tariffs against French goods. This tariff warfare was one of the chief causes of the Dutch War.

Colbert's system of control was resented by traders and contractors who wanted to preserve their freedom of action and to be responsible to themselves alone. Cautious and thrifty people, moreover, still preferred the old ways of placing their money (land, annuities, moneylending) to investing in industry. The period, too, was one of generally falling prices throughout the world. Colbert's success, therefore, fell short of his expectation, but what he did achieve seems all the greater in view of the obstacles in his way: he raised the output of manufactures, expanded trade, set up new permanent industries and developed communications by road and water across France (Canal du Midi, 1666–81). He ensured progress in every sphere of the economy.

The Navy.—As secretary of state for the navy from 1668, Colbert undertook to revive the power of France at sea. This meant forming a fighting fleet, building and equipping the king's ships, fortifying ports and encouraging the merchant navy. The Atlantic fleet was composed of sailing ships, the Mediterranean fleet of galleys. To man the Atlantic fleet the system of *inscription maritime* and of *classes* was devised: under this, professional sailors were required to sign on for the king's service so that crews of 300 men could be formed; they were then divided into *classes,* which served in rotation. Those not called up were free to serve in the merchant navy. They received half pay when they were not serving, their families received their pay when they were serving overseas, their children had free education and pensions were provided. Ill-received at first, this system was soon in general practice. For the galleys Colbert encouraged magistrates to sentence common criminals to serving in them and had no scruple about other means of recruiting: political offenders, Protestants and slaves seized from Africa and Canada might all be made to serve.

Colbert reconstructed the works and arsenal of Toulon and founded the port and arsenal of Rochefort and naval schools at Rochefort, Dieppe and St. Malo. Calais, Dunkerque, Brest and Le Havre were fortified. The need for naval construction goes far to explain Colbert's vigilance over the forests (*Ordonnance des eaux et forêts,* 1669), one of the most corruptly administered sectors of the royal domain. As he also wanted the French ships of the line to have a handsome appearance, in order to impress foreigners, he engaged excellent artists, such as Pierre Puget, to decorate them. Encouragement was given to the building of ships for the merchant navy by allowing a premium on those built at home and imposing a duty on those built abroad; and as French workmen were forbidden to emigrate, so French seamen were forbidden to serve foreigners on pain of death.

The Arts.—Colbert was also concerned with the intellectual and artistic activity of the country in his capacity of secretary of state for the king's household (from 1669). It was necessary for the prestige of France to beautify towns and to protect scholars and writers, even foreign (pensions were given to Christiaan Huygens, Isaac Vossius and Nikolaes Heinsius). Also, the richness of the king's collections and of Colbert's own collection served to enhance their reputation throughout Europe.

Colbert, himself a member of the Académie Française, founded the Académie des Inscriptions et Belles-Lettres (1663) to choose inscriptions for medals and monuments celebrating the king's victories; the Académie des Sciences (1666) to study how the sciences could be exploited to the kingdom's advantage; and the Académie Royale d'Architecture (1671) to lay down rules and refine the taste of French work. He also founded schools, such as the Académie de France in Rome, in which artists could be trained under some of the great masters of the time; schools for practical purposes, such as the École des Jeunes de Langues, for the study of oriental languages; and the Observatoire in Paris, of which Giovanni Cassini was put in charge. G. L. Bernini was invited to submit a design for the Louvre, but its execution proved too expensive, so that plans by French architects were eventually adopted.

Other Spheres of Activity.—Colbert encouraged emigration to Canada to form the colony of New France, which had about

10,000 inhabitants in 1680. He promoted legislation on various matters; *e.g.*, the *Ordonnance criminelle* of 1670, commercial laws and the so-called *Code noir* on slave labour. For agriculture he tried to protect the peasants so far as was consistent with his general economic system, to improve the breed of horses and sheep and to promote new crops. His concern for economic progress made him hostile to measures against the Protestants (many of whom were in business) and mistrustful of monks and of even the secular clergy (on the ground that too many men who should have been in commerce took holy orders). He himself remained a faithful Catholic.

Conclusion.—Colbert died in Paris on Sept. 6, 1683, a very rich man. His eldest son, Jean Baptiste, marquis de Seignelay, had been granted the right to succeed his father as secretary of state for the navy; the second son, Jacques Nicolas, was archbishop of Rouen; the fourth son, Armand, marquis d'Ormoy, was *surintendant des bâtiments;* and three of his daughters were married to dukes.

At the end of his life Colbert was a disappointed man. To profit from his reforms, the country needed peace, but the department of war was in the hands of his great rival, the marquis de Louvois (*q.v.*), who drew Louis XIV into a series of wars that counteracted all Colbert's planning. Even so, by energetically applying the authoritarian methods of the times, without distinction of persons or heed to public opinion, Colbert had made the monarchy stronger and the nation better equipped. Moreover, the order that he had introduced into the administration was to have a lasting effect. Though he did nothing to change the structure of society, Colbert treated all men as equals in so far as obedience to the king's orders was required of them.

Colbert left among his papers *Mémoires sur les affaires de finance de France,* written *c.* 1663; a fragment entitled *Particularités secrètes de la vie du Roy;* and other accounts of the earlier part of Louis XIV's reign. There is an edition of the *Lettres, instructions et mémoires de Colbert,* by P. Clément, 9 vol. (1861).

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COLCHAGUA, a province in central Chile, lying between the Argentine border and the Pacific. Created in 1826, it has undergone various alterations in outline and administrative structure. It has an area of 3,255 sq.mi., and most of the 158,024 population (1960) lives in the longitudinal valley, where the production of wheat, rice, legumes, forage crops, grapes and tobacco is important. Numerous cattle and sheep are raised on valley pastures and range land in the coastal mountains and along the lower Andean slopes. Wheat and rice milling, tanning, and shoe and cigarette manufacturing reflect the dependence upon agriculture. This is the heart of the *huaso* or cowboy country and the rodeo at San Fernando (pop. [1960] 37,834 [mun.]) is among Chile's best. This city was founded in 1742 and became the provincial capital in 1840. It lies on the main line of the state railway and is the terminal for a branch railway that extends westward to the popular beach resort of Pichilemu. The paved longitudinal highway also serves San Fernando and the central part of the province. Lesser roads thread across the valley into the coast ranges and to some cordilleran spas and resorts. Important coastal salt evaporation ponds are operated south of Pichilemu; sulfur and copper deposits are reported for the Tinguiririca volcano area.

(J. T.)

COLCHESTER, CHARLES ABBOT, 1ST BARON (1757–1829), British lawyer and speaker of the house of commons, who is especially remembered for his work for the preservation of the national records, was born at Abingdon, Berkshire, on Oct. 14, 1757. Educated at Westminster and Oxford and called to the bar in 1783, he entered parliament for Helston in 1795, a year after he had been given the office (worth £2,700 a year) of clerk of the rules in the king's bench. There and in the house of commons he introduced many practical administrative reforms, notably the taking of the first census in 1801. He was appointed chief secretary for Ireland in 1801, and through Henry Addington's influence he was elected speaker in 1802. In 1809 he refused Spencer Perceval's offer of a secretaryship of state. When ill-health compelled him to resign the speakership in 1817, he was given a peerage and a pension of £4,000. He died in London on May 8, 1829.

See Charles, Lord Colchester (ed.), *The Diary and Correspondence of Lord Colchester,* 3 vol. (1861). (A. AL.)

COLCHESTER, a municipal borough in the Colchester parliamentary division of Essex, Eng., 22 mi. N.E. of Chelmsford and 50 mi. N. of London by road, on the river Colne. Pop. (1961) 65,072. Area 18.8 sq.mi. In pre-Roman and Roman history it was known as Camulodunum, the capital of the Belgic chief Cunobelinus (*q.v.*), and is named on his coins. After his death and the Roman conquest, the emperor Claudius established a *colonia* of discharged soldiers. It was stormed and burned in A.D. 60 during the rising of Boadicea (*q.v.*) but soon became one of the chief towns in Roman Britain. Roman sculptures and inscriptions have been discovered and considerable stretches of the walls remain, forming a rectangle about two miles in extent and including the ruined Balkerne gate. Several excavated remains of buildings can be seen. In the vicinity are many dikes and earthworks. Domesday Book mentions Colneceaster with 276 burgesses and land *in commune burgensium,* a phrase that could point to a nascent corporation. The castle keep, built about 1070, is quadrangular, turreted at the angles, and is the largest of its kind in England. The quadrangle was roofed in 1930, and the castle houses a museum, chiefly of Romano-British antiquities of which it has the biggest collection taken from a single site in Great Britain. Medieval legend associates Colchester with Old King Cole of nursery lore. The Augustinian priory of St. Botolph (late 11th century) retains part of the fine Norman west front (in which Roman bricks occur), and of the nave and arcades; and there is the restored gateway of the Benedictine monastery of St. John, a beautiful specimen of Perpendicular work, embattled, flanked by spired turrets and covered with panel work. The church of Holy Trinity possesses the oldest church tower in Colchester, dating from 1050, an interesting specimen of late Saxon architecture. The Colchester Royal Grammar school was founded by Henry VIII in 1539.

The first charter was given in 1189 and new grants obtained in 1447 and 1535. Charles I granted another charter which was amended in 1653 and a new one granted in 1663; this one remained in force with modifications until 1741. In 1763 George III made a renewed grant of the town's liberties. Colchester returned two members to parliament from 1295 until 1885. Fairs were granted by Richard I in 1189 and by Edward II in 1319. In the 13th century Colchester was an important port, its ships plying to Winchelsea and France. Elizabeth I and James I encouraged Flemish settlers in manufacture of baize, and the making of clothing still flourishes. Both William Camden and Thomas Fuller mention the trade in barrelled oysters and eryngo (candied sea-holly root). Colchester was held, apparently against the citizens' will, by royalists in 1648 and it was fined in consequence.

The town is the centre of an agricultural district and has corn and cattle markets, besides extensive nurseries for roses and other plants. The chief industries produce agricultural implements, boilers and gas engines. The oyster fisheries at the mouth of the Colne belong to the borough corporation and are held on lease by the Colne Fishery company. The harbour, with quayage at the suburb of Hythe, is controlled by the borough. The town is a military centre.

Colchester was made a suffragan see by Henry VIII, and two successive bishops were appointed by him after which no further appointments were made until it was re-established as a suffragan see of Chelmsford under Queen Victoria.

COLCHICUM, a genus of about 50 species of crocuslike herbs. The best known is the meadow saffron or autumn crocus (*Colchicum autumnale*), a perennial plant of the family Liliaceae

T. H. EVERETT

MEADOW SAFFRON OR AUTUMN CROCUS (COLCHICUM AUTUMNALE)

(*q.v.*), found wild in rich, moist meadowland throughout most of Europe. It has pale purple flowers, stemless, rarely more than three in number; the perianth is funnel-shaped, and prolonged below into a long slender tube, in the upper part of which the six stamens are inserted. The ovary is three-celled, and lies at the bottom of this tube. The leaves are three or four in number, flat, lanceolate, erect and sheathing.

Propagation is by the formation of new corms (bulblike structures formed by the enlargement of the stem base) from the parent corm, and by seeds. The latter are numerous, round, reddish-brown and of the size of black mustard seeds. The corm of the meadow saffron attains its full size in June or early in July. A smaller corm is then formed from the old one, close to its root; and this in September and October produces the crocuslike flowers. In the succeeding spring it sends up its leaves, together with the ovary, which perfects its seeds during the summer.

The young corm grows continuously until the following July and attains the size of a small apricot. The parent corm remains attached to the new one and keeps its form and size until April in the third year of its existence, after which it decays. In some cases a single corm produces several new plants during its second spring by giving rise to immature corms. *C. autumnale* and its numerous varieties, as well as other species of the genus, are well known in cultivation, forming some of the most beautiful of autumn-flowering plants.

Colchicine, the alkaloid of *C. autumnale,* applied to the skin, causes pain and congestion; inhaled, causes violent sneezing; and taken internally, increases the amount of bile poured into the intestine. In larger doses it produces enteritis and nephritis with vomiting, diarrhea, hemorrhage from the bowel and ultimately death from collapse. This is accelerated by a depressant action upon the heart and nervous system. The sole medical use of colchicine is in gout. It lessens the severity and frequency of the attacks when given continuously between them, and benefits such symptoms of gout as eczema, bronchitis and neuritis, though inoperative against them when not of gouty origin.

Colchicine is a specific for doubling of chromosomes and is much used in genetics to produce new forms (*see* PLANT BREEDING: *Polyploidy*). (N. TR.)

COLCHIS, the name given by ancient writers to the valley of the Phasis (modern Rion) river in Asia Minor, the region formerly known as Mingrelia in the west of the modern Georgian Soviet Socialist Republic. Colchis formed an almost triangular district at the eastern end of the Black sea, bounded on the north by the Caucasus mountains, which separated it from Scythia and Sarmatia, on the east by Iberia (equivalent to the modern regions of Kartalinia and Kakhetia) and on the south by Armenia, the Montes Moschici (modern Surami range), and Pontus.

The Colchians are first recorded early in the 1st millennium B.C.: inscriptions of the king Sardur (Serduri II, 750–733 B.C.) of Urartu mention his expeditions against Colchis. The Greeks regarded Colchis as the special domain of sorcery, a land of fabled wealth, as symbolized by the myth of the Argonauts (*q.v.*). Several colonies were founded there by settlers from Miletus, chief among them being Dioscurias (Roman Sebastopolis, modern Sukhumi). The Colchians supplied the Greeks with flax and linen cloth, agricultural produce, furs and skins, pitch, wax, timber, gold and slaves. The Greeks brought in salt, olive oil, pottery and fine textiles. Some ancient writers describe the Colchians as dark and woolly-haired, and akin to the Egyptians in language and customs; elsewhere they are depicted as yellow, fat and lazy from living in sultry and marshy valleys and drinking the stagnant waters of the Phasis—an allusion to malaria, prevalent in the region. Women were buried after death, the corpses of men exposed in trees. Excavations show that the land was covered with villages surrounded by orchards, vineyards and arable lands and connected by a network of roads and tracks and many bridges. Weaving, metalwork, carpentry and tanning were practised. The artistic and cultural influences of Hellenism spread among the upper classes. Colchis was long ruled by its own petty dynasts and tribal chieftains, who sometimes acknowledged nominal Persian suzerainty.

Early in the 1st century B.C., Colchis came under the rule of Mithradates VI Eupator, king of Pontus. Following the defeat of Mithradates by Pompey in 66 B.C., a Roman client ruler, Aristarchus, was installed. In 48 B.C., Pharnaces, son of Mithradates Eupator, revolted against the Romans in Colchis, but was soon expelled from the area by the armies of Julius Caesar. Colchis was then incorporated with Pontus (*q.v.*) under Roman rule. Various local kings were appointed or confirmed by the emperor Trajan and his successors. Arrian, the legate of the emperor Hadrian, made an inspection of all the forts around the eastern Black sea coast including Phasis, described in his *Voyage Around the Black Sea.*

In the 4th century A.D., the weakening of Roman power in the eastern empire led the peoples of western Georgia to assert their independence. The Colchians became part of a new and powerful state, Lazica, which was for a time an ally of Rome; later, war broke out, leading to the expulsion of the Byzantines in A.D. 456. During the 6th century, Lazica was disputed between the Byzantine empire and the Persian empire under the Sassanid dynasty. The emperor Justinian I built a fortress at Petra, at or near the modern Batumi. The arrogance of the Byzantines alienated their Laz and Colchian allies, who revolted once more against Byzantine domination. In the peace settlement of 562 between Justinian and Khosrau (Chosroes) I, however, Justinian retained Lazica with Colchis.

In the 790s, Leo, duke of Abkhazia (northwestern Georgia), conquered Lazica and set himself up in Kutaisi as king of a new state, Abasgia, which included Colchis. Abasgia was in turn united with the other Georgian principalities by the king Bagrat III (975–1014), after which its history becomes merged in that of Georgia. In the 15th century, however, the breakup of the Georgian monarchy under the sons of Alexander I led to the emergence of the Dadiani as ruling princes in Mingrelia. Mingrelian autonomy was suppressed by the Russians in 1857.

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COLCOTHAR (adapted in Romanic languages from Arabic *golgotar*), a name given to the brownish-red ferric oxide residue obtained in the preparation of fuming sulfuric (Nordhausen) acid by the dry distillation of ferrous or ferric sulfate. It is used as a polishing powder by jewelers and as the pigment Indian red. It is also known as Crocus Martis, *caput mortuum,* Prussian red, rouge, etc.

COLD: *see* LOW-TEMPERATURE PHYSICS (CRYOGENICS); REFRIGERATION; THERMOMETRY.

COLD, COMMON. The term cold is applied by physicians and laymen alike to various acute, subacute and even chronic maladies affecting the respiratory tract. Investigators usually limit the term to a condition commonly described as coryza or a cold in the head. Typical symptoms of such colds are sneezing, watery nasal discharge and nasal stuffiness. At the onset there is often a dryness or irritation of the throat, sometimes accompanied by a sensation of chilliness. In the early stages of the acute cold, nasal discharge is profuse and watery, but in two or three days it becomes thicker and mucopurulent. Involvement of the paranasal sinuses and the lower portions of the respiratory tract, with coughing, is common.

Colds and their complications are responsible for a large amount of illness and disability. A survey conducted by the American Institute of Public Opinion showed that in one week of November

colds were reported in one-third of U.S. homes. Thus, during this particular week, approximately one person in seven throughout the country was afflicted with a cold. A corresponding survey for a week in October revealed that one-fourth of all families reported colds.

Other surveys indicate that approximately 75% of the people have at least one cold each year, 25% have four or more and the average is between two and three per person per year. A 10-year record of illness among employees of the Edison Illuminating company, covering an average of 100,000 employees annually, showed that 54% of the absences from sickness were caused by the respiratory group of diseases. These and other studies indicate that the common cold and its complications are a major cause of loss of time in industry. The annual cost in the United States (economic loss and expenditures for drugs and medical and hospital services caused by the common cold and its complications) has been estimated as between $2,000,000,000 and $3,000,000,000.

Cause.—As the name suggests, colds are widely believed to be caused by chilling. In some persons chilling does produce symptoms of sneezing and coryza. Physicians call this condition vasomotor rhinitis, but to the average person it is a "cold in the head." Hay fever (*q.v.*), a similar condition, is caused by an allergy or hypersensitivity of the nasal mucous membranes to some substance in the air, such as pollen of plants, grasses or trees. Unquestionably many attacks of hay fever are mistaken for colds, particularly when they occur in the spring of the year.

Observations of the common cold indicate that the commonest type is communicable; in fact, the widespread colds that occur in several waves throughout the year, usually in the early autumn, in midwinter and in early spring, are of this type. Investigations seem to indicate that a majority of such colds are caused by a virus (*q.v.*). Colds are particularly difficult to study because they cannot be tested by any of the techniques ordinarily used in investigating virus diseases. The only test for the presence of a cold virus is production of a cold by dropping material up the nose of a human subject or a chimpanzee. Other animals are not susceptible. Walther Kruse, at the Institute of Hygiene in Leipzig, Ger., first showed, in 1914, that colds could be transmitted with filtrates. In the early 1920s A. R. Dochez and his collaborators in New York city extended these findings and first showed that chimpanzees could be infected. Claims by them and by other workers to have cultivated the virus in eggs were not substantiated, however.

Since 1946 colds have been under continuous study by a team of workers under the Medical Research council at the Common Cold Research unit at Salisbury in southern England. Their main object has been to find a way of studying the virus readily in the laboratory. Normal volunteers, students and others are housed in pairs under conditions of isolation from other people. They remain for ten days and after a preliminary short period of observation are subjected to experiment, usually by intranasal instillation of cold virus or other material under test. They are then observed for another week to see whether a cold develops as a result of the test. Under these conditions, filtrates of nasal washings from colds will transmit infection, though rarely to more than 50% of inoculated persons. Such colds can be similarly passed on in series to other subjects; a multiplying agent is therefore clearly concerned. The incubation period is usually around 48 hours, though for at least one strain of virus it is a day or two longer. Nasal discharge is a constant feature in the experimental colds; fever is rare. Through experiments of this type it has been possible to determine many of the properties of the virus, such as size and resistance to physical and chemical agencies. It seems to be smaller than the influenza virus, which is quite distinct from it; the diameter of the cold virus is probably about 0.05μ or one half-millionth of an inch. It can be preserved for years at $-76°$ C. in dry ice. It is destroyed outside the body by ordinary antiseptics, but like other viruses is not affected by antibiotics such as penicillin. Attempts have been made to grow the virus in cultures of living tissues, especially human embryonic tissues. Despite hopeful reports in 1953, definite success was not achieved.

Workers at Bethesda, Md., and in Washington, D.C., were successful, after 1953, in growing in tissue culture viruses causing fever and sore throats, and sometimes conjunctivitis; these came to be called adenoviruses. Vaccines against them showed promise. Adenovirus infections, however, though they may sometimes resemble common colds, are distinct from them and are of unknown importance in civil life, though often troublesome among recruits in the armed services.

During 1957 and 1958 there were published from several countries further reports of cultivation of viruses from minor coldlike illnesses: these were probably not typical colds. It was necessary, however, to keep an open mind as to whether there would ultimately prove to be one common cold virus or many.

Spread of Colds.—Colds can obviously be spread if a cold victim sneezes into another person's face. Apart from that, cross-infection seems to occur especially from prolonged and intimate contact as within a household. Children seem to transfer infection to others more easily than do adults. In a rural community, adults in households containing schoolchildren had $2\frac{1}{2}$ times as many colds as had adults not closely associated with schoolchildren. Small particles of virus remaining suspended in the air for some time after talking and sneezing have been shown capable of conveying infection; but breathing such remotely infected air does not lead to catching cold as easily as does closer contact, and handling contaminated articles seems even less effective.

Bacteria of various types have also been described as a cause of colds; their role, however, seems to be mainly that of secondary invaders following virus colds. Climate is much less a factor in the occurrence of colds than is generally supposed. Studies by the U.S. public health service show that the attack rates of colds in college students and family groups in various parts of the country are remarkably uniform and show no consistent relationship to latitude, longitude or climate. These studies also show surprising similarity in the time of occurrence of colds in various sections of the country. Studies in isolated arctic communities indicate that epidemics of colds are related not to temperature but to contact with infected persons from the outside world. In fact explorers, or other persons isolated for many months, find when they return to civilization that they are then more prone to infection than normally. This suggests that in the ordinary way resistance is maintained by repeated contact with tiny doses of infection; in the absence of such contact, resistance tends to wane.

In the tropics colds are less common and less severe than in the temperate zones, but they do occur and in general present a miniature picture of colds in temperate regions. Despite the widespread association in the public mind between cold and colds, evidence to support this notion is lacking. Experiments have been carried out in which human subjects have been chilled by standing about in drafts in wet bathing suits, by wearing wet socks, by going for walks in the rain; yet no colds were induced, nor were the subjects abnormally susceptible to administration of small doses of common cold virus. Possibly the association in the public mind is due to the fact that a sensation of chilliness may be the earliest symptom of a cold. Undoubtedly colds are commoner in winter than in summer; this might be due not directly to the temperature but to a tendency for people to collect closely together indoors during the winter.

Complications.—The importance of colds lies not only in the colds themselves but also in their complications. An uncomplicated cold runs a short, relatively mild course of a few days' duration. The complications, however, are numerous and important. Of these, the commonest are sinusitis, otitis media and infections of the lower respiratory tract, such as laryngitis, tracheitis, bronchitis and pneumonia. Closely allied but distinct disease entities are influenza and some types of sore throat. The paranasal sinuses are all connected with the nose and are lined by mucous membrane that is continuous with the membrane of the nose. Some inflammation of the sinuses, therefore, probably follows most if not all acute head colds. These are of importance, however, only when secondary infections occur and drainage is inadequate. Treatment of infected sinuses is a problem for the physician.

Infection of the middle ear (otitis media) occurs from the nose and throat by way of the Eustachian tube. Formerly otitis media

was often complicated by mastoid infection, but this is controllable to a large extent by penicillin, other antibiotics and the sulfonamide drugs.

Prevention.—Natural resistance, possibly with a hereditary element, plays an important role in a person's susceptibility to colds. Studies from Cornell university (Ithaca, N.Y.) indicated that 25% of the students had approximately 75% of the colds in that institution. In many persons, however, susceptibility seems to vary over a period of several years. Various defensive mechanisms against infection are provided in the nose, notably the tiny hairs at the entrance of the nasal passage, the mucous secretions of the membranes lining the nose, and the cilia, and it is important that these natural defenses not be destroyed or interfered with.

The prevention of communicable colds should be possible by the avoidance of exposure to persons with colds, but under the conditions of modern life this is impossible. However, the degree of exposure can be reduced by keeping away from persons who have colds. Also, people with colds can refrain from infecting others by avoiding crowded places. Unfortunately it appears that an infected person is infectious even before symptoms begin, so that no amount of care can altogether stop the spread of colds in a modern, crowded community.

Vitamins and various measures are widely advocated and advertised for the prevention of colds, but there are no conclusive scientific studies or records indicating that any special diet or the addition of vitamins to adequate, well-balanced diets has this effect. Vaccines have long been used for the prevention of colds. In general, they consist of killed bacteria of the types usually found in the nose and throat during colds. Some of these vaccines are given by mouth, some by hypodermic injection and a few by spraying into the nose, and medical journals contain many papers reporting benefits from them. However, a number of carefully controlled studies were conducted in which half the subjects received vaccine while the other half, chosen at random and without their own knowledge, received exactly the same treatment but were given injections, capsules or nasal sprays that contained no vaccine. The subjects who received the vaccines had as many colds as the subjects in the control groups, and subjects in both groups reported considerably fewer colds than they thought they had had during the previous year. Various antiseptics also are recommended, including sprays, nose drops, gargles and mouth washes. Antiseptics do not act to kill germs instantaneously; only mild antiseptics can be tolerated by the membranes of the nose and throat, and these can be brought in contact with only a small portion of these membranes and for only a few seconds at a time. There is therefore no reason to think, and no scientific evidence, that antiseptics are of any value for the prevention of colds or other respiratory infections. On the contrary, there is danger that at least some of these preparations interfere with the normal protective action of the cilia and mucous secretions in the nose. Sterilization of the air by ultraviolet light or chemical vapours is theoretically sound but impractical for general use.

Treatment.—An acute infectious cold usually runs a course of three to ten days. If nasal discharge persists longer, a complicating infection of one of the sinuses should be suspected. As recovery progresses, the nasal congestion and stuffiness decrease and the secretions become scanty and more purulent. Most treatment is directed toward the relief of symptoms. Bed rest is advisable in the early stages of a severe cold to protect others from exposure, increase general resistance and keep the body warm. Hot baths are frequently advocated, their effect being to dilate the blood vessels of the skin and increase the blood flow through them and thus to reduce nasal congestion and stuffiness. Such relief is only temporary. Large quantities of liquids in the form of water, lemonade or orange juice are frequently recommended in treatment, but their value is open to question. Advertised and recommended treatments are legion; most of these do little more than give some temporary relief of certain symptoms. The salicylates, such as aspirin, and similar drugs give some relief from aching and reduce fever. Nose drops and inhalers of various types cause shrinking of the membranes of the nose and so give temporary relief of stuffiness and nasal congestion. Unfortunately the reaction of the nasal membranes to these drugs frequently results in more swelling than was present before they were used. Experiments also show that most preparations used in the nose stop the action of and in many instances actually destroy the cilia, which play an important role in defense against infections.

Colds are of such variable severity and duration that individual experience is of little significance in judging the value of any preparation for either prevention or treatment. For this reason, the value of any medication can be determined only by carefully controlled experiments. Such studies were conducted over a period of approximately five years at the University of Minnesota, Minneapolis. The subjects in the studies were all treated in the same manner and all thought they were receiving the same medication. Actually the control group received capsules or tablets of only starch or milk sugar. Approximately 35% of the control subjects reported that "the medication resulted in complete cure or marked improvement of their colds in 24 to 48 hours." Such results explain why it is so easy to become enthusiastic about any preparation for the treatment of colds if it is recommended by well-meaning friends or sufficiently promoted by skilful advertising. Most preparations widely utilized for cold treatment are of no more value than sugar tablets. Controlled studies have shown that there is no justification for the use of antihistamine drugs, various preparations of the sulfonamides, penicillin or other antibiotics. On the contrary, there are definite objections to their use for this purpose. One is that a certain number of persons have undesirable reactions of greater or less severity to the sulfonamides and even to penicillin. Another is that if these drugs are used for minor infections, such as colds, there may develop in the nose and throat strains of germs that are resistant to them; they become valueless for the treatment of severe infections to which these germs may give rise.

See also Hay Fever; Sinusitis. (C. H. As.)

COLDEN, CADWALLADER (1688–1776), American physician, philosopher, scientist, historian, politician and colonial official, was born on Feb. 7, 1688, in Ireland where his mother, the wife of a minister of Duns, Scot., was visiting. He was destined by his family to enter the ministry but his studies at the University of Edinburgh aroused his interest in science. After receiving his A.B. degree in 1705, he went to London to study medicine. In 1710 he emigrated to Philadelphia, Pa., where he engaged in a general mercantile business and in the practice of medicine. A promise by Gov. Robert Hunter that he would be appointed master in chancery and surveyor general of New York led to his moving to that colony in 1718. These appointments were duly made in 1720 and one year later he became a member of the governor's council. This was the beginning of a public career that was continuous until his death and was culminated with the lieutenant governorship (1761–76). His biographer sums up his public career as follows: "Whether straightening out with industrious skill the tangle of the colonial lands; demonstrating the ease with which huge patents could be automatically reduced by the exaction of legal quit-rents, which, in turn, could be used as a salary fund to insure the independence of crown officials; formulating an Indian policy; or, discredited, living in watchful retirement . . . , he never ceased to fight colonial aggression with the same indomitable resolution which characterized everything he did." In the historical setting in which this efficiency and dedication were exercised, only failure and frustration could result.

Colden had that remarkable versatility of mind so characteristic of the intelligentsia of his age. As a physician he contributed to medical knowledge with studies of cancer, yellow fever, smallpox and the effect of climate on disease. His scientific interests and observations encompassed physics, astronomy, chemistry, botany and what would now be called psychology. After having mastered the Linnaean system of botanical classification, he classified the flora around his New York estate and had the pleasure of having his work praised and published by the Swedish botanist. His *History of the Five Indian Nations* published in 1727 is still useful. Philosophically, he was first and foremost of the early American materialists.

He died at his Long Island estate on Sept. 28, 1776.

See Alice M. Keys, *Cadwallader Colden: a Representative Eighteenth Century Official* (1906); Max Savelle, *Seeds of Liberty* (1948).
(RA. MU.)

COLD HARBOR, OLD and NEW, two localities in Hanover county, Va., U.S., 10 mi. N.E. of Richmond, which were the scenes of two battles of the American Civil War. The first (sometimes called the battle of Gaines's Mill) was fought June 27, 1862, between the army of the Potomac under Gen. G. B. McClellan and the army of northern Virginia under Gen. R. E. Lee. The second encounter was a succession of battles from May 31 to June 12, 1864, between the Union forces under command of Gen. U. S. Grant and the Confederates under Gen. R. E. Lee, who held a strongly entrenched line at New Cold Harbor. *See* AMERICAN CIVIL WAR; WILDERNESS.

COLD SORE. Technically known as herpes simplex, this is a virus disease in which groups of small tender blisters develop rather suddenly on a reddened and swollen base on the skin or the adjacent mucous membranes. After a few days the blisters rupture or dry up, crusts are formed which soon fall off and the lesion heals without marks. Although cold sores commonly occur on the lips, they may appear anywhere on the body surface. The filter-passing virus can be demonstrated by inoculation of blister content on a rabbit's eye or by microscopic examination of scrapings from the base of blisters. Herpes simplex is often associated with acute infections such as common cold, pneumonia and epidemic cerebrospinal meningitis. It is assumed that the herpes virus is present inside the body of everyone and that diseases activate the virus so as to cause the eruption. Besides febrile diseases, sunshine exposure, menstruation and gastric indigestion are among the numerous activating factors. Some persons suffer from frequently recurring cold-sore attacks, an annoying condition which often can be cured by smallpox vaccination.

Originally, the herpes virus enters the body usually in infancy or early childhood and causes a rather severe, febrile inflammation of the inside of the mouth; recurrent eruptions are milder. *See* SKIN, DISEASES OF. (S. RON.)

COLD STORAGE: *see* REFRIGERATION; FOOD PRESERVATION.

COLDSTREAM, a small burgh of Berwickshire, Scot., 48 mi. S.E. of Edinburgh by road. Pop. (1961) 1,226. It stands on the north bank of the Tweed river, there spanned by John Smeaton's fine bridge of seven arches, erected in 1763–66. The railway station is on the English side at Cornhill in Northumberland. Because of its position on the border and also as the first ford of any consequence above Berwick, Coldstream played a prominent part in Scottish history. There Edward I forded the stream in 1296 with his invading army, and the 5th earl of Montrose crossed with the Covenanters in 1640. No trace remains of the Cistercian abbey founded about 1165 by Cospatric, 3rd earl of Dunbar, and destroyed by the 1st earl of Hertford in 1545, which adjoined the present market place, but for nearly 400 years it was a religious centre. In the reign of Henry VIII the papal legate published a bull there against the printing of the Scriptures, but the site was occupied in the 19th century by an establishment, under Adam Thomson, for the production of cheap Bibles. At Coldstream Gen. George Monck crossed the Tweed in 1660 with the regiment raised there, now famous as the Coldstream guards.

Like Gretna Green (*q.v.*), Coldstream was long a resort of runaway couples, the old tollhouse at the bridge being the usual scene of the marriage ceremony. Although unused, Marriage house, as it is called, still exists. Among the chief industries of Coldstream are agricultural engineering, knitwear and cold-process bakery.

At the village of Birgham, 3 mi. W., William the Lion, king of Scotland, conferred with the bishop of Durham in 1188 concerning the attempt of the English church to impose its supremacy upon Scotland; there in 1289 was held the convention to consider the marriage of the Maid of Norway with Prince Edward of England; and there, too, in 1290 was signed the treaty of Birgham, which secured the independence of Scotland.

COLD WAR, a term that won wide popular and official acceptance after World War II to denote the strained relations that developed between the Soviet Union and the western powers. Beginning late in 1945 the wartime coalition of anti-Axis powers, which had always been an uneasy one, began to break up. Many points of friction developed between the western nations and the U.S.S.R. (and, particularly after 1949, Communist China) on the status of Germany, Austria and Korea, on the control of nuclear weapons, communist threats to Greece and Turkey, the North Atlantic Treaty organization and other matters. Except for the neutrals, all the nations of the world soon found themselves divided into two hostile camps; each camp employed diplomatic maneuvering, threats, espionage, economic pressure and propaganda to strengthen its position. The resulting tension was often described as a "war of nerves" rather than a shooting war or "hot" war.

See EUROPE: *History: Communism and Europe;* STRATEGY: *Cold War in the Atomic Age;* TRUMAN, HARRY S.; TRUMAN DOCTRINE.

COLE, SIR HENRY (pseudonym FELIX SUMMERLY) (1808–1882), English public servant, art patron and educator, intimately associated with the conscious formation of the Victorian style, was born at Bath, July 15, 1808. At the age of 15 he started clerking for the public records historian, and eventually he became assistant keeper of the public record office. Involved in a multiplicity of projects, boldly conceived and ably prosecuted, Cole strove his life long to better the existence of the common man. In 1845 the Society of Arts, whose new patron was Prince Albert, announced a competition for tea services and beer mugs; the next year "Summerly's" tea service, manufactured by Minton's pottery works, won a silver medal. Cole, explaining its many practical details, stated that the design "had as much beauty and ornament as is consistent with cheapness." The tea service sold well, and in 1847 Summerly's Art Manufactures was founded "to promote public taste." Through it, till it closed in 1850, painters and sculptors, including academicians, designed for industries. In 1849 Cole and the painter Richard Redgrave founded the *Journal of Design and Manufactures,* which, by "establishing recognized principles" generally derived from the books of A. W. N. Pugin, hoped to promote "the germs of a style which England of the nineteenth century may call its own"; a naturalistic, narrative style emerged. In 1848 Cole proposed a national industrial exhibition. Sponsored by Prince Albert, this project was transformed into the unprecedented Great Exhibition of the Industry of All Nations, opened in 1851; it was a huge success, featuring "art applied to industry" "not to gratify the tastes of the few, to supply the wants of the many."

When the Great exhibition closed, its ample profits were used to establish better design schooling in England. In 1852 the board of trade set up a department of practical art (later, of science and art) with Cole as secretary; in this capacity he formed the nucleus of the Victoria and Albert museum. He was strongly attacked: Dickens thought him too functionalistic; industrialists believed they could better train their own apprentices, as before. In 1857 his school, collection and library, now under the council for education, moved to the great complex of schools, museums and institutes planned by Cole for Prince Albert at South Kensington. Cole then launched national training schools for cookery and music, and the grand scheme for Royal Albert hall. In 1873 he resigned his departmental secretaryship and two years later was made knight commander of the Bath.

In 1877 Ruskin attacked his work, writing "Cole at Kensington has corrupted the system of art-teaching all over England into a state of abortion and falsehood from which it will take twenty years to recover," and William Morris continued the attack. The arts and crafts movement was rising against industrial design. Before the reaction reached its crest, Cole died on April 18, 1882, but his views of design eventually prevailed. (ER. K.)

COLE, THOMAS (1801–1848), U.S. painter, who was a founder of the Hudson River school and the painter of some of its most characteristic landscapes, was born at Bolton-le-Moors, Eng., on Feb. 1, 1801. In 1819 the family emigrated to the U.S., settling first in Philadelphia, Pa., and then at Steubenville, O., where Cole learned the rudiments of his profession from a wandering portrait painter named Stein. He went about the country painting portraits, but with little financial success. Moving to New York

(1825), he displayed some landscapes in the window of an eating house, where they attracted the attention of the painters Asher Durand and Col. John Trumbull, who sought him out, bought his canvases, and found him patrons. From this time Cole was prosperous. A series of pictures consisting of four canvases representing "The Voyage of Life," and another series of five canvases representing "The Course of Empire," the latter now in the gallery of the New York Historical society, were allegories, in the taste of the day, and became exceedingly popular, being reproduced in engravings with great success. The artist's romantic conception of the American landscape had an influence on his time and his fellows that was considerable. Cole spent the years 1829–32 and 1841–42 abroad, mainly in Italy, and at Florence lived with the sculptor Horatio Greenough. After 1827 he had a studio in the Catskills, which furnished the subjects of some of his canvases, and he died at Catskill, N.Y., on Feb. 11, 1848. William Cullen Bryant wrote a eulogy for him, and Durand commemorated him in a painting. His pictures are in many public and private collections. "Expulsion From Eden," in the Metropolitan museum in New York city, is typical of Cole's style.

See E. I. Seaver, *Thomas Cole* (1949).

COLE, TIMOTHY (1852–1931), U.S. wood engraver, the last and best-known member of the great school of American wood engravers and probably its most distinguished master, was born in London on April 6, 1852, his family emigrating to the United States in 1858. Living in Chicago, he lost everything he possessed in the great fire of 1871. He moved to New York city and began to work on Scribner's magazine in 1875. He was sent abroad by his publishers in 1883 to make engravings of the old masters in European galleries. These were published with notes by Cole as *Notes to Old Italian Masters* and achieved great success. Though the advent of new mechanical methods had rendered wood engraving almost obsolete, Cole was able to continue his work, and he became one of the greatest masters of wood engraving. He died on May 17, 1931.

See A. P. and M. W. Cole, *Timothy Cole, Wood-Engraver* (1931). (H. Es.)

COLEBROOKE, HENRY THOMAS (1765–1837), English scholar, the first European to study and appreciate Sanskrit documents, was born in London on June 15, 1765. His father, Sir George Colebrooke, became chairman of the court of directors of the East India company, and in 1782 Henry Colebrooke entered the company's service and went to Bengal. For the next 32 years he rose gradually: in 1801 he was made a judge of the new court of appeal at Calcutta, and in 1807 he became a member of the council. He returned to England in 1814 and died in London, March 10, 1837.

His first publication, *Remarks on the Husbandry and Commerce of Bengal* (privately printed, 1795), was occasioned by the duties of his office, and its recommendation of free trade between Great Britain and India so offended the directors of the company that it was not published in England. Similarly, Colebrooke's study of Sanskrit originated in his need to know Indian law for his work as a magistrate. *The Digest of Hindu Law on Contracts and Successions* (1798) was a translation of the work of codifying Mohammedan and Hindu law begun by Sir William Jones, and it revealed the knowledge Colebrooke had laboriously acquired both of Indian law and of the Sanskrit language. In 1805 Lord Wellesley appointed him professor of Hindu law and Sanskrit at the new college of Fort William, and in acknowledgment of this honour Colebrooke, too busy to undertake lectures, wrote his *Grammar of the Sanskrit Language* (1805), valuable for its emphasis on the work of native grammarians which had previously been ignored. Among later works were papers on Hindu religious ceremonies and an *Essay on the Vedas* (1805), the first authoritative account and for long the standard work.

See *Miscellaneous Essays*, 3 vol., edited, with a life, by his son, Sir T. E. Colebrooke (1873).

COLEMANITE, a hydrous calcium borate found in California as monoclinic crystals contains 50.9% of boron trioxide, and is an important source of commercial borates and boric acid. The principal source of borax (*q.v.*) until the 1930s, the mineral was first discovered in 1882 in Death valley, Inyo county, Calif., and in the following year it was found in greater abundance near Daggett, in San Bernardino county, Calif., forming with other borates and borosilicates a bed in sedimentary strata of sandstones and clays. Beautifully developed crystals, up to two or three inches in length, encrust cavities in compact, white colemanite, they are colourless and transparent with brilliant lustre. There is a perfect cleavage parallel to the plane of symmetry of the crystals. Hardness is 4 to 4.5; specific gravity 2.42. The formula is $Ca_2B_6O_{11}.5H_2O$.

Priceite and pandermite are hydrous calcium borates with very nearly the same composition as colemanite.

COLENSO, JOHN WILLIAM (1814–1883), Anglican bishop of Natal, was one of those who become famous entirely by accident. The intellectual quality of his book, *The Pentateuch Critically Examined* (1862–79), is moderate, its literary appeal negligible and its originality doubtful, but its date and the author's episcopal dignity made it the focus of a celebrated controversy in which momentous dogmatic and legal issues were involved.

Colenso was born at St. Austell, Cornwall, Jan. 24, 1814, the son of a minor civil servant. An evangelical of latitudinarian tendencies, he hesitated between the Anglican priesthood and the Nonconformist ministry. The chief appeal of the former in his eyes was legal security of tenure; so it is ironical that he became the only bishop in modern times to be solemnly deposed by his fellow bishops. In 1836 he was second wrangler at Cambridge, and he became a fellow of St. John's college, where, after an unsuccessful interlude at Harrow school, he taught and wrote mathematical textbooks on algebra (1841) and arithmetic (1843). He took Anglican orders and became rector of Forncett St. Mary, Norfolk, in 1846, and bishop of Natal in 1853. Questions put to him by Zulu converts led him to doubt the historical accuracy of the Pentateuch. His argument was entirely mathematical; he retained from his early training a literalist interpretation of the Old Testament; so, taking Genesis to be pure history, he argued that any numerical discrepancies must decisively overthrow all the authority of the Bible. It was in his nature to follow out his own reasonings to their utmost limit; he had already been led by his observation of Zulu social customs to write justifying polygamy for African converts in certain cases.

His metropolitan, Robert Gray, bishop of Capetown, a high churchman, acting, as it seemed, in accordance with the charter given him by the crown, summoned Colenso to appear before him on a charge of heresy and convicted him. But on appeal the judicial committee of the privy council reversed the decision (March 20, 1865) and completely repudiated the legal assumptions on which both sides had acted. It said that the crown was powerless to appoint a bishop in a colony possessing an independent legislature, and so the royal courts could not uphold Gray's legal authority. For Colenso, the victory was only technical, for the royal supremacy, in which he firmly believed, was declared invalid in South Africa. Gray's legal authority disappeared, but his religious authority, to which Colenso had sworn allegiance, might be increased if the church in South Africa were recognized as autonomous. After some hesitation, the English bishops decided to fill the vacuum of authority which the privy council had declared to exist, deposed Colenso and appointed (1869) a new bishop, W. K. Macrorie, known as bishop of Maritzburg. But Colenso remained at his post, often meeting his rival in the street, ministering to a dwindling band of supporters until his death in 1883. He consecrated no new bishop; despite the privy council's decision, no official help from England was forthcoming. But his followers, though few in numbers, remained in existence as a sect, until in 1955 they were able to persuade a bishop of Anglican consecration to become their leader, despite the opposition of the archbishop of Canterbury. Colenso, in his defeat, was remarkably free from bitterness, and when Gray died in 1872 he preached in terms of heartfelt praise of the man forced by conscience to be his enemy. He remained to the end simple, stubborn, generous, devoted and sublimely unaware that any type of biblical studies larger than the mathematical could exist.

See his *Life* by Sir G. W. Cox, 2 vol. (1888). (A. O. C.)

COLEOPTERA, the scientific name for the beetles, the largest order of insects. *See* BEETLE.

COLEPEPER, JOHN COLEPEPER (CULPEPPER), 1ST BARON (d. 1660), English statesman who was an influential counselor of Charles I during the Civil War and of Charles II in exile, was the only son of Sir John Colepeper of Wigsell in Sussex. Elected member for Kent in the Long parliament, he took the popular side, supporting the earl of Strafford's attainder and being appointed to the parliamentary committee of defense in Aug. 1641. He separated, however, from the popular party on the church question, opposing the proposals to abolish episcopacy and for religious union with the Scots. In the following session he opposed the militia bill and the Grand Remonstrance. On Jan. 2, 1642, he joined the king's supporters, taking office as chancellor of the exchequer, but he disapproved of Charles's attempted arrest of five members of the commons (Jan. 4). He delivered the king's final proposals for peace at the bar of the commons on Aug. 25, 1642. In the Oxford parliament he advised concessions to secure peace. He received a peerage in 1644.

Colepeper was sent with Edward Hyde (afterward earl of Clarendon) in charge of the prince of Wales to the west in March 1645 and, after Charles's final defeat, went with the prince to the Scilly Isles and thence to France (1646). In 1648 he accompanied the prince on his unsuccessful naval expedition and returned with him to The Hague. After Charles I's execution, he pressed upon Charles II the acceptance of the Scots' proposals. Sent to Russia in 1650, he obtained from the tsar a loan of 20,000 rubles. The treaty between Oliver Cromwell and Cardinal Mazarin in Aug. 1654 compelled Colepeper to leave France for Flanders.

At the Restoration he returned to England, but survived only a few weeks, dying on June 11, 1660. He was succeeded in turn by his three sons, the title becoming extinct in 1725.

(S. R. BT.)

COLERAINE, a seaport, market town and municipal borough of County Londonderry, Northern Ireland, on the Bann river 4 mi. from its mouth and 27 mi. E.N.E. of Londonderry. Pop. (1961) 11,912. The main town on the east bank radiates from a central square, the Diamond, but a suburb extends west of the river across the bridge. There were once a priory, a monastery and a castle at Coleraine. The modern town of Coleraine (Cuil Rathain, "ferny corner") owes its foundation to the companies of the City of London who undertook the colonization of County Londonderry under the scheme for the Plantation of Ulster, operating through the Honourable the Irish society, founded in 1610. The society still owns property and confers benefits on the district. Industries include linen spinning and weaving, shirt and collar making, distilling, bacon and ham curing, salmon fishing and manufacture of milk products and automatic numbering machines. Coleraine is a road and rail junction. The harbour accommodates small vessels.

(HU. S.)

COLERIDGE, (DAVID) HARTLEY (1796–1849), English poet whose wayward genius achieved its most sustained expression in sonnets of great skill and sweetness, was born on Sept. 19, 1796, at Kingsdown, Bristol. The eldest son of Samuel Taylor Coleridge, he spent his childhood at Greta hall, near Keswick, Cumberland, alarming and delighting his family and the Southeys and Wordsworths by his mental agility and the "exquisite wildness" which caused his father and Wordsworth to address poems to him prophetic in their forebodings. At school at Ambleside (1808–14), he was ridiculed for his oddity but admired for his power to carry his schoolfellows into his own intensely imagined world of fantasy. He entered Merton college, Oxford, in 1815, and in 1819 gained an Oriel fellowship, but forfeited it after a year by intemperance and lack of application.

In 1820 he began literary hackwork in London, and contributed to the *London Magazine,* but again instability cut short a promising career and he returned to teach at his old school. In 1832 he moved to Leeds, to work for a young publisher, F. E. Bingley. Bingley's bankruptcy terminated the contract and in 1833 Coleridge returned to Grasmere, where, with two short intervals of teaching at Sedbergh, he lived until his death on Jan. 6, 1849. He became a legendary figure among the dalesmen, who loved "Li'le (little) Hartley" for his simple friendliness, were proud of his brilliance and pitied his excesses which, although they made him prematurely old, never destroyed either his sweetness of temperament or his intellectual ability.

Both the defects and the qualities of Hartley Coleridge's character are reflected in his writings. There are many brilliant beginnings, but few are sustained. His sonnets are sensitive, revealing acute observation and the self-knowledge which caused him to describe himself as "a thriftless prodigal of smiles and tears." His unfinished lyric drama, *Prometheus,* shows intellectual power. A scholarly edition of Massinger and Ford and his critical essays are marked by sane judgment and masterly use of the illuminating, discursive aside. His prose recalls Lamb in its learned humour and unexpectedness, and reveals a personality equally lovable though fatally flawed.

BIBLIOGRAPHY.—Bingley published *Poems* (1833); *Essays and Marginalia* and *Poems,* with a memoir by his brother Derwent, appeared posthumously (1851). His *Letters* were ed. by G. E. and E. L. Griggs (1937). *See* also E. L. Griggs, *Hartley Coleridge* (1929); H. Hartman, *Hartley Coleridge* (1931).

COLERIDGE, JOHN DUKE COLERIDGE, 1ST BARON (1820–1894), lord chief justice of England, was the eldest son of Sir John Taylor Coleridge. He was born at Heath's Court, Ottery St. Mary, on Dec. 3, 1820, and was educated at Eton and Balliol college, Oxford, of which he was a scholar. He was called to the bar in 1846, went the western circuit, and in 1865 was returned as a Liberal member for Exeter. In 1868 when the Liberals returned to power Coleridge was made first solicitor general and then (1871) attorney general.

His arrival in parliament strengthened the body of Oxford men who had attacked the legislation that kept the university under ecclesiastical domination. In addition to his own talents he carried weight with the clerically minded section as the eldest son of Sir John Taylor Coleridge; as the godson of John Keble; and as the great-nephew of the man who was an indirect cause of the Anglican revival of 1833—Samuel Taylor Coleridge, the poet.

The Tichborne trial of 1871–73 (*see* TICHBORNE CLAIMANT), involving a contested inheritance, was the most conspicuous feature of Coleridge's later years at the bar and taxed his powers as an advocate to the uttermost, though he was assisted by Charles (afterward Lord) Bowen (*q.v.*). In Nov. 1873 Coleridge succeeded Sir W. Bovill as chief justice of the common pleas, and in 1874 was raised to the peerage. In 1880 he was made lord chief justice.

In jury cases his quickness in apprehending facts and his lucidity in arranging them were remarkable. He was not one of the most learned of lawyers, but he was a great deal more learned than many thought, and as an ecclesiastical lawyer had few superiors. His fault—natural in one who had been so successful as an advocate—was that of being too prone to take one side, and he allowed political or personal prepossessions to colour the tone of his remarks from the bench. Latterly his health failed, and he became somewhat indolent.

Coleridge's addresses and papers have not been published. One of the best and most characteristic of the man was his inaugural address to the Philosophical institution at Edinburgh in 1870; another was a paper on Wordsworth (1873). He was an exceptionally good letter writer. He was sarcastic and critical, and at times oversensitive. But his strongest characteristics were love of liberty and justice. By birth and connection Conservative, he was a Liberal by conviction. He died in London on June 14, 1894.

His *Life and Correspondence,* ed. by E. H. Coleridge, was published in 2 vol. in 1904; *see* further Edward Manson, *Builders of Our Law* (1904); for the history of the Coleridge family *see* Lord Coleridge, *The Story of a Devonshire House* (1907).

COLERIDGE, SAMUEL TAYLOR (1772–1834), English poet, lecturer, journalist, and critic of literature, theology, philosophy and society. Known as the author of *The Ancient Mariner,* or as an opium addict, or as the friend of Wordsworth or as Carlyle's "Oracle of Highgate," he has been obscured rather than comprehended by vague and imperfect epithets.

Early Years, School and University.—The distortions of fact and interpretation, some of them self-inflicted, that were to

pursue him begin with the time and place of his birth. He was born at Ottery St. Mary, Devon, on Oct. 21, 1772. The general opinion about the place has often been erroneous; it was the old King's school in Ottery St. Mary, not the vicarage. He himself was wrong about the date; he lived under the impression that he was a day and a year older than he was and suffered guiltily all his life from procrastination and an oppressive sense of wasted time. His father, John Coleridge, was headmaster of the King's school and later vicar of Ottery St. Mary. Described by S. T. C.—so he often styled himself—as "a perfect Parson Adams," he was also a scholar. Coleridge was said to resemble him physically and he had certain intellectual affinities with him. By him the child's mind was "early accustomed to the Vast"; *i.e.*, the starry heavens and Platonic theology. His sudden death when Coleridge was seven was, according to Coleridge's autobiographical letters to Thomas Poole, what would now be called a traumatic experience. S. T. C. was the youngest of ten children, nine boys and one girl, but far from being the spoiled darling of the household, he was solitary, moody and, as he said, "a tall-tale," temperamentally alien from his brothers. Like them, his mother appears to have been ambitious in practical ways for her sons, but not especially tender toward her least conventional and most imaginative child.

In his ninth year Coleridge entered Christ's Hospital, the noteworthy facts of his school days there being, in addition to loneliness and possibly the beginnings of ill-health, his friendship with Charles Lamb and the acute and strenuous instruction of James Bowyer in English composition, described in *Biographia Literaria*. There too began his first love affair, with Mary Evans, broken off, unhappily and with misunderstanding, in 1794.

In Oct. 1791 Coleridge entered Jesus college, Cambridge, as a sizar (as Wordsworth had entered St. John's) and went down in 1794 without a degree. The most notorious episode of his college life was his runaway enlistment in the 15th light dragoons, in Dec. 1793, out of embarrassment over college debts, and his return to Cambridge, bought out of the army by his family, in April 1794. More important facts of his undergraduate days were: his winning the Browne gold medal in 1792 for a Greek ode on the slave trade; his reputation for conversation, sociability and a lively interest in contemporary thought; his ardent support of William Frend in his trial by the university authorities for his liberal *Peace and Union* pamphlet in 1793; and his meeting during his last Cambridge long vacation in 1794 with Robert Southey, and their scheme for founding a utopian or "pantisocratic" community on the banks of the Susquehanna river in America.

Life with Southey, Marriage to Sara Fricker and Meeting With Wordsworth.—For the first half of 1795 Coleridge and Southey lived together in Bristol, writing, planning and lecturing. Southey's defection from pantisocracy led to a quarrel which lasted for about a year from Sept. 1795. However, 1795 saw them both giving public lectures, more controversial than profitable, Southey's on historical, Coleridge's on political and theological subjects. *The Plot Discovered* and *Conciones ad Populum* were at once published, probably as evidence for the defense in case it were needed against a threatened charge of treason. (These were reprinted by Sara Coleridge in *Essays on His Own Times*, 1850.) Six theological lectures were given and exist in incomplete reports. Of a course of six political lectures announced on "A Comparative View of the English Rebellion Under Charles the First and the French Revolution," there are no known records.

For all this mundane if idealistic activity, it is perhaps worthy of note that the youthful Coleridge was already in 1797 referred to as a "bard" (so nicknamed a year later by the villagers of Nether Stowey) in verses addressed to him in *Felix Farley's Bristol Journal*. His friend Joseph Hucks, with whom he had taken a walking trip in Wales in 1794, in a volume of poems (1798) two years before his early death, addressed some "Lines to S. T. Coleridge." They show clearly the community of idealistic interests of the young men of this period: protests against the condition of the poor, opposition to the war against France, and attacks on the slave trade, as well as sentiments for solitude, moonlight, ruins and the like; they also suggest Coleridge's intellectual leadership.

The most unfortunate and almost the sole consequence of the plan for an ideal community (necessarily based on a group of married couples) was Coleridge's imprudent and apparently half-reluctant marriage on Oct. 4, 1795, to Sara Fricker, sister of Edith Fricker, later Mrs. Robert Southey. It appears from some reminiscences dictated in old age to her daughter that Sara Fricker at one time expected Southey to marry her, a fact which might help account for Southey's pressure on Coleridge to carry through a rash and immediately regretted proposal of marriage and for Sara's acrimonious comparisons of S. T. C. with Southey as husband, which, among other temperamental and practical difficulties from both sides, eventually made the Coleridge marriage a failure.

Coleridge's youthful reputation as poet was based on a few short poems in the *Cambridge Intelligencer* and the *Morning Post*, on the play *The Fall of Robespierre* (written in Aug. and published in Oct. 1794) and on other poems, such as "Religious Musings," circulated among friends. His literary and social interests in Bristol introduced him to the bookseller and publisher Joseph Cottle and, in autumn 1795, to William Wordsworth.

From the time of his meeting with Wordsworth and his marriage to Sara Fricker, Coleridge was beset by a continual conflict which in a sense these events represented: the struggle to realize and release his creative abilities; and the struggle with what he called "bread and cheese," the effort to be a practical husband, father and professional man. The conflict, acute enough in the economic conditions of the wars against France, was not lessened on the professional literary side by the shifting intellectual currents and values of the period after the French Revolution. Coleridge's personal problem was also exacerbated, to an extent unrealized either by him or his circle of family and friends, by what the autopsy after his death in July 1834 showed to be a progressive disease going back at least to this time: a disease of heart and lungs which made him appear neurotic or hypochondriacal all his life, *i.e.*, a greatly enlarged heart and liver and cysts on the lungs. This physical state, usually referred to in connection with his later life and death, may well have been one of the governing facts of Coleridge's life from about 1795.

First Collection of Poems and Literary Collaboration With Wordsworth.—For the first four years of his marriage, the practical problem was met partly by newspaper contributions and book reviews, the full extent of which is only now being discovered. On his own initiative a periodical called the *Watchman*, largely written by him with some articles by Thomas Poole and a few others, was published from March to May 1796, but it ended with the tenth number, a financial disaster as Coleridge's domestic responsibilities at this time included not only his wife and child but her mother and brother. The crisis was smoothed over with help from Poole, Josiah Wade, George Dyer and perhaps others, and by Cottle's publication in April of *Poems on Various Subjects*, Coleridge's first collection of poems. At the close of 1796 he wrote and published separately his *Ode to the Departing Year*. On the last day of the year, the Coleridges moved to Nether Stowey to be near his friend and benefactor, the public-spirited tanner Thomas Poole. The year 1797 saw a second edition of the *Poems*, "To which are now added Poems of Charles Lamb and Charles Lloyd." By Coleridge's own account, 1797 also saw the beginning of "The Ancient Mariner" and the writing of "Kubla Khan" at Brimstone farm on the northwest coast of Somerset close to Culbone church; the ending of "Kubla Khan" was lost forever by the interruption of the unknown but now notorious "person from Porlock" who called on Coleridge there. Coleridge's 1797 date has been disputed by Elisabeth Schneider but accepted on probably stronger grounds by E. K. Chambers, H. M. Margoliouth and others. *Osorio*, a tragedy, was also written in 1797 but was rejected for Drury Lane theatre by Sheridan, whose jeers and failure to return the manuscript became a cause of grievance.

That autumn Coleridge also met Thomas Wedgwood, as a result of whose friendship he received from Thomas and his brother Josiah early in 1798 an annuity of £150 a year on condition that he give up the idea of becoming a Unitarian minister and devote himself to writing. Hazlitt, who met Coleridge at Shrewsbury when he preached there, has described Coleridge as preacher in his essay "My First Acquaintance With Poets." Coleridge was much in-

volved with Unitarians at this time and sympathetic to their rational theological and liberal political views, but he was undoubtedly relieved to be free of close subscription to any particular dogma and a confined way of life. The relief from pressing financial worries and the increasingly close intimacy with the Wordsworths released a flow of some of his best poems, "Frost at Midnight," the completion of "The Ancient Mariner," "Christabel" (part 1), "Fears in Solitude," "The Nightingale" and *France, An Ode* (or *The Recantation,* as it was once called). In Sept. 1798 the *Lyrical Ballads* was published by Cottle, an anonymous volume opening with "The Ancient Mariner" and ending with Wordsworth's "Tintern Abbey"; there were three other poems by Coleridge, 19 by Wordsworth.

The close literary collaboration, one of the most far-reaching and influential in the history of English literature, though based on a friendship that lasted about 15 years, was relatively brief. In Sept. 1798 Coleridge and the Wordsworths—William and his sister Dorothy—went to Germany to learn the language and something of the literature and philosophy, the Wordsworths to Goslar and Coleridge to Ratzeburg and to Göttingen, where he matriculated at the university in Feb. 1799. He appears to have spent an energetic few months learning the language and attending lectures on various subjects. He was also said to be "the life of the party" socially, speaking German badly but volubly. In April he had word from Sara of the death of their second son Berkeley. In July he returned to England and Stowey and renewed his broken friendship with Southey by a walking trip in Devon. In Oct. 1799, with Cottle, he went north at Wordsworth's invitation and for the first time saw the Lake district, with John and William Wordsworth. It was on this journey, at Sockburn in Yorkshire, that he first met Sara Hutchinson (whose sister Mary was later to marry Wordsworth). The love of Coleridge and Sara from the beginning was deep and painful, for Coleridge, who had long realized the imperfection of his marriage to the other Sara, did not believe in divorce. He returned to London as leader writer for the *Morning Post* and to begin a translation of Schiller's *Wallenstein* from a manuscript made available by Schiller.

Leader Writer for the "Morning Post"; Life at Keswick.—In spite of the stresses of his personal life, his *Morning Post* contributions of this—as of later periods—are vigorous journalism of a high order, opposing the Pitt ministry and the war against France and advocating liberal and moderate yet anti-Jacobin views. He reported parliamentary debates and wrote some skilful and cogent pieces; *e.g.,* on Grenville and on Pitt.

The translation of *Wallenstein* he found a "soul-wasting" business, and in April, the moment it was finished, he left London for the north, paying his first visit to Dorothy and William Wordsworth in Dove cottage. He then went to Stowey and Bristol to visit his friends there and to join Mrs. Coleridge and his son Hartley. After considerable conflict about whether to settle in the south near Poole or in the north near Wordsworth, the issue was decided by Dorothy Wordsworth's practicality in finding a house for him at Keswick; the Coleridges settled in Greta hall in July 1800.

The description "lake poet" is thus for Coleridge a misnomer. Actually his periods in the lakes were short, a broken one from July 1800 to Jan. 1804, and another shorter stay from Aug. 1808 to Oct. 1810. The decision to live there may have been one of his most serious errors. Mrs. Coleridge was unhappy, separated from her family and acquaintances; Coleridge himself found the climate too cold and wet for his asthmatic and rheumatic condition; and even the society of the Wordsworths 16 mi. away in Grasmere was less consoling than having Poole next door, especially after Aug. 1800 when Charles Lloyd, mischief-maker among them all and satirist of Coleridge in his novel *Edmund Oliver* (1798), settled at Ambleside and by mere proximity disrupted the peace of Coleridge's visits to Dove cottage.

Another and perhaps chief element in his unhappiness, frustration and self-disappointment, was his sense of the loss of creative imaginative power by continual comparison of himself as poet with Wordsworth. The contrast between his own misery and inertia, and Wordsworth's increasing power and happiness was symbolized in Wordsworth's publication over his own name of the second edition of the *Lyrical Ballads* (1800) without (as had been intended) the addition of "Christabel"; in 1802 his marriage to Sara Hutchinson's sister Mary sharpened the contrast. A tour of Scotland in 1803 undertaken by Wordsworth, Dorothy and Coleridge showed a few premonitory signs of difficulties between them. They separated after 15 days and Coleridge walked with almost disastrous energy 263 mi. in eight days, apparently making an effort to conquer the opium habit by violent physical exertion.

Stay in Malta and Italy.—At the end of 1803 he decided that a warmer, drier climate was essential to his health (already breathing had become frequently difficult) and felt also that he must escape from the whole complex of emotional conflicts represented by Greta hall and Dove cottage, Keswick and Grasmere. His self-awareness has been insufficiently known, as the notebooks now demonstrate. In a painful and lonely state of mind he sailed in 1804 for Malta, one result of the semitropical voyage being some interesting revisions and additions to "The Ancient Mariner." Arriving in May, he became in July private secretary to the acting governor, Alexander Ball, and in Jan. 1805, on the death of the public secretary, he assumed that office temporarily. This is one of the least-known, and in practical activity one of the busiest, periods in Coleridge's life, in literary respects one of the least productive. Yet Coleridge in six months had learned sufficient Italian to understand even the rapidly spoken Italian of angry seamen in dispute: he had mastered the problems of Maltese and Sicilian economy so far as to prepare reports for Ball and to support him in the view that Malta had strategic importance to Britain not only as a military base but as the potential granary storehouse of the Mediterranean. He also wrote (with Charles Pasley) on the advisability of Britain's cultivating Egypt rather than relying on the West Indies for cotton, sugar, fruits, etc. His summer vacation (Aug. to Nov. 1804) in Sicily gave him a wide insight into Mediterranean problems, took him twice up Etna and acquainted him with a number of U.S. naval officers, including the distinguished Stephen Decatur and Comdr. Edward Preble, whose ships were stationed at Malta and Sicily during the American-Tripolitanian war. Coleridge's sympathy with the American Revolution and American views was extended and developed by the experiences and acquaintances of this period and especially by his friendship with the American painter Washington Allston, whom he met in Rome a few months later, in Jan. 1806.

The work as acting public secretary in Malta detained him there until Sept. 1805 when the new public secretary, Edmund Chapman, arrived. Worsening health, boredom with the narrow social confines of Malta, loneliness in the entire absence of literary or any intimate society and the sense of a profitless dead-end existence made him anxious to return home. There he felt he might usefully advocate the cause of the Maltese and a more aggressive British policy in the Mediterranean, especially in regard to Egypt. He had hoped to be franked home overland as a government courier, but the end of the year 1805 which saw the battles of Ulm (Oct. 19) and Austerlitz (Dec. 2) was a poor time for English travelers in Europe. On leaving Sicily he went first to Naples where he had an introduction from Alexander Ball to Hugh Elliot, the British ambassador to the court of Naples, whence he took a mysterious journey lasting two or three weeks into the depths of Calabria. He returned to Naples just in time to hear of Nelson's death at Trafalgar. In Naples he stayed some weeks with the English painter George Wallis, through whom he may have met other English artists when he reached Rome on Dec. 31, 1805; one of these, a young student named William Russell, from Exeter, gave him some much-needed financial help. In Rome he met the artist colony, of whom Washington Allston was one of the more important members, and various other interesting persons, such as Ludwig Tieck (with whom he was to resume a connection years later at Highgate), the Prussian ambassador Wilhelm von Humboldt and his brother Alexander, the scientist. As in Germany, so in Malta, Sicily and Italy, Coleridge wherever he went attracted or was attracted to an eminent literary and intellectual society and appears to have been at ease in what, it seems, was his natural social milieu; in this geniality he was very different from Wordsworth, the reserved northerner.

Allston painted a portrait of Coleridge at this time and though it was never finished it is one of the most attractive and one of the best. With Allston he saw many works of art though unfortunately the records of his comments are few, possibly from the loss of many of his papers on the homeward journey. In turn, he exerted a considerable influence on Allston's own work and on his views of literature and painting, as Allston's lectures and letters testify.

It is some indication of the scale of warfare in those days that on being advised to quit Rome to avoid the French, Coleridge went about 30 mi. into the country to stay with Allston in his villa at Olevano Romano. From there he returned to Rome and left on May 18 with young Russell for Florence, Pisa and Leghorn. A story about his having left Rome hurriedly in Cardinal Fesch's carriage appears to have been garbled or largely invented. It is true that he had advance warning to leave because of the approaching French army, but he did not leave suddenly, nor by stealth in a carriage: whether or not he was on Napoleon's black list because of his articles in the *Morning Post* and whether he was warned of it by some emissary of the pope, as he stated in *Biographia Literaria*, is not corroborated. In the atmosphere of the times there is no reason to doubt the possibility. In Florence he was seriously ill, and until June 23, when he finally embarked at Leghorn in a U.S. ship, he was much preoccupied with the difficulties of finding a passage home. This may account for the fact that there are almost no records of his response to Florentine art, though he was frequently to refer later to the "Triumph of Death" murals at Pisa, but in a moralistic rather than an aesthetic context.

The journey homeward took 39 days, to which were added 17 days at the end for quarantine. He had been acutely ill on the ship and landed at Stangate creek in Kent on Aug. 17, 1806, about two years and four months after his departure from Portsmouth, very much the worse physically, financially and emotionally for his severe, lonely experience. On the positive side, the chief gains were a certain cosmopolitanism of sympathy and enlarged views of English foreign affairs, as well as an enhanced though critical patriotism, which appear in his later writings.

Years of Depression, 1806–1816.—Coleridge's life may be viewed as a composite of several careers (poet, preacher, lecturer, playwright, journalist, reviewer and miscellaneous writer), all broken off from time to time, but a recurring pattern appears in almost every decade from 1794 to 1834. In 1806 on his return to England, therefore, he returned to several of these occupations. He procrastinated in returning to Keswick; he was undoubtedly loath to return to Mrs. Coleridge and the tensions of Greta hall and to face the Dove cottage circle with his sense of failure and deterioration, but at the same time he was also very short of money, perhaps even for the fare, and was trying to find work with the foreign office and then with newspapers. An article for the *Courier* on Charles James Fox, recently dead, appears to have been proposed but not written. He began rewriting *Osorio*, and was invited by the Royal institution to give a course of lectures, to which he felt unequal. He visited Thomas and Catherine Clarkson at Bury St. Edmunds and went north with them via Cambridge where he saw Richard Porson again (who may have introduced him years before to William Godwin); here he paid a small debt and was shocked by the gambling at Newmarket. He arrived on Oct. 26 at Kendal, where the Wordsworths and Sara Hutchinson were alarmed by his unhealthy appearance. Two weeks in Keswick were enough to convince him that the incompatibility of their temperaments made separation from Mrs. Coleridge inevitable. In December he took his son Hartley with him to Coleorton, the country house of Sir George Beaumont, where the Wordsworths and Sara Hutchinson were spending some weeks. The old easy atmosphere was, however, not recaptured. Coleridge grew jealous of what he interpreted, in an unhappy episode and in Sara Hutchinson's attitude, as a preference for Wordsworth and a diminution of affection for him. It was one of many blows, exaggerated in effect by illness and despair.

The year 1807 was almost a total loss in Coleridge's life so far as productivity is an indication of vitality. It was further vitiated by the reduction of the Wedgwood annuity (the whole of which for years had gone to Mrs. Coleridge and her mother) and by inability to form any clear plan of work or settle on any fixed abode. He lived in this year chiefly with Poole, with Bristol friends and with John and Mary Morgan and Mrs. Morgan's sister, Charlotte Brent; with the three last he appears to have reproduced a faint facsimile of his relation to the Wordsworth household. Longman offered to publish two volumes of poems which did not materialize. A Greek grammar and vocabulary was also abortive. In this summer the earl of Egmont, greatly impressed with Coleridge's learning and eloquence, proposed that he do a theological work, and it is clear that he was thinking and talking a good deal about religion at this time and affirming and confirming his transition from a unitarian to a trinitarian position. But no fruit matured in writing. His suggestion that he should follow his nephew Edward as a master at the Ottery school was not taken up by his family. There was an additional and more rending contretemps over a proposed visit with Mrs. Coleridge and the children (precipitately in Bristol for the purpose) to Ottery, to gloss over and get approval for the separation. In August he had met the young Thomas De Quincey (*q.v.*), hitherto an unknown idolater of Coleridge and Wordsworth; in November, through Cottle, De Quincey made him a harely disguised anonymous gift of £300 and took Mrs. Coleridge back to Keswick. It now seems fairly clear that out of gratitude for hospitality, Coleridge lent or gave most of the £300 to Morgan, who was threatened with imprisonment for debt.

Yet Coleridge began 1807, barren though the year was for him, with the composition in January of the lines "To William Wordsworth" and ended it in December in London preparing his lectures for the Royal institution series on poetry. The lectures ran from January to June, a course much broken by illness and frequently very disappointing in quality.

The years after the return from Malta were years of uncertainty of every sort, personal and domestic, financial, professional and physical. Health deteriorated until Coleridge himself more than once considered the possibility of imminent death, a mental institution or laying his whole case before a doctor for treatment. In Dec. 1808 the death of his old friend, the physician Thomas Beddoes, was a blow to the third plan.

By that time he had sufficiently mastered his health temporarily to inaugurate his second private periodical, *The Friend*. Twenty-eight numbers were published in spite of unimaginable mistakes in practical judgment, difficulties of every sort and the almost unanimous discouragement of friends. From Sept. 1808 till March 1810 he had the assistance of Sara Hutchinson, who took much of it at his dictation. They were both staying with the Wordsworths at Allan Bank. But though the atmosphere was better for a time than it had been in 1807, all was not well. The Wordsworths feared for Sara Hutchinson's health and encouraged her to go to her brother Thomas in Wales for a rest. Without her support, and in the face of this overt expression of tension and disapproval, and also confronted by the evident financial and practical obstacles to continuing, Coleridge abandoned *The Friend* and went first to Keswick and then in October to London, in search of work.

On arrival in London at the home of Basil Montagu there was precipitated what has come to be known as the Wordsworth quarrel. The immediate basis was a report to Coleridge by Montagu of unkind remarks by Wordsworth about Coleridge as a guest; without judging, one can easily see in it Coleridge's inordinate vulnerability and loneliness, Wordsworth's diminished tolerance and lack of full understanding and Montagu's crass tactlessness. The breach was outwardly patched over chiefly by the efforts of Lamb and Crabb Robinson, but not until 1812; and relations were never restored to the old intimacy, probably because the emotional and intellectual "dyspathy"—a Coleridge word—was partly real; possibly it has been understated in view of the much more important positive and creative sympathy in their early association.

The years from 1810 to 1815 were surely among the most unhappy of Coleridge's life, yet in them there were sporadic bursts of activity, some highly successful. In 1811, in addition to writing for the *Courier*, he gave his second course of lectures, from Nov. 1811 to Jan. 1812 (on Shakespeare and Milton) attended by

Byron, Samuel Rogers and Crabb Robinson. He paid a visit to the lakes in the early spring of 1812, reissued *The Friend* in a single volume with a few revisions and in May–June delivered his third course of lectures, again on drama, chiefly Shakespeare. By the end of the year he had rewritten *Osorio* as *Remorse*, for which Lamb wrote a prologue. It had the unusually successful run at Drury Lane of 20 nights in Jan. 1813 and ran to four editions before the end of the year. From the spring of 1813 for the best part of the next three years, Coleridge lived with various friends in the west country, in and around Bristol, where he lectured again on Shakespeare (six lectures) and twice on education, and in April 1814 gave another course on a variety of subjects; he may have given one or two other sets of lectures. But he was ill and forced to cancel and reannounce, and newspaper reports give but an incomplete picture of events.

The most remarkable literary fact of his next year is that he began to dictate the *Biographia Literaria* to John Morgan, who, as midwife to this remarkable work, should be more known and respected than he has been. That Morgan was able to extract it at this time was a real triumph, for Coleridge was in the depths of despair about his opium addiction, now scarcely concealed; about his financial position, especially in relation to schooling and college for his sons Hartley and Derwent; and about feelings of his moral decline on almost every front. In addition—another mark of that intense inner vitality which very often mystified his friends—by the end of the year he was considering a publication, at Byron's urging, of "Christabel" and "Kubla Khan."

Last Years at Highgate, 1816–1834.—The result of all this pushing and pulling by encouraging friends was a flow of notable publications soon after his establishment at Highgate in April 1816: *Christabel* (three ed. in 1816); *The Statesman's Manual; or the Bible the Best Guide to Political Skill and Foresight* (1816); in 1817 a second *Lay Sermon; Sibylline Leaves* (the fourth and much enlarged collection of his poems); *Biographia Literaria* (two volumes originally intended as a preface to his collected poems); *Israel's Lament* (for Princess Charlotte), the translation of a poem in Hebrew by Hyman Hurwitz; and *Zapolya, A Christmas Tale*. The tide of productivity continued to flow in 1818 with a new edition of *The Friend,* enlarged significantly by the essay "On Method"; he also gave two successful courses of literary lectures. In 1818 Coleridge also produced some of his clearest and best prose in his pamphlets on behalf of Sir Robert Peel's Factory acts to protect children against exploitation in the cotton factories.

From here onward the story is one in which sorrows and disappointments loom large again, above all, Hartley's dismissal from his fellowship at Oriel college, Oxford, chiefly for uncontrolled drinking and consequent inefficiency. This was a severe blow, undoubtedly producing in his father self-recriminations worse than any public embarrassment.

It was in 1819 that an accidental meeting with John Keats took place in Millfield lane, Highgate; the evident respect and admiration of younger men as diverse as Keats, Edward Irving, Thomas Allsop, Joseph Henry Green, Julius Hare, John Sterling, F. D. Maurice and Coleridge's nephews—Edward, Henry Nelson and John Taylor Coleridge—and such recognition as Lamb's moving dedication of his *Works* (1818), were gratifications that helped to counterbalance Hazlitt's attacks in the *Edinburgh Review* and the *Examiner*. In 1822 Henry Nelson Coleridge began making notes for his *Table Talk*. There were new poems germinating and old half-forgotten ones returning to attention, notably the lovely, poignant "Youth and Age," and other shorter lyrics that deserve to be better known than they generally are. As late as 1828 "The Garden of Boccaccio" was written.

In 1824 Coleridge was elected a royal associate of the Royal Society of Literature, for which he prepared a lecture on "The 'Prometheus' of Aeschylus." This election brought him an annual stipend of 100 guineas a year. Life began to feel and to be more benign to him, though Hartley's weaknesses and Derwent's unsettled views were worries; and it transpired that his third child, Sara, was in love with her first cousin, Henry Nelson Coleridge, and that the marriage, which Coleridge could accept but never fully approve, would take place—as it did in 1829.

In 1825 *Aids to Reflection* was published, the work by which Coleridge became best known in American transcendentalist circles and which perhaps did most to fix him as the "Oracle of Highgate," in the public mind; it ran to two English editions and one American by 1831. There is an appropriateness about the fact that Hazlitt's essay in *The Spirit of the Age*, describing the kind of oracle that Coleridge had been for him in his youth, appeared in this same year. In 1827 Coleridge had a serious illness which aged him noticeably, yet in 1828 the fifth collected edition of his poems was published by Pickering in three volumes that included the plays. It is some indication of his prestige and reputation; though it was no financial help, that the 300 copies were sold out by Oct. 1828. A new and much corrected edition appeared in 1829. *The Constitution of Church and State*, Coleridge's last prose work in his lifetime, appeared in two editions—the second considerably augmented—in 1830. In 1834 the third Pickering edition of the *Poetical Works* appeared in time for Coleridge to see it before his final illness and death at Highgate on July 25, 1834.

Reputation and Influence.—The impression of the last years, in fact of the Highgate period generally, is of a growing mellowness, of a gracious and gentle manner with rays here and there of the old ebullience, now somewhat softened by time and made serene by the tenderness with which the Gillmans devoted themselves to caring for him. There were occasional lapses from grace at Highgate in the matter of opium, but in the main the addiction was under control, if not completely conquered until the 1830s. Highgate was a haven and in more than its physical features provided a kind of eminence which both fitted and fostered his powers. Wordsworth said that though he had known many great men, Coleridge was the only "wonderful" man he had ever known. Among the wonders were not only the abilities displayed in the Quantock hills in the composition of "The Ancient Mariner," "Christabel" (part 1) and "Kubla Khan" but the resilience and energy displayed in the recovery in his last years. And perhaps no less remarkable is the in-between period, a wide valley of humiliation in which nevertheless some of the best of the criticism was written or spoken.

Coleridge has been given more numerous and various reputations than perhaps any other English poet, the broad bases of agreement being—though the causes assigned are very disparate—that his powers were never fully realized in his works. Hazlitt called him "an eagle dallying with the wind," Shelley "a hooded eagle among blinking owls." John Stuart Mill, whose essay is still one of the best introductions to him, thought him, with Bentham, one of the two great "seminal" minds of his age. Thomas Love Peacock, satirizing him as Mr. Flosky in *Nightmare Abbey,* described him as living "in the midst of that visionary world in which nothing is but what is not." Opinion has shifted between such extremes as Mill's and Peacock's, but no serious historian of English thought has been able to disregard him, whether antipathetic generally, like Leslie Stephen, H. W. Garrod, and Irving Babbitt, or appreciative, as, for example, George Saintsbury, I. A. Richards, Herbert Read, Kenneth Burke and M. H. Abrams, to select but a few. On the whole, the positive attitude came to prevail.

Coleridge's stature as a poet has not been in doubt; even here his reputation has been enhanced by new attention to poems less known than the great three—"The Ancient Mariner," "Christabel," and "Kubla Khan." "The Ancient Mariner" remains, however, pre-eminent among poems in English, as a tale. Both as narrative and poem it displays those rare qualities, characteristic of Coleridge's poetry: swiftness and clarity; a constant movement of thought and feeling—outward to the natural world of sights, sounds and tangibles, suggested with piercing clarity, and inward to the inescapable enclosure of horrors and fears, vivid or half-realized but starkly expressed; the close observation of both the minute and the panoramic, the miniscule insect and the tropical ocean where "at one stride comes the dark" or a harbour where "the bay was white with silent light"; and, on another level, the insight into the particular and the sweeping sense of the Infinite and the One. And all is controlled by so firm an architecture and so free-flowing a metre as to seem effortless.

His pre-eminence as a critic is almost equally accepted, though

not everyone would go so far as Saintsbury in his *The History of English Criticism* (1911), "So then there abide these three, Aristotle, Longinus, and Coleridge . . . we cannot quite say he is the greatest of the three . . . but his range is necessarily wider." But there are many for whom he is the most important English critic, chiefly because he raised central questions about criticism itself, its methods and philosophical basis. Yet in this field where he is preeminent, he is blamed or credited, according to the propounder, on the one hand with confusing life and literature and leading criticism in the direction of the moral absolutism of such critics as A. C. Bradley, and, on the other, in a glossary of the "new criticism," receives at the least verbal homage of being treated as its fountainhead; his influence on the criticism of the third to the sixth decades of the 20th century, from I. A. Richards onward, is very marked, and increasingly so. Briefly, it depends on his view of literature as requiring that marriage of emotion and thought be described as imagination; of the poem as essentially not a fixity but a continuing dynamic process in poet and reader, and as such, capable of incorporating truths and materials pertaining to any area of life and of articulating the less-than-conscious levels of experience—in fact, universal, and open to reinterpretation in successive ages. The function of criticism itself he conceived to be the lifting of all these elements into awareness, not the prescribing or even describing of rules that can neither be adequately formulated by the critic nor adhered to by the writer, but rather the elucidation of what he called "the principles of grammar, logic and psychology," *i.e.*, the basic elements of the writer's medium (language), of his instrument (the human mind) and of human capacities and needs—the arc of the writer's limits and purposes.

For his journalism, it has been claimed that he set a new standard by being both more faithful and more original and imaginative than others; yet though he was valued by his editors for contributions that increased the circulation of their papers, he was notoriously unreliable with copy and left a trail of unfulfilled commitments behind him. As a social critic he is denounced by some as the youthful, renegade radical turned Tory and opponent of the Reform bill; to others he is the Tory who never forgot his radical conviction of the primacy of social over political considerations and whose thinking was a force among early Christian socialists. Theologically he has been claimed and attacked both by high church Tractarians and liberal Anglicans of the broad church movement, and has been credited with restoring the church to a sense of its real function and with introducing the "higher criticism." Philosophically to him has been attributed the first introduction of German transcendentalism into England by an Englishman and by others his knowledge of German philosophy has been derided or denied. By some he is regarded as more specifically a Platonist of the school of Plotinus and again, "before Kierkegaard was born, Coleridge had already formulated the existentialist philosophy" (Herbert Read). The followers of Freud and Jung both see in his work premonitions of the sort of psychological analysis they favour.

It will be seen that Coleridge has been looked upon as the founder or forerunner of enough antipodal theories to make one suspicious of attempts to assign him to any one school or any one school to him. Vagueness or a careless eclecticism cannot necessarily be deduced from this, but rather the vitality of his thought, and, contrary to some firmly entrenched opinion, its inquiring rather than dogmatic tendency.

In all his roles, as poet, social critic, literary critic, theologian, psychologist, Coleridge displays a continuous concern with the creative principle as central to the human being and, anagogically, to the universe. The imagination is a paradigm of the Logos. But it is also a psychological term for an observable form of human activity. Coleridge combines a sense of the universal and ideal with an acute observation of the particular and the sensory. In the poems this interplay of larger and smaller forces, of objective and subjective, of the generic and the individual, is to be seen, for example, in "The Ancient Mariner" in the close relation between the elements and the mariner's inner states; similarly in "Dejection," "Frost at Midnight" and many others. In social criticism it means an insistence on seeing "The constitution of Church and state according to the idea of each," and the need of individuals to be treated as persons. In literary criticism it means critical attention to the powers of the human mind and the limits of criticism generally and particular attention specifically to the text and to the meanings of each single word in the text. In biblical criticism it means an apprehension of the Bible as a storehouse of ineffable truths and also as close a critical attention to it, textually and historically, as to any other literary document. Psychologically it means the awareness of the human psyche as a whole and a dismissal of 18th-century faculty psychology, along with much subtle analysis of mental states, including a clear anticipation of Freud in observations of varying degrees of consciousness, including the concept of the unconscious mind.

In this last connection it should be pointed out finally that one of Coleridge's chief contributions is the strenuousness with which he followed the Socratic injunction, "Know thyself." His failures here, as in other respects, are obvious; but the attempts are notable and are becoming more fully known with the publication of more and more manuscript remains—letters, notebooks, marginalia, etc. As time goes on, the judgments of an earlier day are modified. The opium taking, the procrastination, the domestic difficulties are seen to have their physiological and otherwise understandable causes, not innate but circumstantial and psychological. Here is found one of the most capacious imaginations in the history of English literature and thought articulating, in spite of complex frustrations and sometimes with extraordinary beauty and a kind of power given to very few human beings, the myriad aspects of the human condition without isolating them from one another. He enriches the awareness, both in breadth and depth, of any reader who reads him in his own spirit of inquiry. *See* also references under "Coleridge, Samuel Taylor" in the Index volume.

BIBLIOGRAPHY.—For a bibliography of Coleridge *see Cambridge Bibliography of English Literature,* vol. iii (1940) and supplement, vol. v, pp. 556–565 (1957).

A complete edition of his works, in progress in 1961, was to appear in approximately 20 vol. published by Rupert Hart-Davis, London, and the Bollingen foundation, New York. By the early 1960s there was no adequate biography. The first full-length one by James Dykes Campbell (1894) is superseded by much new information, and that by E. K. Chambers (1938) is too antagonistic and intellectually limited to be sound, even factually, on personal matters, though it provides a compressed and useful compendium of the more strictly external information.

Of the poems the standard edition is that of E. H. Coleridge, 2 vol. (1912). Of the *Biographia Literaria* the best editions are those by Sara Coleridge, 2 vol. (1847), the 2-vol. ed. by J. Shawcross (1907) and the Everyman edition by George Watson (1956; rev. 1960). The remainder of the literary criticism is most conveniently found, but not by any means complete, in *Coleridge's Shakespearian Criticism,* 2 vol. (1930) and *Coleridge's Miscellaneous Criticism* (1936), both ed. by T. M. Raysor. Some of the political writings were collected by Sara Coleridge in *Essays on His Own Times,* 3 vol. (1850), and these and others have been selected by R. J. White in *The Political Thought of Samuel Taylor Coleridge* (1938) and have received a clear and dispassionate commentary by John Colmer in *Coleridge, Critic of Society* (1959).

The philosophical materials, much of which were long unpublished, are produced in various forms—lectures, marginalia, fragments—in *The Philosophical Lectures of Samuel Taylor Coleridge,* ed. by Kathleen Coburn (1949), A. D. Snyder, *Coleridge on Logic and Learning* (1929), and E. H. Nidecker's publication of numerous marginalia on German philosophers in the *Revue de littérature comparée* (1927–32). J. H. Muirhead's *Coleridge as Philosopher* (1930) has a strong 19th-century idealist bias.

Among the monographs on Coleridge on a variety of subjects, the following make interesting contributions to knowledge of Coleridge, and some incorporate new material: John Livingston Lowes, *The Road to Xanadu* (2nd ed., 1930; rev. 1951); Stephen Potter, *Coleridge and S. T. C.* (1935); I. A. Richards, *Coleridge on Imagination* (1934; 2nd ed. 1950); Kathleen Coburn, *Inquiring Spirit: a New Presentation of Coleridge from His Published and Unpublished Prose Writings* (1951); E. Schneider, *Coleridge, Opium and Kubla Khan* (1953); R. Florence Brinkley, *Coleridge on the 17th Century* (1955); J. Beer, *Coleridge the Visionary* (1959); the *Collected Letters,* in six volumes, ed. by E. L. Griggs, began appearing in 1956; the *Notebooks,* ed. by Kathleen Coburn, in 1957. *A Concordance to the Poetry of Samuel Taylor Coleridge,* ed. by Sister E. Logan, was published privately (1940). The marginalia are to be collected but by 1961 were to be found largely in periodical articles (see *Cambridge Bibliography of English Literature,* vol. v). (K. Co.)

COLERIDGE, SARA (1802–1852), English writer, the only daughter of Samuel Taylor Coleridge, a scholar in her own right,

editor of her father's works and also the author of verses for children. She was born on Dec. 22, 1802, at Keswick, Cumberland, where Coleridge lived with his brother-in-law, Robert Southey. Coleridge was seldom at home and Southey was the chief influence on Sara's early years. In fact she did not see her father between 1812 and 1822, when she visited him at Highgate with her mother. Thereafter his influence developed rapidly. In 1822 she translated from the Latin Martin Dobrizhöffer's *An Account of the Abipones*, with which her father was delighted. In 1825 she followed it with a translation of the *Memoirs* of the Chevalier Bayard.

In 1829 she married her cousin, Henry Nelson Coleridge. For her children she wrote *Pretty Lessons in Verse for Good Children* (1834) and *Phantasmion* (1837), a fairy story with some delightful lyrics. She thus anticipated a minor branch of Victorian literature. When her husband died in 1843 he left unfinished the task of editing Coleridge's works. She continued it, and made several contributions to Coleridgean studies, notably an "Essay on Rationalism" appended to the 5th edition of *Aids to Reflection* (1843), and a supplement and exhaustive notes to the 2nd edition of *Biographia Literaria* (1847). At the end of her life she formed many literary friendships, her comments on them being preserved in *Memoir and Letters of Sara Coleridge* (1873), by her daughter Edith. She died in London on May 3, 1852.

See E. L. Griggs: *Coleridge Fille* (1940). (P. M. Y.)

COLERIDGE-TAYLOR, SAMUEL (1875–1912), a British composer who enjoyed considerable acclaim in the early years of the 20th century, was born in London on Aug. 15, 1875. His father, distressed by his inability to progress as a physician—through apparent racial prejudice—deserted his son and English wife and returned to his native west Africa. At the age of five Samuel began playing the violin and joined the choir of a Presbyterian church in Croydon, where H. A. Walters guided his progress and arranged his admittance to the Royal College of Music in 1890.

Coleridge-Taylor studied composition there with C. V. Stanford. While still a student he published some anthems, but his creative gifts were more apparent in various colourful instrumental works. In 1896 he became conductor of an amateur orchestra in Croydon and began teaching, peripatetic conducting, recital work and adjudication of music festivals in order to support his wife and two children. He persisted as composer and was an early success at the Gloucester festival—to which he was recommended by Edward Elgar—with an orchestral *Ballade* (1898), which was followed by his outstanding achievement, the Longfellow trilogy of *Hiawatha's Wedding Feast* (1898), *The Death of Minnehaha* (1899) and *Hiawatha's Departure* (1900). In these and numerous other works including incidental music, choral works and a violin concerto (1911), influences from Dvořák, Tchaikovsky and Grieg appear, along with a spontaneity derived from appreciation of negro folk music. In this respect Coleridge-Taylor was a pioneer. He was well received in the United States (1904, 1906, 1910), and enjoyed the respect of H. T. Burleigh, Horatio Parker and G. W. Chadwick. He died at Croydon, Surrey, on Sept. 1, 1912.

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COLET, JOHN (1466?–1519), English theologian and founder of St. Paul's school in his native London, was educated at Oxford, probably at Magdalen college, and then spent three years traveling and studying in France and Italy. Returning to England *c.* 1496, he was ordained. He lectured at Oxford on the Pauline Epistles, his exegesis of which was so original that he attracted large audiences. He was appointed dean of St. Paul's cathedral in 1504. His unsuccessful attempt to reform the cathedral chapter was partially compensated by his foundation and endowment of St. Paul's school (*c.* 1509). He died at Sheen, Surrey, Sept. 16, 1519.

In collaboration with Erasmus, Thomas More, William Grocyn and Thomas Linacre, Colet enthusiastically promoted the new learning of the Renaissance. His devotion to the ethos of Christian humanism expressed itself in several ways: in the statutes of St. Paul's school he insisted that the classics be taught; for the most part he expounded the Scriptures in a critical manner; he exulted at the publication of Erasmus' edition of the Greek New Testament (1516); he adopted as his philosophy the Neoplatonism of Plotinus, the "Pseudo-Dionysius" and the contemporary Florentines Marsilio Ficino and Giovanni Pico della Mirandola; and finally he inveighed against the ecclesiastical abuses of his day. Grieved and angry because the church fell far short of the pristine purity of the apostolic age, he so fearlessly denounced the sins of the clergy that he incurred the suspicion of heresy. Yet, although he anticipated the Protestant reformers in his attack on corruption, the evidence suggests that he would have opposed any breach with Rome.

Colet's works, most of which remained unpublished until the 19th-century editions of J. H. Lupton (1867–76), include commentaries on Romans and Corinthians and treatises on the sacraments, the church and the *Hierarchies* of Pseudo-Dionysius. His statutes for St. Paul's school and a Latin grammar written for the school are printed in Lupton's *Life of John Colet* (1909).

See E. W. Hunt, *Dean Colet and His Theology* (1956). (E. W. Hu.)

COLET, LOUISE (née Revoil) (1810–1876), French poet and novelist who was a close friend of Alfred de Musset, Gustave Flaubert and Victor Hugo. Born on March 9, 1810, at Aix-en-Provence, in 1834 she went to Paris where her salon became a haunt of many writers and artists. With Flaubert she had a stormy relationship, lasting eight years, which was responsible for his splendid *Lettres* addressed to "la Muse." After her violent estrangement from him, she avenged herself in a novel entitled *Lui* (1859), which caused a sensation at the time. Her other works include *Fleurs du Midi* (1836), *Penserosa* (1839) and *La Jeunesse de Goethe* (1839) for which, through the agency of Victor Cousin, she received Academy prizes and a pension. She died in Paris on March 9, 1876.

See Gérard Gailly, *Les Véhémences de Louise Colet* (1934) and J. F. Jackson, *Louise Colet et ses amis littéraires* (1937). (R. Dl.)

COLETTE, SAINT (1381–1447), reformer of the Poor Clares, founder of the Colettine Poor Clares, was the daughter of a carpenter, named Boillet, at the monastery of Corbie, France. Orphaned at 17, she entered the third order of St. Francis, living in a hermitage given her by the abbot of Corbie. Her austere way of life drew many visitors; when they ceased to come, she lived in seclusion for three years. Charged by St. Francis in a vision to restore the Poor Clares to the severity of their rule, she undertook the task in 1406. Perceiving the need of strong ecclesiastical authority, she at once visited the antipope Benedict XIII, who took her into the Poor Clares and made her abbess over all the houses she might found or reform. Despite initial opposition, her reform made rapid headway in Savoy, Burgundy, France, Flanders and Spain and spread more rapidly after her death. She was canonized in 1807, and her feast day is March 6. (J. N. G.)

COLETTE, SIDONIE GABRIELLE (1873–1954), the most famous French woman writer of her day, member of the Belgian Royal Academy and the first woman member of the French Académie Goncourt, was born on Jan. 28, 1873, at St. Sauveur-en-Puisaye, Burgundy. She spent her early life there and although she lived many years in Paris she remained a countrywoman at heart, with the sights and sounds of the countryside always in her mind.

At the age of 20 she married Henry Gauthier-Villars, a bohemian adventurer 14 years older than herself. He had literary ability but his talent was chiefly employed in organizing the work of ghost writers to meet his constant need for money. At his instigation she wrote her four "Claudine" stories, a series of fictionalized reminiscences about an uninhibited young heroine, published under his pen name of "Willy" (1900–03). She described this collaboration in *Mes Apprentissages* (1936).

In 1904 she published her first independent work, *Dialogues de bêtes*, under the signature "Colette Willy." These sketches of her cat and dog showed the remarkable knowledge of the ways of animals which characterized her work, particularly *La Paix chez les bêtes* (1916) and *Prisons et paradis* (1932). Her gift for describing nature was seen in the lyrical prose of *Les Vrilles de la*

Vigne (1908). Her feeling for words and for rhythm and cadence seemed as acute as her understanding of the world of birds, beasts and flowers: she could exactly convey whatever the senses could record.

After divorcing her husband in 1906 she began a music-hall career. In 1907 her first independent novel appeared, *La Retraite sentimentale*. *La Vagabonde* (1910) and its sequel *L'Entrave* (1913) reflected her stage experiences, as did *L'Envers du music hall* (1913). From this work onward, she signed her books "Colette."

In 1912 she married Henry de Jouvenel, politician and proprietor-editor of *Le Matin;* a daughter was born in 1913. After the outbreak of World War I she wrote for *Le Matin* and subsequently for many other periodicals. Her journalism included dramatic criticism, sketches of personalities, law-court reporting and chronicles of fashion; her dramatic criticism was reprinted in *La Jumelle noire*, 4 vol. (1934–38).

A series of notable novels began with *Chéri* (1920). In collaboration with Léopold Marchand, she turned *Chéri* into a play and took the part of Léa, the heroine, in three productions between 1925 and 1927. A fairy opera, *L'Enfant et les Sortilèges*, with her libretto and Maurice Ravel's music, was given its first performance in 1925.

Much of her work was autobiographical, notably *La Maison de Claudine* (1922) and *Sido* (1929). Here she wonderfully recaptured the days of her childhood and drew an affectionate, observant portrait of her mother, which is probably her finest character study.

Her later novels included *Le Blé en herbe* (1923), *La Naissance du jour* (1928), *La Chatte* (1933), *Duo* (1934), *Le Toutounier* (1939) and *Julie de Carneilhan* (1941). She tended to write stories rather shorter than the average full-length novel. This desire for conciseness is brilliantly exemplified in her last stories, *Le Képi* (1943) and *Gigi* (1944). Several of her works were successfully filmed, *Gigi* outstanding among them.

Unlike many of her contemporaries, Colette was committed to no doctrine or ideology, nor did she discuss the problems and dilemmas of the 20th century. She depicts human nature in its instinctive reactions and feelings, the pleasures of physical sensation and especially the sadness or disillusion that love may bring.

She divorced Henry de Jouvenel in 1924 and in 1935 married Maurice Goudeket, a writer. This marriage brought much happiness, interrupted by her husband's imprisonment at the hands of the Gestapo in World War II. During her last years Colette wrote reminiscences and descriptive works which gained her new renown, particularly *L'Étoile vesper* (1947) and *Le Fanal bleu* (1949). From 1949 onward she was increasingly crippled by arthritis and tied to her flat in the Palais-Royal, surrounded by the warm regard of the people of Paris; she became a legendary figure. In 1953 she was made grand officer of the Legion of Honour. She died in Paris, Aug. 3, 1954, and was accorded official honours by the French government at her funeral.

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COLEUS, a genus of ornamental herbaceous or shrubby plants of the mint family, natives of the tropics of the old world. They are much cultivated as bedding plants for the colour of their exceedingly varied and often brilliant leaves. They can be wintered over as room plants if the house is not too hot and dry.

COLFAX, SCHUYLER (1823–1885), U.S. congressman and vice-president of the United States (1869 to 1873), was born in New York city on March 23, 1823. After an elementary education in the New York public schools, he moved with his mother and stepfather in 1836 to Indiana, where he became interested in journalism and politics. Combining the two interests, he founded in 1845 the *St. Joseph Valley Register*, which became one of the most influential papers in the state during the 18 years of his editorship.

Not a man of fixed political principles, nor one who made any lasting contribution to national life, Colfax shifted easily from Whiggery, to Know-Nothingism (which he later falsely denied), to the Anti-Nebraska (later Republican) party, which elected him to congress in 1854. There he served from 1855 to 1869, the last six years as the agreeable and popular speaker of the house of representatives. A leader in the radical wing of the Republican party during the Reconstruction era, he favoured extending the suffrage to the Negro and disfranchising those who had prominently served in the Confederacy. In 1868 he was nominated for the vice-presidency on the Republican ticket headed by U. S. Grant and was elected. He was not renominated in 1872, however, because a congressional investigation had implicated him, along with other politicians, in corrupt transactions with the Crédit Mobilier of America. He had also accepted in 1868, as a campaign contribution, a gift of $4,000 from a contractor who had supplied the government with envelopes while Colfax was chairman of the post office committee of the house of representatives.

At the end of his term Colfax returned to private life under a cloud and during the remainder of his life he earned a livelihood by delivering popular lectures. He died at Mankato, Minn., on Jan. 13, 1885.

See Willard H. Smith, *Schuyler Colfax* (1952). (D. Do.)

COLIC, a term in medicine for any paroxysmal pain. There is a tendency, however, to restrict use of the word to a pain produced by the contraction of the muscular walls of any hollow organ of which the aperture has become more or less occluded, temporarily or otherwise. For renal and biliary colic, most commonly associated with stones resulting from inflammatory or abnormal secretions, *see* Urinary System; Gall Bladder, Biliary Tract and Liver, Diseases of.

In infants, usually those who are bottle-fed, intestinal colic is exceedingly common and is shown by the drawing up of the infant's legs, restlessness and continuous cries.

The simplest form of colic is that arising from habitual constipation or from ingestion of indigestible foods. Often it is associated with diarrhea. It may accompany any form of enteritis or an intestinal malignant growth, and certain forms of influenza (*q.v.*) are ushered in by severe colic. Colic also is a common symptom of lead poisoning (*q.v.*).

COLIGNY, GASPARD DE CHÂTILLON, Comte de (1519–1572), admiral of France and leader of the Huguenots during the first half of the Wars of Religion, was born at Châtillon-sur-Loing on Feb. 16, 1519. He was the son of Gaspard de Coligny, known as the marshal de Châtillon (d. 1522), and of Louise de Montmorency, sister of the constable of France, Anne de Montmorency. His brothers, Odet, cardinal de Châtillon, and François, seigneur d'Andelot, also played an important part in the first period of the wars. At the age of 22, Coligny came to court and there formed a friendship with François de Lorraine, 2nd duc de Guise. In 1544 he served in the Italian campaign and was knighted on the battlefield of Cerisoles. After the death of Francis I (1547), his uncle Montmorency returned to favour, and Coligny was appointed colonel general of the infantry. In this capacity he drew up the ordinances (promulgated in 1551) designed to regulate the conduct of soldiers and to protect the civil population from their outrages. He was made admiral of France in 1552. In 1557 he courageously defended St. Quentin against the Spaniards but had at last to surrender. He was then held prisoner at Sluis till 1559.

Already in 1555 Coligny had favoured the plan for sending Huguenots to establish, in safety, the colony of "Antarctic France" in Brazil. When he returned from captivity he had, under his brother d'Andelot's influence, become a Huguenot himself (Calvin's first letter to him is dated Sept. 4, 1558). Thenceforward he was the protector of his coreligionaries in France. After Henry II's death (1559), he demanded religious toleration, gaining the support of Michel de l'Hospital and Catherine de Médicis. At the assembly of notables (1560) there was open hostility between him and the Guise family.

However, when the civil wars began (1562), Coligny took up arms only on the insistence of his wife, Charlotte de Laval (d.

1568), and he was always ready to negotiate. Though not a great strategist, he was able to initiate a war of movement instead of position warfare, and his *sang-froid* and tenacity made him "the hero of misfortune."

In 1569 the death of the first prince de Condé, at Jarnac, left him the sole experienced leader of the Huguenots. Victorious at La Roche-Abeille (June 1569) but repulsed before Poitiers and severely defeated at Moncontour (Oct. 1569), he rallied an army in southern France and advanced as far as the upper Seine valley, thus obtaining for the Huguenots the advantageous peace of St. Germain (Aug. 1570).

Returning to court in 1571, Coligny grew rapidly in favour with Charles IX. To distract the French from civil war and to remove the king from the influence of the Guises, he proposed to attack Spanish Flanders with a joint Catholic and Huguenot army to be commanded by Charles in person. Catherine de Médicis, however, did not want a conflict with Spain and feared for her own influence over the king.

On Aug. 22, 1572, in Paris, Coligny was wounded by a shot from an arquebus. The king visited him and ordered an inquiry into the attempted assassination. Then Catherine persuaded Charles to forestall a rising of the Huguenots by ordering the deaths of all their leaders, and the massacre of St. Bartholomew's Day began.

At dawn on Aug. 24, mercenaries of Henry de Guise attacked Coligny at his house, struck blow after blow and finally threw him, still living, from a window. Mutilated by the mob, his body was hanged on the gibbet at Montfaucon.

Coligny's six children by his first marriage include Louise (1555–1620), who was married in 1571 to Charles de Téligny (d. 1572) and in 1583 to William the Silent, prince of Orange (d. 1584); and François (1557–1591), admiral of Guienne (1589), who served Henry IV. By his second marriage (1571), to Jacqueline d'Entremonts, Coligny had a posthumous daughter, Béatrix.

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COLIIDAE, a family of sparrow-sized, but long-tailed, African birds, often called mousebirds from their habit of creeping about in trees. *See* COLY.

COLIJN, HENDRIKUS (1869–1944), Dutch statesman, the most important figure in Dutch politics in the 1930s, was born at Haarlemmer meer on June 22, 1869. He served in the colonial army during the period of the Atjeh war (1895–1904) in the north of Sumatra, where later as a civil administrator he organized government services and rubber plantations. Back in the Netherlands in 1909 he started a political career as a member of parliament for the orthodox Calvinist Antirevolutionary party. From 1911 to 1913 he was war minister; in 1914 he became director of the Royal Dutch Oil company (Shell). From 1922 onward, after the death of Abraham Kuyper, he led the Antirevolutionary party and edited its daily newspaper *De Standaard*. As minister of finance (1923–25) he began a policy of curtailing government expenditure, the navy excepted, and of reassessing the guilder on the gold standard. As prime minister (1933–39) he attempted to adapt his country's economy to the world crisis by the devaluation of the guilder and the increase of agricultural exports. Finally, because of disagreement over his policy of economy, he had to drop the Roman Catholic party from his coalition cabinet. On July 22, 1939, he attempted to govern without them, but had to resign after five days. Having remained in the Netherlands as editor of *De Standaard*, Colijn was arrested by the Germans in July 1941. He died in a German concentration camp on Sept. 16, 1944.

See B. Offringa, ed., *Een Groot Vaderlander: Dr. H. Colijn* (1947). (F. DE J.)

COLIMA, a small Pacific coast state of Mexico, lying between Jalisco on the northwest and north, and Michoacán on the east. Including the Revilla Gigedo Islands, its area is 2,010 sq.mi. Pop. (1960) 157,339. The larger part of its territory is within the narrow, flat coastal plain, beyond which it rises toward the northeast into the foothills of the Sierra Madre. It is drained by the Armería and Coahuayana rivers and their affluents, which are largely used for irrigation.

The soil is generally fertile and productive, but lack of transportation facilities has been a serious obstacle. The dry and rainy seasons are sharply defined. The climate is hot, humid and malarious, becoming drier and more healthful on the higher mountain slopes of the interior.

Stock raising is an important industry in the higher parts of the state. Agriculture is the principal occupation, the more important products being sugar, rice, Indian corn, palm oil and coffee. The "Caracolillo" coffee, produced on the slopes of the mountains culminating in the volcano of Colima, is reputed the best in Mexico.

There are important mineral deposits in the state, including iron, copper and lead. In 1907 a branch of the Mexican Central railway (now National Railways of Mexico) was completed between Guadalajara and the capital, Colima city, and continues to the port city of Manzanillo, pop. (1950) 13,030, a thriving Pacific coast resort with bathing beaches, coconut palms and fishing facilities. Cuyutlán, immediately south of Manzanillo, is the centre of a large salt-producing industry.

The Revilla Gigedo Islands lie about 500 mi. off the coast. In 1957 an outpost was established on Socorro, the largest island, 24 mi. long by an average of 9 mi. wide. Trees were planted for timber and fruit. The expedition found about 8,000 sheep on the island, the residue of a temporary Australian settlement of the middle 1800s. The islands are rich in sulfur, fish and guano and have excellent pasturage. (J. A. CW.)

COLIMA, capital city of Colima state, Mex., 570 mi. W. by S. of Mexico City, near the Pacific coast. Pop. (1960) 41,007; altitude 1,650 ft. About 30 mi. N.E., the volcano of Colima in the state of Jalisco rises to an elevation of 13,110 ft. The most westerly of Mexico's active volcanoes, its eruption in 1941 caused great loss of life. A well-built, attractive city, Colima enjoys a moderately cool and healthful climate. Founded in 1522 by Gonzalo de Sandoval, Colima has played a minor part in Mexican history because of its inaccessibility. Now connected by rail as well as paved highway to the port of Manzanillo and interior points, Colima's industry centres upon the processing of local agricultural products such as cotton, rice, corn, tobacco, fruits and sugar cane, together with salt refining, alcohol distilling and the manufacture of shoes and leather goods. (H. R. HY.)

COLISEUM: *see* COLOSSEUM.

COLLAR, something worn or fastened around the neck, particularly a band of linen, lace or other material, which, under various shapes at different periods, has been worn by men and women to serve as a completion or finish to the neckband of a garment (*see* DRESS). It is also a chain, worn as a personal ornament, a badge of livery, a symbol of office or as part of the insignia of an order of knighthood. The word also is applied to that part of the draft harness of a horse that fits over the animal's neck, to which the traces are attached (*see* HARNESS AND SADDLERY), and to a circular piece of metal passed around the joints of a rod or pipe, to prevent movement or to make the joint steam- or watertight.

COLLARDS (*Brassica oleracea acephala*) bears the same botanical name as kale, from which it differs only in leaf characters. The leaves form a large, prolific rosette like a cabbage plant that is approaching the formation of a head but never forms a true head. The larger leaves may be removed for use singly as the stem elongates, or the entire rosette may be harvested. The plant is a prolific source of nutritionally important minerals and vitamins A and C. It is widely adapted, easily grown, and is probably the least exacting of any of the crucifers in its requirements for successful seed production. When fully grown the plants may be left unprotected in the garden, through the winter, in the southern half of the U.S. *See* CABBAGE. (V. R. B.)

COLLATERAL, in banking and in law, a term used to describe the security which a borrower surrenders as a pledge to guarantee the repayment of his loan. If the borrower defaults, the lender has the right to sell the collateral and retain the amount due on the debt. (*See* BANKING: *Practice of Banking;* MORTGAGE;

SALE OF GOODS.) The term is also used in the law of succession to describe the relationship between persons descended from the same ancestor but in a different line, such as aunts, uncles and cousins (*see* CONSANGUINITY). Collateral is also used to describe an attack on judicial proceedings which is based on some incidental grounds which do not test the real merits of the complaint.

(E. G. S.)

COLLE, RAFFAELLO DAL (RAFFAELLINO) (*c.* 1495–1566), Italian painter whose claim to distinction is that he was one of the executants of the frescoes planned by Raphael's group in the Vatican Loggia and the Room of Constantine, was born at Borgo San Sepolcro about 1495. Allegedly a pupil of Raphael, he was more probably a pupil of Raphael's chief assistant Giulio Romano (*q.v.*). He assisted Giulio, as he had Raphael, at Mantua in 1524 and, from 1536, helped in large projects of Giorgio Vasari at Florence and Rome. To attempt to sort his work from others is a puzzling task. His independent paintings, executed at Borgo San Sepolcro, are of a much lower provincial standard and give no clue. According to Vasari he died there, Nov. 17, 1566.

See A. Venturi, *Storia dell'arte italiana*, vol. ix, part 5, pp. 607–620 (1932); F. Hartt, *Giulio Romano* (1958). (C. GT.)

COLLECTIVISM as a political theory first emerged in the 18th century as a reaction to individualism (*q.v.*). Whereas individualistic social theories and systems emphasize the priority of the individual and his rights, collectivistic theories and systems emphasize the priority of the community and its rights. Society is conceived in individualistic political theories as having no reality in itself and no interests or aims apart from those of the individuals composing it. In collectivistic theories individuals are conceived as having no real being apart from society. Whereas individualism found typical expression in political theory in the writings of the English philosopher Locke, collectivism found early expression in Rousseau's *Social Contract* (1762) and in the writings of the German philosopher Hegel.

According to the French philosopher Rousseau, the individual finds his true being and freedom only in submission to the "general will" (*volonté générale*) of society, which will is not the sum of particular wills but what remains when private interests cancel each other. "The general will," Rousseau declares, "is always right and tends to the public advantage." For practical purposes he suggests that the "general will" is ascertained by the vote of the majority. In Hegel's political philosophy the individual is conceived as realizing his true being and freedom only in unqualified submission to the laws and institutions of the national state since, in Hegelian thought, the state is the highest and most perfect embodiment of social morality.

Hegel describes the national state as the actualization of the ethical Idea, "the absolute power on earth" and "the march of God in the world." The state includes but transcends the purposes of individuals and is a living entity with a will, purpose and interests of its own. In the philosophy of Karl Marx, which was derived in part from the philosophy of Hegel, it is explicitly stated that "It is not men's consciousness which determines their being, but their social being which determines their consciousness" (*A Contribution to the Critique of Political Economy*, preface). In collectivistic theories and systems the individual acquires significance only by virtue of his membership in some social entity such as a nation, a class or a race.

In an economic context the word collectivism is used to describe any theory or system which favours governmental ownership of the means of economic production, distribution and exchange. But it is sometimes used to describe any system which favours extensive governmental regulation of the economy. In this context collectivism represents a reaction to economic individualism (laissez-faire capitalism), the classic justification of which is found in the writings of the Scottish political economist Adam Smith.

In reaction to individualistic political and economic theories and systems, collectivism finds expression in the contemporary world in four principal types of social systems ranging from liberal democratic to despotic totalitarian: social democracy, socialism, communism and fascism. The least collectivistic is social democracy, which aims at reducing the inequities produced by the capitalistic system and the abuses of unrestrained competition, not by abolishing the private ownership of the means of production but by extending governmental regulation over the economy, by seeking to redistribute the wealth of society by tax legislation and by instituting various schemes of social welfare and insurance. Advocates of social democracy often speak of a "planned economy" and the "welfare state." Social democracy was anticipated in the United States in the writings of Lester Frank Ward and found practical expression in the so-called New and Fair Deals. It found typical European expression in the writings of the German Eduard Bernstein, but in Europe social democracy is practically the equivalent of socialism.

There are many varieties of socialism but all advocate some measure of governmental ownership and operation of the means of economic production. Some socialists favour only the nationalization of "key industries" while others advocate more extensive ownership not only of the means of production but of the means of distribution as well. The first significant socialist thought appeared in France in the 18th century—notably in the writings of François Noel Babeuf, the comte de Saint-Simon and Charles Fourier. Rejecting Adam Smith's belief that in following their own self-interests men are led by the "invisible hand" of Providence to promote the welfare of all, the socialists argued that the welfare of all could only be promoted by gradually abolishing the private ownership of the means of production and by deliberately reorganizing society in the interest of the workers.

Socialists propose to achieve their objectives by peaceful, democratic means (by persuasion and legislation) and generally favour the perpetuation of liberal democratic political institutions such as civil liberties, representative parliaments and the rule of law. Socialist measures have been adopted in Norway, Sweden, Denmark, the Netherlands, Belgium, Australia, New Zealand and Great Britain, among others.

Communism aims at achieving a world-wide socialist society through revolution and the "dictatorship of the proletariat." It rejects in practice, if not always in words, the principles of liberal democracy and finds theoretical support for its tactics in the dialectical materialism of Karl Marx as modified by the interpretation of the Russian Lenin. Expounding a brand of socialism which he described as "scientific," Marx argued that the victory of socialism over capitalism was preordained by the "laws" of history and of economics and that such a victory would be the inevitable result of a cataclysmic revolution to be undertaken by the proletariat or industrial working class. The "liquidation" of the capitalists and the transformation of society into a "classless society" was to be accomplished through a "dictatorship of the proletariat." Lenin held that this "dictatorship of the proletariat" could be nothing other than the dictatorship of the Communist party.

Whereas in communism the individual's interests are identified with those of the proletariat as those interests are interpreted by leading members of the Communist party, in fascism the individual must subordinate his own interests to those of the nation or "race" as those interests are interpreted by a single party claiming to speak for them. Fascism first appeared in Italy in 1922 under the dictatorship of Benito Mussolini and appeared in Germany in more ruthless form in 1933 under the dictatorship of Adolf Hitler. A fascist dictatorship was instituted in Argentina in 1943 under the leadership of Juan Perón. Both communist and fascist systems are characterized by a denial of the basic equality and dignity of human beings, by fanatical suppression of all opposition, by attempts to control politically every aspect of human life and thought and by a leadership principle which claims that a single leader or party infallibly represents the interests of the working class, nation or "race."

See also COMMUNISM; FASCISM; SOCIALISM.

BIBLIOGRAPHY.—W. Y. Elliott, *The Pragmatic Revolt in Politics* (1928); H. W. Laidler, *Social-Economic Movements* (1944); Sir Alexander Gray, *The Socialist Tradition: Moses to Lenin* (1946); J. Messner, *Social Ethics* (1949); J. A. Schumpeter, *Capitalism, Socialism, and Democracy*, 3rd ed. (1950). (J. H. HL.)

COLLEGE. In Roman law a *collegium* was a body of persons, not fewer than three, associated together by the possession of common function. The nearest modern parallel is the corporation.

During the middle ages *collegia* might exist for trade purposes (as the English guilds); for political purposes (as the electoral college of princes which chose the king in medieval Germany); for ecclesiastical purposes, for example, collegiate churches; and, closely linked with the last, for educational purposes. In modern times the term is used occasionally for the Sacred college or College of Cardinals and for electoral colleges; but it most commonly denotes educational establishments, particularly those providing education beyond the level of compulsory schooling.

The name is not applied to schools for children within the public systems of education (though occasionally it is retained for historical reasons), but many independent schools in Britain carry it, a few, such as Winchester and Eton, because they were founded as *collegia*, but most because at the time of their foundation (usually in the 19th century) the name was held to connote social prestige or to indicate that the establishment provided secondary education—then largely a social privilege.

University colleges (*q.v.*), a feature of Great Britain and the commonwealth, grew out of the practice of communal lodging in the middle ages. In Paris, in Oxford and in Cambridge scholars found it more satisfactory and safer to rent a house in which to live jointly than to live in isolated apartments. In these "houses of scholars," which were sometimes the gifts of benefactors or monastic foundations, one member was usually elected as magister, to speak and to be responsible for the rest. The transition from these endowed or unendowed hospitia, or hostels, to colleges with a legally recognized corporate entity was gradually made in the 13th century. The first absolutely clear instance in England was the foundation in 1264 of the "House of Scholars of Merton" (Merton college, Oxford) by Walter de Merton, chancellor of England and bishop of Rochester, though previous endowments laid the foundations of University and Balliol colleges at Oxford. Merton's statutes (made more explicit in 1270), which aimed at regulating the corporate life of the college, were closely followed in the foundation of Peterhouse, Cambridge, in 1284 and in later foundations. They enabled colleges to develop independently of the universities, and though later colleges and universities became virtually coextensive, this independence has been continuously preserved.

There are also in Britain theological colleges, teacher-training colleges, technical colleges, commercial and agricultural colleges, and so on. Apart from its educational use, the name is also borne by a few professional institutions, notably the Royal College of Physicians and of Surgeons, by the College of Arms (or Heralds' college; *i.e.*, the official repository of British family pedigrees) and by the College of Chaplains in the queen's household.

(H. C. D.)

In the United States the term college most commonly refers to a four-year undergraduate institution of higher education which admits students from secondary schools and which grants the bachelor's degree; it developed from the British universities, but has no exact counterpart in other countries. It usually emphasizes a liberal or general education rather than specialized technical or vocational preparation. It may be an independent privately controlled liberal arts college, or it may be the undergraduate division of a private or state university.

In American higher education the term college also refers to: (1) separate degree granting professional institutions, *e.g.*, state teachers colleges and medical colleges; (2) the constituent professional faculties of universities, *e.g.*, colleges of medicine, law, engineering, education, agriculture and commerce; (3) two-year nondegree-granting institutions known as junior colleges or community colleges; and (4) student residence halls in a few universities. The term is sometimes loosely applied to private business "colleges" offering training in routine office procedures and secretarial duties, the period of instruction ranging from a few weeks to two years.

See also UNIVERSITY; EDUCATION, HISTORY OF. For the U.S. electoral college, *see* UNITED STATES (OF AMERICA): *Government*. For the Sacred College of Cardinals, *see* CARDINAL. *See* also references under "College" in the Index volume. (R. F. Bs.)

COLLÈGE (FRANCE), a term used to denote several types of secondary schools in the French educational system. *See* SECONDARY EDUCATION; EDUCATION, HISTORY OF.

COLLEMBOLA, an order of primitive, wingless insects commonly called springtails for their ability to catapult themselves into the air by use of an appendage attached to the underside of the abdomen. *See* SPRINGTAIL.

COLLETT, (JACOBINE) CAMILLA (née WERGELAND) (1813–1895), Norwegian author who first championed the rights of women in Norway. She was born at Christiania (Oslo), Jan. 23, 1813, and died there, March 6, 1895. She was influenced by her love for the poet J. S. Welhaven, her brother Henrik's opponent. Welhaven broke off the relationship and in 1841 Camilla married P. J. Collett, under whose guidance she began her literary career. Her life was darkened by the loss within six years of her parents, brother and husband, and her genius matured in loneliness. Her first novel, *Amtmandens dötre* (1854–55), was a fervent plea for woman's rights. The first realistic Norwegian novel, it inspired Henrik Ibsen, Jonas Lie and later writers. Social and emotional emancipation for women is championed also in *Sidste blade* (1868–73), *Fra de stummes leir* (1877) and *Mod strömmen* (1879–85). Camilla Collett's autobiographical sketches, *I de lange Nætter* (1863), reveal her sensitive and idealistic personality.

Camilla Collett's *Samlede Værker* were published in 3 vol. (1912–13). *See* also A. Benterud, *Camilla Collett. En Skjebne og et livsverk* (1947); E. Steen, *Diktning og virkelighet, en studie i Camilla Collett forfatterskap* (1947). (G. RN.)

COLLIER, ARTHUR (1680–1732), English philosopher, who has had his admirers both in England and on the continent of Europe, was born at the rectory of Langford Magna, Wilts., on Oct. 12, 1680. Educated at Pembroke and Balliol colleges, Oxford, he became rector of Langford Magna in 1704. A close student of Descartes, of Nicolas Malebranche and of John Norris (*q.v.*), he shows no knowledge of Locke's work, but probably read Berkeley at a late stage in the development of his own ideas.

In his *Clavis Universalis* (1713) he denies, like Berkeley, that there is an external world, independent of mind. The fact that what we see seems to be external, he argues, is no proof that it actually is external; for we often experience apparently external objects (*e.g.*, in hallucinations or in double vision) which we nonetheless admit not to be external. Indeed, any imagined object seems to be external. The difference between a seen and an imagined object is not that the seen object possesses a quality of externality which the imagined object lacks, but that the seen is more vividly experienced than the imagined; and this does nothing to prove that it exists independently of us.

Furthermore, the very notion of an external world is self-contradictory. Philosophers, Collier anticipates Kant in arguing, have unanswerably demonstrated both that the external world must be finite and that it must be infinite; that it must, but cannot, be infinitely divisible; that it must, but cannot, contain motion. The only way out of these antinomies is to recognize that there is no external world; *i.e.*, that what we perceive exists only in relation to a mind. Only on this view, too, can we satisfactorily describe mind's relation to its objects and God's relation to created beings. Collier's metaphysics is outlined in his "Confession" (written in 1709) and theologically interpreted in *A Specimen of True Philosophy* (1730) and *Logology* (1732). There is, he says, one supreme substance, God, in relation to which everything else has only a dependent existence. (He was suspected of Arianism.) But within that substance there is an order of dependence which is also an order of perfection. In particular, the visible world of matter is dependent upon, and is less perfect than, the mind which perceives it. Collier has never exerted any considerable influence.

BIBLIOGRAPHY.—For *Clavis Universalis* see E. Bowman's edition (1909); or S. Parr, *Metaphysical Tracts by English Philosophers of the Eighteenth Century* (1837), which includes *A Specimen* and a brief précis of *Logology*. For the "Confession" *see* R. Benson, *Memoirs of the Life and Writings of Arthur Collier* (1837). *See* also J. H. Muirhead, *The Platonic Tradition in Anglo-Saxon Philosophy* (1931); and G. Lyon, *L'Idéalisme en Angleterre* (1888). On Collier and Berkeley, *see* G. A. Johnston, *The Development of Berkeley's Philosophy*, appendix i (1923). For Collier and Kant *see* A. O. Lovejoy, "Kant and

the English Platonists," in *Essays in Honour of William James* (1908); and H. J. de Vleeschauwer, "Les Antinomies kantiennes et la *Clavis Universalis* d'Arthur Collier," in *Mind* (1938). (Jn. A. P.)

COLLIER, JEREMY (1650–1726), English bishop of the Nonjurors (*q.v.*) and author of a celebrated attack on the immorality of the stage, was born at Stow-by-Quy, Cambridgeshire, Sept. 23, 1650. From Ipswich free school, where his father was Master, he entered Caius college, Cambridge in 1669. Ordained priest in 1677, he became chaplain to the countess dowager of Dorset and in 1679 rector of Ampton, near Bury St. Edmunds. He was made lecturer of Gray's Inn in 1685, but resigned at the Revolution and was sent to Newgate for writing *The Desertion Discuss'd* (1688), a pamphlet supporting James II and answering Bishop Burnet's *Enquiry Into the Present State of Affairs*. Released without trial after several months, he was again imprisoned in Nov. 1692 on suspicion of treasonable correspondence with James. He refused to acknowledge the court's jurisdiction by accepting bail, but was freed within ten days. In 1696 he daringly gave absolution on the scaffold to Sir John Friend and Sir William Parkyns, condemned for attempting to assassinate William III. His confederates in this act were imprisoned, but Collier absconded and lived under sentence of outlawry. When the storm subsided he returned to London. His first volume of *Essays*, an enlarged edition of the *Miscellanies* (1694, 1695), appeared in 1697. Further volumes followed in 1705 and 1709.

In his notorious *A Short View of the Immorality and Profaneness of the English Stage* (1698), Collier attacks Wycherley, Dryden, Congreve, Vanbrugh and D'Urfey, censuring them for indecency, for profane language, for abusing the clergy and for undermining public morality by sympathetic presentation of vice. He refers, in evidence, to the comparative decency of ancient drama, of Ben Jonson, of Corneille and, oddly, of Beaumont and Fletcher. Such critical principles as he employs are borrowed chiefly from René Rapin and Thomas Rymer (*q.v.*). Collier's eager accumulation of indecent examples combines unpleasantly with an ostensible moral indignation, and provided an easy target for his adversaries. In the ensuing pamphlet war, which lasted spasmodically until 1726, Congreve, Vanbrugh and D'Urfey, with Charles Gildon, John Dennis, Edward Filmer and James Drake, ranged themselves against Collier, Arthur Bedford, William Law, Whitelocke Bulstrode, Josiah Woodward and J. Field. Collier contributed the *Defence* (1699), the *Second Defence* (1700), the *Dissuasive* (1703) and the *Farther Vindication* (1708), and probably several later anonymous tracts, perhaps terminating with *The Conduct of the Stage Consider'd* (1721), which has been attributed to him.

Collier's *The Great Historical, Geographical, Genealogical, and Poetical Dictionary*, a translation, with additions, of Louis Moréri's *Grand Dictionnaire historique* (1674), was published in 1701, with supplementary volumes in 1705 and 1721. His *Ecclesiastical History*, 2 vol. (1708, 1714), was attacked by Bishops Kennett, Nicolson and Burnet on grounds of popery. Collier ably defended himself in *An Answer to Some Exceptions* (1715) and *Some Considerations on Dr. Kennet's . . . Letters* (1717). Consecrated in 1713 by George Hickes, the sole survivor of the nonjuring bishops, he was created, on July 23, 1716, primus of the church of the Nonjurors. He was a principal mover in the scheme, projected in 1716, for union with the Eastern Church and corresponded with the Orthodox authorities until 1725.

Collier favoured the 1549 Book of Common Prayer and regretted that later editions omitted certain usages from the communion service. His *Reasons for Restoring Some Prayers* (1717) recommended the reintroduction of the oblatory prayer, the invocation, the mixed chalice and the petition for the faithful departed. The consequent "usages" controversy split the nonjuring community and the ultimate extinction of the party may be attributed to this division. In 1718 was published a new *Communion Office* which embodied the changes required by Collier and was probably chiefly compiled by him. The exact dates of Collier's two marriages and the identity of his first wife are unknown. His marriage to Mrs. Cecilia Deacon, a widow, probably took place in 1716. Thomas Deacon, her son, was prominent among the nonjurors and possibly his extreme views influenced Collier in the "usages" controversy. Collier's *Practical Discourses* (1725) were followed, the next year, by an appendix, *God Not the Author of Evil*. He died in London, April 26, 1726.

Bibliography.—The biography in A. Kippis' *Biographia Britannica*, vol. iv (1789), was written partly by Collier himself. There is an informative *Life* in vol. ix of T. Lathbury's 9-vol. ed. of Collier's *Ecclesiastical History* (1852). For Collier's career as a nonjuring bishop *see* Lathbury's *A History of the Nonjurors* (1845). Sister Rose Anthony's *The Jeremy Collier Stage Controversy, 1698–1726* (1937) examines the *Short View* and its consequences. (Jo. C.)

COLLIER, JOHN PAYNE (1789–1883), English Shakespearean scholar and critic, whose great contributions to scholarship were marred by forgeries, was born in London on Jan. 11, 1789, the son of a journalist. He worked as parliamentary and law reporter, critic and editorial writer for the *Times* and *Morning Chronicle*, and, having entered the Middle Temple in 1811, was called to the bar in 1829. His interest in early English literature was stimulated by work on the *Critical Review*, and he produced a new edition of Robert Dodsley's *Old Plays* (1825–27), to which five more plays were added in 1833. Meanwhile he began to mix fraud with his genuine researches, first in his *History of English Dramatic Poetry and Annals of the Stage* (1831). His so-called "new facts and particulars" (1835–39), *Memoirs of E. Alleyn* (1841), *Alleyn Papers* (1843) and the *Diary of P. Henslowe* (1845) combine close scholarly work on neglected and important texts with imposture. Collier added to Henslowe's diary, for instance, and claimed to incorporate in his eight-volume annotated Shakespeare (1842–44) manuscript corrections from a copy of the First Folio. This was supplemented by useful work on *Shakespeare's Library* (1843) and *Book Entries of the Stationers' Register* (1848–49), but during 1852 he announced in letters to the *Athenaeum* the discovery of a copy of the Second Folio, with mid-17th-century annotations (the so-called Perkins Folio, from the name on the title pages). In the notes, punctuation and stage directions were changed; there were cancellations, numerous emendations and additions to the text of up to nine lines. These "revisions" were incorporated into *Notes and Emendations to the Text of Shakespeare's Plays* (1852) and a one-volume edition of Shakespeare (1853). The authenticity of the additions and substitutions was questioned by Alexander Dyce, Charles Knight, Howard Staunton and James Halliwell, and the first doubts were published by S. W. Singer in *The Text of Shakespeare Vindicated* (1853) and by E. A. Brae, anonymously, in *Literary Cookery* (1855). Brae attacked again five years later in *Collier, Coleridge and Shakespeare*, as Collier had by then allegedly discovered his long-lost notes to Coleridge's lectures on Shakespeare. However, Collier's faith in the Perkins Folio was sustained in the 1858 edition of Shakespeare, and it had meanwhile been presented to the duke of Devonshire and subsequently to the British museum for examination (1859). The fabrications were reported in the *Times* by N. E. Hamilton, who also made inquiries into Collier's other papers. The press took up the controversy, but expert opinion was against Collier. Only after his death at Maidenhead, Surrey, on Sept. 17, 1883, was it confirmed, however, that Collier was the actual forger and not merely a dupe. This notoriety inevitably undermined confidence in all Collier's work, even where it was intelligent, useful and honest. His services to the Percy and Shakespeare societies, for instance, should be mentioned; so should his editions of Thomas Heywood (1842–51) and Spenser (1862), and his *Bibliographical and Critical Account of the Rarest Books in the English Language* (1865). And even where he misused documents (as in the Henslowe papers) he directed to them an overdue attention.

See H. B. Wheatley, *Notes on the Life of John Payne Collier, With a Complete List of His Works* (1884); C. M. Ingleby, *A Complete View of the Shakespere Controversy* (1861). (G. A. O.)

COLLIMATOR, a lens (*q.v.*) placed at a distance equal to its focal length from the luminous object under examination; the rays proceeding from the lens are thus rendered parallel, which is equivalent to the removal of the luminous object under examination to an infinite distance, without the loss of light intensity which such removal entails.

Specialized measurements in geometrical and physical optics and

spectroscopy require this collimation of the light. In these cases the collimator is usually a telescope with a slit at the principal focal length of the lens. Light from the luminous source is focused on this slit by a lens of similar focal length and the slit then serves as the luminous object of the optical system.

See also OPTICS.

COLLIN, HEINRICH JOSEF VON (1771–1811), Austrian dramatist and poet whose plays reflect the change from classicism to romanticism, was born in Vienna, Dec. 26, 1771, and died there, July 28, 1811. He wrote patriotic lyrics against Napoleon (*Wehrmannslieder*, 1809) and ballads on medieval subjects (*Gedichte*, 1812). His early plays were in the strict form of French classicism, but later he was influenced by German romanticism. His plays include *Regulus* (1802), *Polyxena* (1803) and *Coriolan* (1804), to which Beethoven wrote an overture.

Collin's *Gesammelte Werke* appeared in 6 vol. (1812–14). *See* also F. Laban, *H. J. von Collin* (1879); M. Lederer, *H. J. von Collin und sein Kreis* (1921). (H. F. GN.)

COLLINGS, JESSE (1831–1920), British politician and agrarian reformer, a strong advocate of the "three acres and a cow" radical land reform policy. He was born at Littleham-cum-Exmouth, Devon, on Jan. 9, 1831. His first employment was as a junior clerk with a mercantile firm, over which he took direction in 1864. He was interested in social questions before he moved to Birmingham in the 1860s and soon became prominent in local radical politics. In 1867 he was appointed secretary of the Birmingham Education society and two years later of the influential National Education league, which developed from it. He had become a member of the Birmingham town council in 1868, and was soon prominent as one of Joseph Chamberlain's (*q.v.*) closest associates, succeeding him as mayor in 1878. In 1880 he entered parliament as Liberal member for Ipswich, and from this agricultural constituency urged an "unauthorized program" of land policy, originally canvassed in 1872 when he helped to found the Rural Labourers' league, associated with the slogan "three acres and a cow." In Jan. 1886 he moved the small-holdings amendment to the address which caused the resignation of Lord Salisbury's government, and became parliamentary secretary to the Local Government board in the new ministry of W. E. Gladstone. In March he resigned with Chamberlain in opposition to Gladstone's Home Rule policy. At the general election in July he lost his seat at Ipswich on petition, but soon after was returned for Bordesley, Birmingham. Although he tried to maintain his radical land ideas, Liberal opposition to him led to his removal from the presidency of the Allotment and Small Holdings association in 1888, and, closely following Chamberlain, he moved increasingly away from radicalism toward the Conservative party. In 1895 he became undersecretary to the home office in Salisbury's government, retaining the post until 1902. He resigned from parliament in 1918 and died at Edgbaston, Birmingham, on Nov. 20, 1920. His chief works are: *Land Reform* (1906); *The Colonization of Rural Britain*, 2 vol. (1914); and *The Great War* (1916). An autobiography was published by J. L. Green (1920). (A. BRI.)

COLLINGWOOD, CUTHBERT COLLINGWOOD, BARON (1748–1810), British naval commander who was Nelson's second-in-command at Trafalgar and held the Mediterranean command thereafter, was born at Newcastle upon Tyne on Oct. 24, 1748, and was sent to sea at the age of 12 in the frigate "Shannon" in the care of his cousin, Captain Braithwaite. He served for several years on the home station with that officer and also under Adm. Robert Roddam. In 1774 he served on the North American station under Adm. Samuel Graves and was in the naval brigade that saw service at the battle of Bunker Hill, there winning his lieutenancy (June 17, 1775). In the following year he was lieutenant of the sloop "Hornet" in the West Indies, and thereafter began his close association with Horatio Nelson. He followed Nelson as commander of the "Badger" and captain of the frigate "Hinchingbrooke" (March 1780). After commanding another frigate and the "Sampson" of 64 guns, Collingwood found himself again with Nelson in the West Indies, this time in the frigate "Mediator." He remained there three years and was present during the difference between Nelson and the commander in chief concerning the severity with which the Navigation laws ought to be enforced against the United States. He agreed with Nelson, with whom he was by now on intimate terms, that no leniency should be shown.

In 1786 Collingwood returned home and, with the exception of one brief command, remained there until 1792. On the outbreak of the French Revolutionary Wars, he was appointed flag captain to Rear Adm. Sir George Bowyer in the "Prince," and with him he shifted to the "Barfleur" and took part in Lord Howe's victory on the "glorious first of June," 1794. In Aug. 1795 he was appointed to the "Excellent" for his first experience of the Mediterranean station; he was engaged in the blockade of Toulon and took a conspicuous part in Sir John Jervis' victory off St. Vincent (Feb. 1797). When Jervis divided the Spanish line, the "Excellent" was the rearmost ship in his fleet and when Nelson, anticipating orders, turned his ship out of the British line to oppose Spaniards that seemed likely to escape, it was to Collingwood that Jervis signaled to go to his friend's assistance. He was already on his way. He and Nelson found themselves greatly outnumbered, until other ships arrived, but the Spanish flight was held up and four ships were made prize. In 1799 Collingwood became rear admiral, and he was at sea in the "Triumph" and other ships until the peace of Amiens in 1802.

On the renewal of war in 1803, Collingwood was at once employed. He began in the channel fleet, under Sir William Cornwallis, which was blockading Brest. He remained there until May 1805 (having in the meantime been promoted to vice-admiral in May 1804), when he was given command of a small squadron which was intended to reinforce the Mediterranean fleet under Nelson. He placed himself off Cádiz when Adm. P. C. de Villeneuve, after his return from the West Indies, made that port, and there he was joined by Nelson, so becoming second-in-command at Trafalgar. In this battle he carried out brilliantly the part assigned to him by the commander in chief. With 15 ships he was to attack the rear of the enemy to prevent their escape. As his flagship "Royal Sovereign" was newly from the dockyard, and a fast sailer, he was the first to engage the enemy and had almost forced a Spanish flagship to strike to him before any other British ship had fired a gun. On Nelson's death in the battle, command passed to Collingwood, and he had the difficult task of conserving the fleet and its prizes during the storm which followed. For his services he was created Baron Collingwood and granted a pension of £2,000 a year.

The completeness of victory at Trafalgar prevented Nelson's immediate successors from achieving any comparable triumph, but Collingwood held the Mediterranean command with distinction until his death. He had wished to retire, but the admiralty would not spare him. As well as being a distinguished leader, he was a gunnery expert, a man of great political insight and diplomatic ability, benevolent and generous both as a commander and as a private person and an excellent letter writer. He died at sea, March 7, 1810, and was buried near Nelson in St. Paul's cathedral.

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COLLINGWOOD, ROBIN GEORGE (1889–1943), English philosopher and historian, born at Coniston in Lancashire, early acquired artistic and scholarly tastes from his father, the friend and biographer of John Ruskin. He was educated at Rugby and at Oxford (University college), where he came under the influence of F. J. Haverfield and so was drawn into those archaeological and historical studies which were to make him the leading authority in his day on Roman Britain and culminated in his *Roman Britain* (1936), a volume of the *Oxford History of England*. These studies, however, were secondary to his profession as a philosopher. He became a fellow of Pembroke college, Oxford, in 1912 and taught philosophy there until he went to Magdalen college as Waynflete professor of metaphysical philosophy. This chair he held from 1935 to 1941, when he resigned because of ill health. He finally returned to Coniston and died there Jan. 11, 1943. Collingwood regarded it as his life work to bring about a *rapprochement* between philosophy and history. Philosophers

since Descartes, he thought, had been too much preoccupied with science and so with methods and concepts inapplicable in the study of thought or action. Two world wars had convinced him that the sciences had been unable to solve the problems of human affairs, but a philosophy fused with history seemed to him to promise more success. The last of his works, *The New Leviathan* (1942), contains his only contribution to this result, but he had earlier made history the *Leitmotiv* of his work by arguing that the task of metaphysics was the historical one of disentangling and expounding the fundamental beliefs presupposed by a given civilization, or by natural science, or by history at different periods in their evolution. All his life he was keenly interested in art, and he both painted and composed. This first-hand experience gives a special freshness to his remarkable work on aesthetics, *The Principles of Art* (1938). His most important work, however, is perhaps his *Essay on Philosophical Method* (1933), where in defiance of logical analysis, the type of philosophy dominant in his day, he goes back to Plato and Georg Hegel and argues that the way to understand any philosophical concept (*e.g.*, goodness) is to recognize it as a universal whose varying particularizations (*e.g.*, pleasure, utility and duty) are specified on a scale of which each stage differs both in degree and in kind from its predecessor.

(T. M. K.)

COLLINGWOOD, an inner suburb of Melbourne, Victoria, Austr., lying on the Yarra river about 2½ mi. N.E. of the centre of the city. Pop. (1954) 27,155. Named after Adm. Cuthbert Collingwood, the town has grown into a thickly populated and highly industrialized quarter of Melbourne, its chief industries being the manufacture of footwear and textiles. It has two large technical schools and extensive parklands, arenas and sports grounds.

(G. J. Bn.)

COLLINS, ANTHONY (1676–1729), English deist and freethinker, was born at Heston, near Hounslow in Middlesex, on June 21, 1676. He was educated at Eton and King's college, Cambridge. An important influence in his life was his intimacy with John Locke, who in his letters speaks highly of him. Collins died at his house in Harley street, London, on Dec. 13, 1729.

His writings summarize the work of previous English freethinkers. Though unorthodox, Collins was not an atheist, nor even an agnostic. In his own words, "Ignorance is the foundation of atheism and freethinking the cure of it" (*A Discourse of Free-Thinking*, p. 105).

His first work of note was *An Essay Concerning the Use of Reason in Propositions the Evidence Whereof Depends on Human Testimony* (1707), in which he rejected the distinction between *above* reason and *contrary to* reason and demanded that revelation should conform to man's natural ideas of God. Like all his works, it was published anonymously. In 1713 appeared his chief work, *A Discourse of Free-Thinking, Occasioned by the Rise and Growth of a Sect Called Free-Thinkers*. In England this essay, taken as a plea for deism, caused a sensation, calling forth numerous replies.

In 1724 Collins published *A Discourse of the Grounds and Reasons of the Christian Religion*, with *An Apology for Free Debate and Liberty of Writing* prefixed. Ostensibly, it is written in opposition to William Whiston's attempt to show that the books of the Old Testament did originally contain prophecies of events in the New Testament which had been eliminated or corrupted by the Jews, and to prove that the fulfillment of prophecy by the events of Christ's life is all "secondary, secret, allegorical and mystical." No less than 35 answers were directed against this book, the most noteworthy being those of Bishop Edward Chandler, Arthur Sykes and Samuel Clarke. Collins replied with the *Scheme of Literal Prophecy Considered* (1727). An appendix holds, against Whiston, that the book of Daniel was forged in the time of Antiochus Epiphanes.

In philosophy, Collins is a defender of necessitarianism. His brief *Inquiry Concerning Human Liberty and Necessity* (1715) is an excellent outline of the determinist position. Attacked by Samuel Clarke, he replied after Clarke's death with a dissertation on *Liberty and Necessity* (1729).

Collins also wrote *A Letter to Mr. Dodwell* (1707), arguing that it is conceivable that the soul may be material and, secondly, that if the soul be immaterial it does not follow, as Clarke had contended, that it is immortal; *Vindication of the Divine Attributes* (1710); and *Priestcraft in Perfection* (1709).

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COLLINS, JOSEPH LAWTON (1896–), U.S. army officer, commander of the VII corps in Europe during World War II, was born in New Orleans, La., May 1, 1896. On graduation from the United States Military academy at West Point in 1917, he was commissioned second lieutenant of infantry. He served with occupation forces in Germany, 1919–21.

In 1941 Collins was chief of staff, VII corps, and then chief of staff, Hawaiian department. He was commander of the 25th division in the Pacific, 1942–44, and of the VII corps in Europe, 1944–45. The latter force landed on Utah beach in Normandy on June 6, 1944, later captured Cherbourg, led the breakout from Normandy, pierced the Siegfried line, captured Aachen and Cologne, enveloped the Ruhr from the south and east, and then drove eastward to a meeting with the Russians on the Elbe at Dessau.

Collins, who attained the rank of general in 1948, served as chief of staff, U.S. army, 1949–53, and in 1953 became U.S. representative to the military committee and standing group of the North Atlantic Treaty organization. In 1954 he served as special representative of the United States in Vietnam. (F. C. Pe.)

COLLINS, MICHAEL (1890–1922), Irish revolutionary leader and a hero of the struggle for independence, was born near Clonakilty, County Cork, on Oct. 16, 1890, the eighth child of Michael Collins, a prosperous farmer, and his young wife, Mary Anne O'Brien, whom he had married at the age of 62. He entered the British civil service and went to London in 1906. He stayed for ten years, working first as a postal clerk and then in a solicitor's office. During this time he became interested in Irish nationalists activities and in 1909 joined the Irish Republican brotherhood.

In 1916 Collins returned to Ireland in time to fight under P. H. Pearse in the Easter rising at Dublin. He escaped being taken under arms but later was arrested and sent with the great body of suspects to the detention camp at Frongoch, Wales. Released with the rest in Dec. 1916, he was returned at the general election in Dec. 1918 as Sinn Fein member for West Cork. Out of 73 elected only 27 were present when the *dail eireann* (assembly of Ireland) met in the Mansion house and declared for the Irish republic. Eamon de Valera, their elected president, was in jail, so was the vice-president, Arthur Griffith. Much responsibility now fell on Collins, who became first Sinn Fein minister for home affairs and, after the dramatic escape of De Valera from Lincoln jail in Feb. 1919 (for which Collins was largely responsible), minister for finance. But it was in his military capacity as adjutant general of the volunteers and director of organization and of intelligence for the Irish Republican army that Collins became famous. Until 1921 and during the time when he was head of the list of men "wanted" by the British authorities, Collins discharged the responsibilities of these various offices. He controlled the entire correspondence of the revolutionary movement and almost all enterprises were considered, financed and many were also carried out by him. A reward of £10,000 was offered for his arrest and pictures of him were published. Yet he used no disguise, went about Dublin alone on a bicycle and frequently made appointments for an interview in the streets. He helped to demoralize the British secret service and created a most effective spy system of his own. In the debate on the Irish treaty in the *dail* Griffith was to speak of Collins as the man "who won the war."

When the truce with Britain was proclaimed in July 1921, Collins for the first time became directly known to the Irish public. No other figure was so popular. Griffith and Collins were the principal Irish plenipotentiaries at the negotiations in London in Oct.–Dec. 1921. By his genial personality and his realism Collins undoubtedly smoothed over many of the difficulties. Though in principle a republican he was not a doctrinaire and signed the treaty on Dec. 6, 1921, as marking the greatest advance in Ireland's status that could be obtained in the circumstances. He recognized that

in so doing he was almost certainly signing his own death warrant. In the ensuing debate in the *dail,* Griffith alone could not have persuaded the majority to approve the treaty against De Valera's opposition. This achievement was largely due to the magnetic personality of Collins. When the result of the voting (Jan. 1922) showed the narrow majority of seven for acceptance, Collins warned the *dail* of the anarchy that might follow dissension.

The first result of the *dail's* decision was confusion. Griffith was elected president, not of the Free State but of the Irish republic. Collins was appointed chairman of the provisional government, but administration in the ordinary sense was impossible. Civil life had been destroyed in the guerrilla war; the Royal Irish constabulary was disbanded; the British garrison was evacuating the country, and the Irish army, still considered the army of the republic, was disaffected. Mutiny broke out and Collins, hoping against hope to avoid civil strife, refrained from drastic action. He was instrumental in postponing the general election (stipulated for under the treaty), and when at last a date for it was fixed in June he entered into a compact with De Valera by which he and the republican leader agreed to appeal for the unopposed return of candidates jointly nominated by them. This would have given a very large representation to opponents of the treaty. When, however, independent candidates were put forward, Collins at the last moment advised his countrymen to vote as they wished. At the elections the republicans were heavily beaten and the Irish government challenged by force even in the capital, decided to use force in return.

Civil war began. Collins, assuming chief command, flung himself into the struggle with all his energy. Opposition was crushed in Dublin and all the large towns. Suddenly, on Aug. 12, 1922, Griffith collapsed and died and Collins became at once head of the state and of the army. He went to Munster, where the chief resistance lay. On Aug. 22, traveling with a strong escort from Skibbereen to Cork, his party was ambushed at Beal-na-Blath, and in the skirmish he was shot through the head. No man since C. S. Parnell had so caught the imagination of Ireland. *See* also IRELAND, REPUBLIC OF: *History.*

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COLLINS, WILLIAM (1721–1759), English poet in whose hands one of the most rigid poetic conventions of his time, the personified abstraction, became the vehicle for a unique vision of reality. He was born at Chichester on Dec. 25, 1721, the son of a wealthy hatter and mayor of that town.

Collins' literary career was brief and, in terms of bulk, not very productive; yet he was a precocious writer. He was sent to Winchester college, where he established one of the most stable and fruitful relationships of his unstable life, with his fellow poet Joseph Warton. Tradition speaks of a poem "On the Battle of the Schoolbooks," written in Winchester when he was 12. On the other hand a poem "On the Royal Nuptials," printed in 1734 but lost, which was long attributed to Collins, seems to have been the work of another. More certainly his are the verses, "When Phoebe Formed a Wanton Smile," in the *Gentleman's Magazine* for 1739, and the "Song. The Sentiments Borrowed From Shakespeare," both apparently composed while Collins was a schoolboy. He was only 17 when, under the influence of Pope's *Pastorals,* he composed his four *Persian Eclogues* (published in 1742; 2nd ed. as *Oriental Eclogues* in 1757) which alone of his works were much esteemed in his lifetime. Published when Collins was at Magdalen college, Oxford, they were followed the next year by his *Verses Humbly Address'd to Sir Thomas Hanmer,* in heroic couplets. To a second and revised edition, published as *Epistle: Addressed to Sir Thomas Hanmer,* issued the next year over the poet's name, was appended the exquisite "Dirge from Cymbeline." It is already notable how these early pieces lean upon other poems; what is more striking, in view of their date, is that the precedent they lean on most is Shakespeare.

Collins graduated in 1743 and, having failed to secure a fellowship, came to London in 1744. By the death of his mother in this year he came into a little money, and with further allowances from his uncle, Colonel Martin, who had supported him at Oxford, he was able to live for the time as a man about town. He made friends with both Garrick and Johnson; the latter expressed respect for his talents and, later, concern for his fate. By 1746 Collins was in and out of the bailiff's hands, and there was mention of a project (one of many which came to nothing) to translate Aristotle's *Poetics.* Meanwhile he had agreed to collaborate with Warton on a volume of odes. In the outcome Warton's odes and Collins' appeared separately, both in Dec. 1746, the title page of Collins' *Odes* being dated 1747. Warton's collection was well received, but Collins' *Odes on Several Descriptive and Allegorical Subjects* (the title was exact and considered) was barely noticed. Collins, though indignant, continued to practise the style announced and exemplified in the "Ode to Simplicity" and he surpassed himself in the "Ode to Evening" and "Ode Written in the Beginning of the Year 1746," both published in Dodsley's *Miscellany,* and in an elegiac ode on James Thomson, with whom Collins had been intimate in the last years before Thomson's death in 1748. In 1746 Dodsley's *Museum,* to which Collins may also have contributed some essays, printed "A Song. Imitated from the Midsummer Night's Dream of Shakespeare," a poem now attributed to him.

In April 1749 Colonel Martin died, leaving his nephew enough money to extricate him from his debts. In the next few months Collins wrote a lost poem, "Epistle to the Editor of Fairfax His Translation of Tasso," and also his "Ode on the Popular Superstitions of the Highlands of Scotland." This, left unperfected, was addressed to John Home, author of *Douglas;* it anticipates most strikingly some attitudes and interests of the romantic revival. In 1750, in a letter to William Hayes, who had set to music the ode on "The Passions" for public performance in Oxford, Collins wrote of another ode, now lost, on "The Music of the Grecian Theatre." In 1754, after a vain attempt to cure himself by travel of the mental illness, joined with physical debility, which had threatened him since 1751, Collins was confined in a lunatic asylum. Released to the care of his sister, he survived wretchedly in Chichester until June 12, 1759.

Although some theorists had allowed that personification could play a more positive role in poetry than merely to permit of economical phrasing, although in contemporary painting and funerary sculpture personifications were sometimes profoundly imaginative and although the Wartons had elevated this possibility into a conscious poetic program, only Collins constantly visualized his personifications so intensely as to transform them from set pieces of allegory into visionary apprehensions of a transcendent world. Enthralled by this possibility and dedicated to achieving it, Collins vowed himself to a classicism more thoroughgoing and exacting than his contemporaries conceived of. In particular it was Greek rather than Roman and it turned upon what Collins exalted as "simplicity." This has nothing to do with plainness and easiness (his diction for instance is throughout choice, sumptuous and elaborate), but rather has the meaning of "severity." It shows itself particularly in a calculated avoidance of sensuous appeal, as (consummately) in the "Ode to Evening," where the abstraction, Evening, is made concrete by steady negation of all sounds but the faintest, all colours but the most subdued. The severity that everywhere precluded rhythms in the least insistent or intoxicating here precluded rhyme also. Yet in fact, and by this very process of negation, the world evoked by Collins is very distinctly present to the senses, as a world above all damp and chill. The noble elegy on Thomson is only one example of how Collins assigns moral values to moistness and cold, sensations which he consistently associates with spiritual worth and achievement.

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(D. A. DE.)

COLLINS, WILLIAM WILKIE (1824–1889), English novelist, and an early master of the mystery story, was the elder son of William Collins (1788–1847), the landscape painter. He was born in London on Jan. 8, 1824, and died there on Sept. 23,

1889. At the age of 12 he was removed from the Maida Hill academy to accompany his parents to Italy; returning two years later, he was sent to a private boarding school in Highbury, where the senior boy is said to have employed him as a storyteller, rewarding success with pastries and visiting failure with a cat-o'-nine-tails. He was articled to a firm in the tea trade, but soon abandoned commerce to enter Lincoln's Inn. Although called to the bar in 1849 he had no disposition to practise law. He worked on a historical novel, had a picture hung at the Royal academy, engaged in theatricals and visited Paris where he was attracted by the morgue. His father had died in 1847, and his first essay in literature was *The Life of William Collins,* published in 1848. Then his fiction began to appear: *Antonina, or The Fall of Rome* in 1850; *Basil,* a highly coloured tale of seduction and vengeance with a contemporary middle-class setting and passages of uncompromising realism, in 1852; *Hide and Seek, or The Mystery of Mary Grice* in 1854. He made the acquaintance of Dickens, to whose *Household Words* he contributed as serials *After Dark* (1856) and *The Dead Secret* (1857). His first major achievement, *The Woman in White* (1860), is based upon a French *cause célèbre,* but its opening has been declared to contain a reminiscence of Collins' first encounter with Caroline Courtenay, his mistress for many years. Among his most successful subsequent books were *No Name* (1862), *Armadale* (1866) and *The Moonstone* (1868). The quality of his later writing shows a steady decline. His health was poor and he made injudicious use of opium.

Collins was one of the first and greatest masters of the mystery story, a literary kind which was to proliferate astonishingly in the 50 years after his death. Less concerned than Edgar Allan Poe to emphasize the intellectual aspect of detection, he lends to the progressive elucidation of unaccountable events and perplexed situations something of the traditional amplitude of the English novel. *The Moonstone* is a masterpiece of construction and *Armadale* of controlled melodrama; Count Fosco in *The Woman in White* is the illustrious original of innumerable bravura villains.

See Kenneth Robinson, *Wilkie Collins* (1951). (J. I. M. S.)

COLLITZ, HERMANN (1855–1935), German-U.S. philologist, noted for his work on the Indo-European languages, particularly the Germanic languages, was born Feb. 4, 1855, at Bleckede near Lüneburg. He entered the University of Göttingen in 1875, where he studied under a number of distinguished scholars; he received his doctorate in 1878. His dissertation dealt with the origin of the Indo-Iranian palatal series of consonants. In collaboration with Bechtel and others he edited the *Sammlung der griechischen Dialektinschriften* (4 vol., Göttingen, 1884–1915). During the later period of his life, however, and especially after he settled in the U.S., his teaching and publications were devoted mainly to the comparative and historical study of the Germanic languages. After several years in Berlin and Halle, Collitz went in 1886 to Bryn Mawr college, Pa., as associate professor of German. In 1907 he became professor of Germanic philology at Johns Hopkins university in Baltimore, Md., where he remained as emeritus professor after 1927. In 1912 his *Das schwache Präteritum* was published. He died on May 13, 1935. (J. W. P.)

COLLODION, a colourless, sticky fluid, made by dissolving guncotton and the other varieties of pyroxylin (*see* NITROCELLULOSE) in a mixture of alcohol and ether. It was first described in 1846 by the Swiss-German chemist C. F. Schönbein, discoverer of guncotton. The quality of collodion differs according to the proportions of alcohol and ether and the nature of the pyroxylin it contains. Collodion in which there is a great excess of ether gives by its evaporation a very tough film; the film left by collodion containing a large quantity of alcohol is soft and easily torn. Under the microscope, the film produced by collodion of good quality appears translucent and colourless. To preserve collodion it should be kept cool and out of the action of the light. For the iodizing of collodion, ammonium bromide and iodide and the iodides of calcium and cadmium are the agents employed. (*See* PHOTOGRAPHY.) Collodion is used in surgery since, when painted on the skin, it rapidly dries to a thin contractile film, affording both pressure and protection. Flexible collodion, containing Canada balsam and castor oil, does not crack, but, on the other hand, does not contract.

COLLOID, a substance in a particularly fine state of subdivision, much larger than atomic or simple molecular dimensions, but much smaller than particles visible to the unaided eye. The art of preparing and processing colloidal materials goes back many thousands of years; as far back, in fact, as civilization itself. Colloids and colloidal materials are vital to everyday life, common examples being butter, cheese, dough, inks, paints, silk, wool and other fibres, soils, rubber, plastics, potter's clay, even fog and smoke, to mention only a few. The long-known method of splitting open rocks by inserting dry wooden wedges, which are then moistened, is an interesting practical use of the swelling pressures of colloids. The alchemists of the middle ages were familiar with "potable gold" (a gold suspension still used for medicinal purposes), and the preparation of gold ruby glass goes back to the 16th century.

This article is divided into the following sections:

I. History
II. Irreversible Systems
1. Lyophobic Sols (Dilute Suspensions)
2. Emulsions
3. Foams
4. Pastes (Concentrated Suspensions)
5. Gel Structures
III. Reversible Systems
1. Polymers
2. Proteins
3. Gels
4. Association Colloids (Soaps and Dyes)

I. HISTORY

The scientific study of colloids dates only from the beginning of the 19th century, and of the early investigators special mention must be made of F. Reuss, Robert Brown, F. M. Ascherson and Francesco Selmi. Reuss (1809) packed a clay plug into a U tube, and after filling the two sides with water applied a potential from a voltaic cell across the plug. The small suspended particles of clay were seen to move toward the positive electrode, and after some time the water level stood lower in the arm containing this electrode. Such movements of suspended colloidal particles and of liquid under an applied electrical field are termed "electrophoresis" or "cataphoresis" and "electroosmosis" respectively.

If suspensions of very finely divided (colloidal) particles are examined under the microscope they are seen to undergo unceasing irregular movements, termed the Brownian movement (*q.v.*) in honour of the botanist Robert Brown, who in 1827 first recorded the phenomenon with aqueous suspensions of pollen. Brownian motion is now known to be caused by the irregular bombardment of the molecules of the surrounding liquid, and its study provided one of the earliest and most striking pieces of evidence in support of the real existence of atoms and molecules and of the simple kinetic theory.

In 1838 Ascherson, then lecturer in medicine at the University of Berlin and interested in the physiological role of fats, gave a paper to the Paris Academy of Sciences upon his studies of olive-oil droplets in the presence of dissolved proteins (*e.g.,* egg white or serum). He records that "coagulation in form of a membrane occurs inevitably and instantaneously when albumin comes into contact with a liquid fat." This observation explained the skins around fat droplets in living systems and laid the basis for the study of "denaturation" of proteins at interfaces.

Francesco Selmi, an Italian professor, published (1845–50) the first systematic study of inorganic colloids, in particular silver chloride, prussian blue and sulfur. Selmi showed that salts would coagulate these colloidal bodies and that they differed in their precipitating power. From the absence of heat changes upon coagulation or upon peptization he concluded that the dispersed particles were not in a state of molecular dispersion, a conclusion fully vindicated by later work.

Thomas Graham (1805–69) is usually regarded as the founder of modern colloid science, although his contributions to other branches of chemistry were also outstanding. Of his 46 publications the two of particular interest here are entitled *Liquid Dif-*

fusion Applied to Analysis (1861), and *On the Properties of Silicic Acid and Other Analogous Colloidal Substances* (1864). Graham realized very clearly the properties that we regard as characterizing the colloidal state, such as low diffusivity, absence of crystallinity and of ordinary chemical relations, as well as its biological significance. Low diffusivity arises from the large size of colloidal particles (*c.* 10^{-7} cm. to *c.* 10^{-3} cm.) as compared with ordinary molecules.

The term "colloid" (from the Greek word for glue) was coined by Graham in 1861 and applied by him to substances such as gelatin, albumin, gums, etc., which are retained by membranes such as parchment paper when subjected to dialysis (*q.v.*). Substances such as salts, sugars, etc., which readily pass through the membrane, he termed "crystalloids," by virtue of the comparative ease with which they could be obtained in crystalline form from their solutions. Of Graham's other contributions to the nomenclature of colloids, those still in use are the terms "sol," "gel," "peptization" and "syneresis." A sol is a dispersion of a solid in discrete units, the type of dispersion medium being shown by a prefix; *e.g.*, hydrosol (for dispersions in water), aerosol (for dispersions in air), etc. If the solid particles were linked together to form a structure with some mechanical strength the system was termed a gel. Peptization—from analogy with peptic digestion—referred to the spontaneous dispersion of a precipitate to form a colloid, as for example, the dispersion of a precipitate of prussian blue when an attempt is made to wash it. Syneresis was the term suggested by the study of silicic acid (obtained from water glass and dilute acids) for the phenomenon of spontaneous shrinkage of a gel with exudation of the dispersion medium.

Gold sols, prepared by reducing dilute solutions of gold chloride, are usually strikingly coloured (ruby red, blue, green, etc.). Although they were known to the alchemists of the 17th century, it was Michael Faraday (1857) who first made a scientific study of their preparation and properties. He showed that addition of salts turned the ruby sols blue and then coagulated them, and that these effects could be prevented by addition of gelatin and other hydrophilic colloids. The ruby sols, which had all the appearances of solutions, were shown by him to contain particles (of gold) since, unlike true solutions, a cone of light passing through them became visible to an observer situated at right angles to the beam. This phenomenon was later studied in more detail by John Tyndall, and is usually referred to as the "Tyndall effect."

Of the metal sols, those of silver were much studied, particularly by Carey-Lea (1823–97) in the U.S., in connection with the photographic process. The preparation and purification of sols were facilitated by electrodialysis, and by ultrafiltration, *i.e.*, filtration through porcelain filters of very fine pore size.

The stability of hydrophobic sols to salts was quantitatively examined by Hans Schulze (1882) and somewhat later by W. B. Hardy. Electrophoresis had shown that all colloids carry a charge to which hydrophobic colloids owe their stability, since the like charges prevent collision. According to the Schulze-Hardy rule, coagulation is brought about by the ion carrying the opposite charge to that on the colloidal particle, and the coagulating power of an ion increases very rapidly with its charge (*e.g.*, to coagulate negatively charged sols such as Au or As_2S_3, the requisite concentration of Na^+, Ca^{2+} and Al^{3+} are approximately in the ratio 1:1/70:1/900).

Addition of a hydrophilic colloid to a hydrophobic one protects it from the coagulating action of salts, a phenomenon termed protection and first pointed out by Faraday.

Hydrophilic colloids such as the proteins are only precipitated by high concentrations of salt. For a series of salts the efficacy runs approximately parallel to the solubility in water (F. Hofmeister, 1888), indicating that precipitation is caused by dehydration of the colloid. A series of cations or anions in order of coagulating power (*e.g.*, $Li^+ > Na^+ > K^+$) is termed the Hofmeister or lyotropic series.

In 1903 a notable advance was introduced in the techniques for examining colloidal systems with the invention of the ultramicroscope by H. Siedentopf and R. Zsigmondy (*see* Microscopy). The chief difference from the usual method of microscopic examination was the mounting of the microscope at right angles to the incident beam; the colloidal particles, because of the light they scatter laterally, then stand out as bright points of light on a dark ground. This apparatus can detect particles down to about 100 Å in size, compared with about 2000 Å (0.2 μ) for the ordinary microscope.

Jean Perrin in 1905 introduced the terms hydrophilic and hydrophobic to differentiate aqueous suspensions of markedly differing properties, as typified by gelatin and the colloidal metals respectively. These differ in many ways, the most striking being in their stability to salts and reversibility after precipitation. A gelatin solution, for example, is only precipitated by high concentrations of salts and after drying will readily take up water again. A sol of a metal, or of an insoluble salt like As_2S_3, is precipitated readily by traces of salts and does not return to the colloidal state, even if the salts are eliminated by washing the precipitate. This explains the indications reversible for hydrophilic and irreversible for hydrophobic systems. To cover dispersion media other than water, the terms lyophilic and lyophobic were proposed by Herbert Freundlich.

The early years of the 20th century witnessed many striking developments in physics and chemistry, many of which bore directly upon colloids; for example, the electronic structure of the atom and its bearing upon valency, the ideas of molecular size and shape as revealed by X-rays and the nature of solutions, to mention only a few. In addition, powerful new methods for studying the size and shape of colloidal particles were developed, such as the ultracentrifuge, electrophoresis, diffusion, the scattering of light and of X-rays, etc.

The study of interfaces, a topic clearly of great relevance to colloids, developed into a major field under the title of surface chemistry. The investigation of colloids in industry and biology also led to major developments in such fields as detergents, dyes, proteins, polymers, etc.

The main classification of colloids is that into reversible and irreversible systems. In the latter systems, to which belong sols (dilute suspensions), emulsions, foams, pastes (concentrated suspensions) and certain types of gels, the size of the particles is dependent greatly upon the method of preparation. In the reversible systems particle size is either given by the molecular size of the colloidal material, as in polymers, polyelectrolytes, proteins, etc., or the particles are formed from small molecules by a reversible association, as in soaps, detergents and certain dyes. Some of the important aspects of these diverse systems are outlined below.

II. IRREVERSIBLE SYSTEMS

1. Lyophobic Sols (Dilute Suspensions).—Lyophobic sols are dilute systems; some typical examples, such as colloidal metals, silver chloride and prussian blue, have already been mentioned. Of suspensions in gaseous media (aerosols) some, such as fogs, mists and smokes, are well known; others, such as air-borne suspensions of bacteria, viruses and molds, are less obvious but of equal importance. Smokes have found considerable use in wartime for camouflage and antipersonnel purposes. The peacetime uses of aerosols include insecticidal sprays and frost prevention in orchards by means of smudge pots. The removal of smokes still presents a major industrial problem. In the electrostatic precipitator, one of the best-known methods, the smoke passes between wires charged to a high potential difference; because of the charges which they carry, or which are induced upon them, the smoke particles are attracted to the wires and thereby removed.

Dilute suspensions are known in all the three possible dispersion media (gas, liquid and solid), of which only those in air and in aqueous solutions can be considered here. The dispersed particles are almost invariably composed of a large number of atoms or molecules, and are usually visible in the ordinary or ultramicroscopes (about 100 Å—about 10 μ). The amount of dispersed phase is always small, usually much less than 1%.

Suspensions can be prepared by breaking down particles of macroscopic dimensions (dispersion) or by growth from molecular or atomic units (aggregation) until particles of the requisite colloidal dimensions are obtained.

Dispersion is usually carried out in the laboratory by grinding in an agate mortar, commercially by means of a colloid mill in which the mixture of coarse particles and dispersion medium is subjected to intense shearing forces between a rotor and stator (a protective colloid is frequently added to prevent the colloidal particles from reaggregating). As first shown by G. Bredig, metals can be dispersed in liquids by striking an electric arc between them, usually in the presence of a trace of sodium hydroxide to stabilize the sol formed. In some cases dispersion can be brought about by adding a small amount of a third substance termed a peptizing agent. Examples are the peptization of clays by alkalies (caused by OH^- ion) and many finely divided precipitates by soaps or other hydrophilic colloids.

In aggregation processes the first step is to form a supersaturated solution, by chemical or physical means. This leads to formation of nuclei that grow to colloidal size and that have then to be stabilized in order to prevent flocculation. An example of a chemical process is the reaction between arsenic oxide and hydrogen sulfide in very dilute solution, $As_2O_3+3H_2S \rightarrow As_2S_3+3H_2O$, in which the insoluble arsenic sulfide appears in the form of minute particles dispersed in the aqueous solution. A common physical method is typified by the formation of sulfur sols by pouring a solution of sulfur in alcohol into water. Mist, fog and clouds are aerosols formed by physical means—rapid cooling of air saturated with water vapour.

The size of the particles formed in aggregation processes is determined by the ratio of nucleation and crystal growth. A high rate of nucleation is imperative for the formation of small particles.

Liesegang Rings.—Another phenomenon, named after its discoverer, R. E. Liesegang, where nucleation plays an important role is observed if an insoluble precipitate is formed during the diffusion of one reactant into the other. If, for example, a thin layer of dilute potassium dichromate in a gelatin gel is placed on a glass plate and a crystal of silver nitrate is placed at the centre, a periodic precipitate of insoluble silver chromate is eventually formed, as shown in fig. 1.

Each band is formed when a certain supersaturation has been reached locally, so that nucleation occurs. By subsequent growth of the nuclei the concentration is lowered also in the neighbourhood of the band, and the diffusion of $AgNO_3$ can proceed a certain distance before a sufficient degree of supersaturation is again reached and the next band precipitates.

These bands are very similar to the banding in some minerals, such as agate, and are believed to explain such formations.

Stability.—As has been mentioned earlier, the stability of sols arises chiefly from the charges carried by the particles preventing contact under conditions such that collision would otherwise occur. The charges are usually obtained by the preferential adsorption of one type of ion, often a negative ion, since most sols are negatively charged. When the sol particles are close together, attractive forces of the same nature as the London-Van der Waals forces in gases make themselves felt.

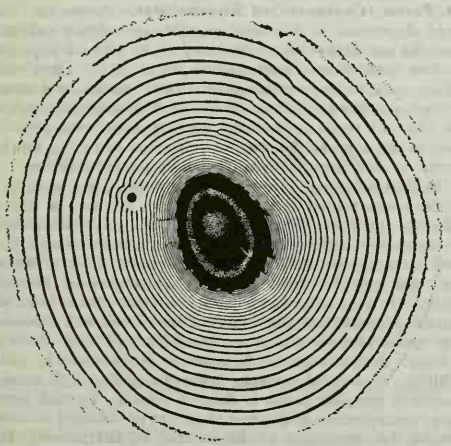


FIG. 1.—LIESEGANG RINGS OF SILVER CHROMATE STRIKINGLY RESEMBLE THE BANDING IN MANY MINERALS, SUCH AS AGATE, AND ARE BELIEVED TO EXPLAIN THE MINERAL FORMATION

Addition of inorganic salts, which effectively screen the charges on the colloidal particles, leads to a reduction of the range of the electrical repulsive forces so that the attraction becomes predominant and coagulation follows. It has been possible to explain the Schulze-Hardy rule (*see* above) on this basis.

2. Emulsions.—The term emulsion is used to denote any stable colloidal dispersion of one liquid in another, but in practice only oil and aqueous solutions need to be considered, since biological emulsions, as well as those of most domestic and industrial importance, contain an oil and some aqueous solutions as the two immiscible phases. In order to attain the requisite degree of stability a third component, in addition to the oil and aqueous phases, is necessary. This component is termed the emulsifying agent, and is usually present in amounts of about 1%–5%.

Emulsions can exist in two types, oil-in-water (denoted by O/W) and water-in-oil (W/O), depending upon whether the aqueous or the oil phase is the continuous one. Two fundamental problems arise therefore—the origin of the stability induced by the emulsifying agent and the reason why some agents promote O/W and others the inverse type.

The subject of the technical and biological aspects of emulsions is a vast one. The principal technical uses are in pharmacy and cosmetics (creams and ointments are usually emulsions), in food preparations (*e.g.*, salad cream, mayonnaise, margarine) and in many industries, particularly leather, textiles and paper. Margarine, for example, is a W/O emulsion stabilized by about 1% of oxidized soybean oil; mayonnaise and salad cream are emulsions of edible vegetable oils in aqueous solutions of edible acids stabilized by egg yolk.

Oils are often emulsified commercially. The three main reasons are dilution of the oil, increase in area of interface and modification of physical properties. Dilution effects economy of the oil (*e.g.*, polishes, oil-soluble insecticides) by spreading it over a larger surface. Increase in area of interface may accelerate some chemical reactions (*e.g.*, polymerization of vinyl compounds, hydrolysis of fats in soap manufacture). Modification of physical properties includes removal of objectionable characteristics; for example, emulsification diminishes the taste or smell of pharmaceutical preparations such as cod-liver oil and increases the fluidity of heavy oils such as tar. On the other hand, crude petroleum is frequently produced as a W/O emulsion. Breaking of this emulsion is often difficult but necessary before further processing.

In evaluating the stability of emulsions, creaming, coagulation and coalescence should be distinguished. Creaming is the accumulation of the droplets (usually at the top of the emulsion) under the influence of gravity. Small drops cream much more slowly than large ones. In coagulation the droplets come together forming aggregates in which the original drops are still separated. Coagulation enhances creaming. Coalescence means that the drops unite to form a continuous phase. Fresh milk creams markedly in a few hours. By acidification it can be made to coagulate. Coalescence is strongly increased by churning.

Emulsification is achieved by intense agitation of the mixture. On the small scale this can sometimes be done merely by hand shaking, but it is more usual to force the coarse emulsion under pressure through some type of valve, as in the household "cream machine." Industrially various types of colloid mill are used, in which the emulsion is subjected to very intense shearing forces, finally passing through a homogenizer. These treatments decrease the particle size and so increase the stability. (Milk is frequently homogenized in order to diminish creaming.)

The principal emulsifying agents are as follows: for O/W emulsions—proteins, gums, carbohydrates, natural and synthetic soaps, clays and certain hydrated oxides, particularly of silica or aluminum; for W/O emulsions—heavy metal salts of the fatty acids

(*e.g.*, zinc stearate, nickel oleate), long-chain alcohols such as cetyl alcohol, long-chain esters such as glycerol monooleate, oxidized oils, soot, lampblack, graphite, etc.

Various theories have been advanced to explain emulsion type, the most obvious being that originally suggested for solid powders. As fig. 2 shows for idealized spherical particles, if the solid is preferentially wetted by one phase then more particles can be accommodated if the interface is convex to that particular phase, and in an encounter between two droplets actual contact between the liquid in the drops is prevented, so that coalescence cannot occur. In other words, preferential wetting by water should tend to give O/W emulsions as in fig. 2(A), preferential wetting by oil the inverse type as in fig. 2(B). This is in agreement with the above list of emulsifiers, those promoting O/W emulsions being all hydrophilic whereas those that favour W/O are more oleophilic. It must be realized that other factors also enter, in particular the relative amounts of oil and water and even the order in which the phases are mixed.

The natural and synthetic soaps soluble in water are among the most widely used O/W emulsifying agents. Certain synthetic soaps (see *Association Colloids* [*Soaps and Dyes*] below) are often preferable to ordinary fatty acid soaps, as they are not precipitated by calcium ions and so can be used with hard water. The electric charge obtained by the oil drops by adsorption of the soap ions is one factor in stability; the mechanical properties of the adsorbed film seem to be another one. The strong reduction of the interfacial tension, which may become as low as 0.1 dyne/cm., facilitates emulsification greatly.

As previously mentioned, di- and trivalent fatty acid salts (*e.g.*, nickel oleate) are efficient emulsifiers for the W/O type. In these systems the interfacial film consists of solid particles or a polymolecular skin rather than a monolayer. A simple experiment to illustrate phase inversion is to prepare an O/W emulsion stabilized by sodium oleate and to add a few drops of saturated magnesium chloride. On being shaken the system inverts to the W/O type because of the magnesium oleate formed by double decomposition.

Proteins and gums normally only promote the O/W type of emulsion. A great variety of proteins are used commercially, such as egg albumen, dried blood, casein (from milk), etc., and proteins are wholly or partly responsible for the stability of many natural emulsions such as milk and rubber latex. Food emulsions are frequently stabilized by proteins, gelatin, etc. The stabilizing action of these substances arises from the mechanical protection given by the adsorbed skins which form spontaneously and which are relatively impenetrable for oil.

3. Foams.—A foam is a gaseous dispersion (usually of air) in a liquid continuum. Pure liquids do not give stable foams and for any reasonable stability a third component, the foaming agent, is essential. Of the great variety of substances that act as foam promoters the best known are the soaps (natural and synthetic), proteins including gelatin and other degraded proteins, certain finely divided solid powders, certain polymers and the saponins.

Household soap, which consists chiefly of a mixture of sodium stearate ($C_{17}H_{35}COONa$) and sodium palmitate ($C_{15}H_{31}COONa$), is well known for its bubble-blowing capacity. This property is greatly improved by the addition of glycerol, which probably acts by increasing the viscosity of the film. An excellent composition for blowing stable bubbles is as follows: 28.2 g. oleic acid, 100 ml. N.NaOH, 300 ml. glycerin, 1,200 ml. distilled water. Many synthetic soaps, sodium cetyl sulfate ($C_{16}H_{33}SO_4Na$), for example, are equally effective, with the added advantage that their lathering power is not so readily diminished by hard water (see *Association Colloids* [*Soaps and Dyes*] below). The thinning of a soap bubble is well known to be accompanied by the development of interference colours, the final films being black with thicknesses a small multiple of the ultimate one, which has a thickness of about 50 Å.

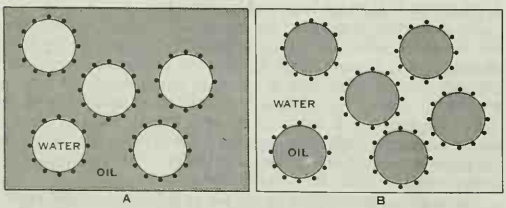


FIG. 2.—SOLID POWDER AT AN OIL/WATER INTERFACE SHOWING (A) HOW PREFERENTIAL WETTING BY OIL TENDS TO GIVE WATER/OIL EMULSIONS AND (B) HOW PREFERENTIAL WETTING BY WATER TENDS TO GIVE OIL/WATER EMULSIONS

Stabilization of foams arises mainly from the same factors that govern the stability of emulsions. Indeed as to polarity a suspension of air bubbles in water (a foam) is very similar to a suspension of oil droplets in water. In both cases we find the same type of stabilizers.

Proteins find a wide use as foaming agents, because of their edible nature, in foodstuffs such as whipped cream, marshmallow (made from gelatin and sugar) and meringue (from egg white) where the foaming agent must be edible or at any rate nontoxic. The "firefoam" used to combat oil fires consists of bubbles of carbon dioxide (liberated from sodium bicarbonate and aluminum sulfate) stabilized by dried blood, glue or any other cheap protein-containing materials. Beer froth is believed to be stabilized by the colloidal constituents present, which include proteins and carbohydrates.

Saponins are noted for their foaming capacity and as obtained commercially from various plants are complex mixtures. They form rather solid surface films to whose mechanical strength their foams owe their stability, just as in the case of proteins.

Of the polymers with foaming power for aqueous solutions, the most important are methyl cellulose (water-soluble type) and polyvinyl alcohol (see *Polymers* below).

Certain finely divided solids, particularly if they have a waxy or hydrophobic surface, such as aluminum stearate or heavy metal soaps insoluble in water, remain at the air/water interface on agitation and stabilize the foam so formed. By suitable treatment many other materials can be made to behave similarly, and this forms the basis of the "froth-flotation" method for separating minerals. The structure of a single bubble in a foam stabilized by a fine powder is quite similar to that of the emulsion droplet represented in fig. 2(A).

Foaming may often be an undesirable property, as in lubricating oils, and its prevention is not always easy. Aqueous foams can usually be broken by spraying with small amounts of certain alcohols (*e.g.*, amyl, octyl) or fatty acids.

4. Pastes (Concentrated Suspensions).—Pastes are concentrated dispersions of fine solid particles in a liquid continuum. From the practical point of view they are of extreme importance, covering such diverse materials as paints, putty, clays, dough, drilling muds, tooth paste and so on. These materials are all noted for their peculiar and characteristic mechanical properties, as denoted by such terms as plasticity, ductility, moldability, etc. The study of the flow and deformation properties of pastes, which are so vital in their practical usage, has been termed rheology.

The flow behaviour of a paste is determined not only by the volume concentration of the solid particles but also by their size and shape, their size distribution and by the colloidal stability of the suspended particles. At a given solid concentration a flocculated paste may be stiff and plastic whereas a stable or deflocculated one may be easily pourable. Examples of flocculated systems are very polar compounds in organic media (*e.g.*, silica, calcium carbonate and other inorganic salts in oils such as benzene), or nonpolar substances such as carbon black in polar media such as water. Such systems can be rendered deflocculated by suitable additives, a practical example being the addition of aluminum stearate to inorganic paints in their oil vehicle. By such means a higher concentration of disperse phase can be obtained without increasing the consistency of the material or, alternatively, an increase in pourability at the same solid concentration. It is for the former reason that materials such as sodium silicate are added to potter's clay, since the water present, having ultimately to be re-

moved, should be kept to a minimum. Putty is a paste of finely ground whiting (natural calcium carbonate) in a medium of linseed oil, its characteristic property being termed "string." Pure calcium carbonate and acid-free linseed oil give a friable putty without string, the system being a typical flocculated one. After adding small amounts of free fatty acid to the oil and of oxides of aluminum or iron to the calcium carbonate, the system is deflocculated and possesses excellent string. The desirable properties of the usual commercial material are therefore believed to arise from reaction between traces of these oxides and of fatty acids in the oil, forming a metal soap which deflocculates the system.

Pastes, particularly those with the higher concentrations of disperse phase, usually show some sort of yield value upon deformation. This is clearly essential if the material is to exhibit plastic properties (*e.g.*, potter's clay), since it has to retain its shape against the forces of gravity.

Certain pastes exhibit the phenomenon known as thixotropy; *i.e.*, after stirring or shaking they become much thinner in consistency, returning to their original state on being allowed to stand. A well-known example is quicksand, which consists of a paste of sand and water made thixotropic by the presence of certain clays.

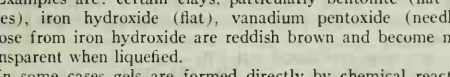
Paint should be thixotropic in order to flow easily under the brush and to allow the brush streaks to disappear. After a short time it should solidify to prevent the paint from flowing away from vertical planes.

The reverse phenomenon, termed dilatancy, in which a suspension that flows freely under a small force turns rigid when larger forces are applied, is shown by very concentrated, highly stabilized suspensions; *e.g.*, by pastes of pure silica in water.

5. Gel Structures.—A flocculated paste or suspension of very fine particles often behaves as a gel; *i.e.*, a quasi-homogeneous solidlike system, rich in liquid. During the flocculation a scaffolding structure is formed preventing sedimentation and enmeshing the dispersion medium. Such structures are preferentially formed by long or flat particles. The systems are often thixotropic, the bonds between the particles can be broken by mechanical action. They show syneresis; *i.e.*, in the long run the scaffolding retracts by further flocculation and liquid is exuded.

Examples are: certain clays, particularly bentonite (flat particles), iron hydroxide (flat), vanadium pentoxide (needles). Those from iron hydroxide are reddish brown and become more transparent when liquefied.

In some cases gels are formed directly by chemical reaction. Substances that tend to separate as amorphous precipitates frequently give gels when first formed, the hydroxides of aluminum, chromium and silicon being good examples. Of these, the formation of silica gel by reaction between sodium silicate (water glass) and acids, or between silicon tetrachloride and water, has been much studied. The sol first formed slowly transforms spontaneously into a translucent gel showing bluish opalescence, and this gel may later shrink, exuding the aqueous medium (syneresis). The changes are believed to arise from the polymerization of the monosilicic acid first formed; *e.g.*,



It is clear that the process can be repeated in one, two or three dimensions, leading to high molecular weight silicic acids and a rather rigid three-dimensional gel.

Silica gel undoubtedly owes its high mechanical strength to the linking of the silicic acid molecules through primary valence bonds ( ), this also explaining the absence of thixotropy, the irreversibility of the gelling process and the comparatively small effect of drying on the gel volume.

With the thixotropic types, where the gel structure can be easily and reversibly produced, it seems improbable that primary valence bonds can be involved in linking the particles together. The most plausible theory is that the particles are linked at the points of contact through weak, secondary valence forces, the same forces that are active in ordinary flocculation.

Ion Exchange or Base Exchange.—A property of clays of great importance in agriculture is termed base exchange or, more correctly, ion or cation exchange. If, for example, a salt solution such as potassium sulfate percolates through a soil, the potassium ions are removed and replaced by an equivalent amount of calcium ions originally present in the clay.

Ion exchange also forms the basis of the zeolite or permutite water-softening process. In this case calcium ions are replaced by sodium ions and the water is thus softened.

Clays, the finest ($< 2\ \mu$) mineral constituents of the soil, consist of layer structures of alumosilicates in which some cations of low valency are easily accessible and exchangeable. The nature of these ions is not critical for maintaining the clay structure; only their total electric charge is important.

Zeolites are essentially infinite three-dimensional frameworks as in the various forms of silica (SiO_2), except that some of the Si atoms (often about one-half) are replaced by Al atoms. This replacement of Si by Al makes the framework negative and equivalent cations are taken up in the interstices to maintain electrical neutrality. Permutite (sodium permutite) has the approximate composition $Na_2Al_2Si_2O_8.6H_2O$. It is manufactured in various ways, such as by fusing a mixture of sodium carbonate, china clay or alumina and silica (sand, quartz, etc.), the resulting vitreous mass being then leached with water.

III. REVERSIBLE SYSTEMS

Reversible colloids are characterized by the fact that colloidal solutions or gels can be formed spontaneously when the dry colloid and the dispersion medium are brought together. The size of the particles in reversible colloids is determined by the molecular weight of the colloidal material in the case of polymers or by reversible association in the case of detergents, certain dyes and a few other substances.

1. Polymers.—Polymers are high molecular weight substances built up of a large number of identical (or practically identical) repeating units, the single molecules being of colloidal dimensions. Nature has always made considerable use of polymeric materials, such as cellulose in wood and plants and proteins in horn, hair, wool, etc. The synthetic polymer industry began to grow rapidly in the 1920s, and plastic became a household word.

In nature three different functions of polymers can be distinguished. They serve as building materials (cellulose, proteins of skin and muscle), storage substances (starch, glycogen) and they play a fundamental role in biochemical reactions (enzymes, nucleic acids, genes). These functions are clearly related to the high molecular weight of these substances. The primary valence bonds in organic molecules are quite strong, not inferior to the bond strength in inorganic molecules. The secondary bonds, however, between organic molecules are weak and can be easily disrupted. Crystals of organic substances of low molecular weight as a rule are soft. Consequently a structure built of organic materials should contain a high proportion of primary bonds and this can be realized by building the structure with polymers. The advantage of using organic materials is that they can be "processed" at much lower temperatures than inorganic materials like metals or ceramics. In synthetic plastics man uses the same principle, although as a rule with other substances.

Polymers are used for storage purposes because for similar chemical structures the solubility is lower the higher the molecular weight.

The intricate functions necessary to regulate biochemical reactions including reproduction can, of course, be more easily incorporated in large than in small molecules, because the large molecules allow more diversification.

Most polymers, both natural and synthetic, are linearly built. In solution and often even in the dry state this long chain is folded or coiled. In proteins the folding is very regular. In synthetic polymers and in many natural ones like rubber and gums the

coiling is very irregular and determined by chance rather than by some building principle. One speaks of "statistical coils." The large extension in solution of polymer molecules is the cause of a high viscosity, which can be used for determining the molecular weight of the polymer.

When linear polymers are interconnected locally, a cross-linked polymer network is obtained. Such a network, when deformed, tends to return to its original shape because that was the situation of most probable coiling. This tendency explains both rubber elasticity and swelling of dried polymer gels.

For the purposes of discussion polymers are usually subdivided, according to their origin, into natural and synthetic, although an intermediate class, man-made derivatives from natural polymers, is also convenient. Some of the more important members of these three subgroups are as follows:

1. Natural polymers: cellulose, starch, rubber, proteins, the products from linseed and other "drying" oils.

2. Derivatives from natural polymers: nitrocellulose, cellulose acetate, regenerated cellulose (viscose, cellophane, etc.), vulcanized rubber.

3. Purely synthetic polymers: nylon, polystyrene, polythene, synthetic rubber, silicones, phenol-formaldehyde and urea-formaldehyde resins.

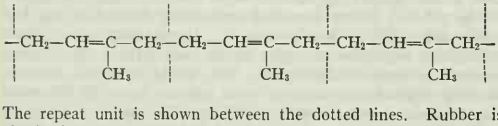
Natural Polymers.—Cellulose is the principal building constituent of the plant kingdom. Paper is derived from wood pulp, after treatment to separate the cellulose from the lignins and other substances present.

Cotton and flax, widely used in the textile industries, are almost wholly cellulose.

The cellulose molecule was shown by W. N. Haworth and others to consist of a linear array of condensed glucose units. (*See* CELLULOSE: *Chemical Constitution.*) The chain length or degree of polymerization depends upon the source and the method of extraction. The chain may reach a length several thousand times that of the monomer.

Starch is also of great importance in the plant world, not as a building material but as a convenient means of storing glucose, and hence energy and food; wheat, maize and other grains consist largely of it. It resembles cellulose in being a polycondensation product of glucose, but differs in having a branched-chain structure rather than a straight-chain one. Starch can be dispersed in hot water and is then used as a household material for laundry purposes. In the laboratory it is well-known for its blue coloration with iodine, a very sensitive test much utilized in volumetric analysis.

Natural rubber is a linear polymer built up from isoprene units, having the structure:



The repeat unit is shown between the dotted lines. Rubber is obtained naturally in the form of a milky suspension or latex from a wide variety of plants and trees. Commercially the genus *Hevea* is grown on a vast scale in Malaya and Indonesia, and forms the principal source of supply. The loss of these territories to the Japanese in World War II gave an enormous impetus to synthetic rubber production (*see* below).

After the latex has been coagulated by adding acetic acid or in other ways, the resulting "crepe" rubber is usually compounded with other materials to make it suitable for industrial use. For example, in the manufacture of tires it is compounded with carbon black, certain inorganic fillers such as zinc oxide and sulfur, and then subjected to heat treatment.

The action of sulfur leads to vulcanization, as it is termed, which is the formation of cross links between the chains through one or more sulfur atoms. Vulcanization makes the product more resilient and less liable to plastic flow.

Paints usually consist of a fine dispersion of an inorganic coloured powder (*e.g.*, lead chromate, zinc oxide) in an oily medium containing unsaturated glycerides such as linseed oil. These oils, when exposed as a thin film to the action of air, rapidly oxidize and polymerize, forming a protective skin for the underlying material and the pigment.

Derivatives from Natural Polymers.—Cellulose forms the basis from which several important substances are derived.

Nitrocellulose, or cellulose nitrate as it should more appropriately be termed, is the nitric acid ester of cellulose, made by treating cotton or other cellulosic materials with a mixture of nitric and sulfuric acids. If fully nitrated a trinitrate is obtained, each —OH group in the original glucose subunit having become $-O.NO_2$. Depending upon the degree of nitration the properties vary considerably, the higher members being used as propellants (*e.g.*, cordite), the lower ones for lacquers, Celluloid, etc. Celluloid, the oldest commercially made plastic, consists of a mixture of cellulose nitrate with camphor, the latter being termed a plasticizer since it enables the polymer to be more readily worked. The major disadvantage of Celluloid is, of course, its inflammability.

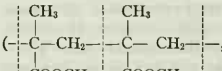
Cellulose acetate, the acetic acid ester, is made on the larger scale for artificial silk, for lacquers and for safety film (because of its comparative inertness).

Cellulose can be dissolved in a number of solvents from which it can be precipitated more or less unchanged. Common forms are cellophane, widely used as a transparent waterproofing film, and viscose rayon, the oldest and still widely used artificial silk.

Purely Synthetic Polymers.—The science and the production of purely synthetic polymers was greatly developed during World War II. Synthetic rubber was and is still made on a large scale by copolymerizing a mixture of butadiene (CH_2=CH—CH=CH_2) and styrene (—CH=CH_2), both of synthetic origin. This gives a linear polymer resembling in many ways natural rubber. Nylon is made by condensing diamines with dibasic acids, a typical member having the structure —$NH.CH_2.CH_2.CH_2.CH_2.CH_2.NH.CO.CH_2.CH_2.CH_2.CH_2.CO$—, etc. This structure has a close resemblance to that of natural silks and other fibrous proteins.

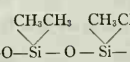
Many other types of polymers are made by polymerization of vinyl compounds (*i.e.*, compounds containing active double bonds), for example,

polythene (—$CH_2.CH_2.CH_2.CH_2$.—, etc.),
polyvinylchloride (—$CH_2.CHCl.CH_2.CHCl$—, etc.),
polymethylmethacrylate (perspex or Plexiglas)



polyvinylalcohol (—CH_2—CH(OH)—CH_2—CH(OH)—, etc.)

The silicones are polymers based upon a silicon-oxygen chain. A member of this series would be:



They are much more stable to heat, organic solvents and chemical reaction than are the older plastics and should thus find many uses.

Finally, mention must be made of the well-known type of polymer Bakelite, made by heating phenols or urea with formaldehyde. These are cross-linked polymers and are termed thermosetting, since once formed they do not soften when warmed, in contrast with the above linear polymers which are thermoplastic; *i.e.*, they soften upon warming and harden again upon cooling. (*See* also POLYMERIZATION.)

Polyelectrolytes.—Polymers carrying a large number of ionizable groups deserve special attention. An example of these so-called polyelectrolytes is polyacrylic acid, a long-chain polymer with a carboxylic group on every other carbon atom of the chain.

Many natural polymers, as gum arabic, agar and proteins, are also polyelectrolytes.

Because of the mutual repulsion between the ionized groups, the form of the coil of a linear polyelectrolyte depends greatly upon its degree of ionization. Viscosity and swelling increase strongly with ionization.

2. Proteins.—A number of references to proteins, typical members of the hydrophilic class of colloids, have already been made. Proteins occur naturally in all living systems and are responsible for carrying out a great variety of vital functions. Many enzymes and certain viruses appear to be proteins. Tobacco mosaic virus, for example, can be prepared as a pure crystalline nucleoprotein which, nevertheless, has the ability to reproduce itself when injected into an uninfected plant. Nature not only utilizes proteins in the transport of insoluble materials, such as fat particles in milk, rubber particles in latex, oxygen in blood, but also as a means of building up rigid structures where mechanical strength is required. Most biological membranes consist, wholly or in part, of insoluble proteins or protein derivatives. Materials such as horn, hair, skin, cuticle, connective tissue and muscle are largely protein in nature. Gelatin and glue are breakdown products from complex proteins such as collagen.

It has long been known that proteins are essentially polycondensation products of α-amino acids, of which glycine $H_2N.CH_2.COOH$ and alanine $H_2N.CH(CH_3).COOH$ are the simplest members. The structure of the polypeptide chain can be written

$$-CO.NH.CH(R)-CO.NH.CH(R^1)\ldots$$

etc. where R and R^1 represent different side chains such as $-H$, $-CH_3$, $-CH_2.C_6H_4OH$, $-CH_2.CH_2.NH_2$, $-CH_2.COOH$, etc.

Proteins can be classified in various ways—for example, according to their degree of complexity, their size and shape, solubility or other physical properties, origin, etc.

Classified on the basis of complexity, proteins are divided into those which contain only α-amino acids (*e.g.*, egg albumen, the chief constituent of egg white), and those which contain additional groups (*e.g.*, hemoglobin, the red pigment of blood responsible for oxygen transport, where the protein part of the molecule is linked to hem, a porphyrin). "Derived proteins" would, as the name implies, include such materials as gelatin, glue and proteoses, obtained by the partial decomposition of more complex proteins.

On the basis of shape, proteins are frequently classed as globular or fibrous, the former having a corpuscular shape (*e.g.*, hemoglobin, egg albumen), sometimes approximately spherical, the latter being very much more elongated (*e.g.*, myosin, an important constituent of muscle). Two other important fibrous proteins—both insoluble—are keratin (of which hair and wool are largely composed) and fibroin (the chief constituent of natural silk). Under some conditions (*e.g.*, strong urea solutions) globular proteins can be unrolled, or denatured, forming fibrous proteins that after suitable chemical treatment can be spun into a material closely resembling wool.

In the early days proteins were largely separated by means of fractional precipitation with salts—those precipitated by half-saturated ammonium sulfate being termed globulins, whereas the albumins required fully saturated ammonium sulfate.

As pointed out earlier, salts differ very markedly in their ability to "salt out" proteins. For a given cation (*e.g.*, K^+, NH_4^+) the following sequence of anions in decreasing order of efficacy is found:

$$SO_4^{--} > CH_3COO^- > Cl^- > NO_3^- > I^- > CNS^-$$

The last two—the iodide and thiocyanate—do not salt out even in saturated solutions. Alcohol can also precipitate proteins; added in subprecipitating amounts it renders them more readily coagulated by salts. In all cases precipitation occurs most readily at the isoelectric point (*see* below).

Of other physical properties of proteins a great deal of attention has been given to their size, shape and charge.

The size and shape of soluble proteins (and of other polymers in solution) have been chiefly found by measuring rates of diffusion and their rate of movement in very strong centrifugal fields. In the ultracentrifuge, developed largely by T. Svedberg at the University of Uppsala, Swed., the protein molecules are subjected to intense forces up to 1,000,000 times that of gravity. Under these conditions particles as small as 50 Å sediment at measurable speeds, whereas if only gravity were available nothing less than about 10000 Å (1 μ) could be attempted. By such means the molecular weight and approximate shape of many proteins were determined, the former ranging from about 10,000 to several million. The single molecules are thus of sufficient size to bring them into the colloidal range. For example, hemoglobin has a molecular weight of about 68,000, hemocyanin (the respiratory pigment of certain snails) one of about 5×10^6. In both these cases the molecules are approximately spherical in shape, showing that the polypeptide chain must be folded in some way, whereas others, such as myosin, are quite elongated, with the polypeptide chain more or less fully extended.

Because of the presence of ionizable groups, particularly $-NH_2$ and $-COOH$, protein molecules in solution normally carry a charge. In very acid solutions they are positively charged (because of $-\overset{+}{N}H_3$), in very alkaline ones negatively (because of $-COO^-$); at some value of the hydrogen ion concentration the net charge is zero. This value is termed the isoelectric point and is of considerable importance. It can be determined in various ways, usually by measuring the electrophoretic mobility in buffer solutions of different pH on both sides of the isoelectric point, plotting the results graphically, and reading off the pH of zero mobility. (*See* also PROTEINS.)

As different proteins contain different numbers of ionizable groups, their electrophoretic mobilities at a given pH are different. A. Tiselius of the University of Uppsala developed a technique of electrophoresis in which these differences in mobility are used for analytical or for preparative purposes.

3. Gels.—Several lyophilic colloids can form gels. Table jellies, blancmange and cold starch paste are well-known examples. These gels can all be considered as network structures with enmeshed liquid. The jelling component may be gelatin, agar, starch, pectin, etc., and is usually present in concentrations of less than 10%. Table jellies are usually made from gelatin (a protein) (2%–3%); jams are jelled by pectin (a carbohydrate derivative). Agar slopes or plates, widely employed in bacteriological work, consist of a suitable nutrient medium jelled by the addition of 1%–2% agar, a polymer of carbohydrate nature prepared from certain seaweeds. Fatty acid salts such as aluminum, calcium and zinc oleates are the thickening agents in many greases, which are examples of gels with a nonaqueous liquid phase. Some materials such as gelatin and agar set to a gel on cooling whereas in other cases gelation is brought about by heating (egg white). In both cases, however, gelation arises from a process akin to a diminution of the solubility of the jelling agent leading to the formation of interconnections between the individual molecules.

4. Association Colloids (Soaps and Dyes).—Soaps and other detergents and a number of dyes constitute by far the most important substances classed as association colloids; *i.e.*, substances of relatively small molecular weight which associate spontaneously to micelles of colloidal size in certain concentration ranges.

Soaps.—Originally limited to substances of natural occurrence, a very great number of compounds have been prepared synthetically in view of their importance as wetting agents, emulsifiers, detergents, etc. A few typical soaps are given below, the classification into anionic, cationic and neutral types being based on the charge carried by the organic part of the molecule.

Compound	Formula	Type
Sodium palmitate	$C_{15}H_{31}COO^-$ and Na^+	Anionic
Sodium dodecyl sulfonate	$C_{12}H_{25}SO_3^-$ and Na^+	Anionic
Cetyl trimethyl ammonium bromide	$C_{16}H_{33}\overset{+}{N}(CH_3)_3$ and Br^-	Cationic
Polyethylene oxide derivatives; *e.g.*,	$C_{12}H_{25}(OCH_2CH_2)_3.OCH_2CH_2OH$	Neutral

In addition, there are naturally occurring compounds such as the bile salts and lecithin, of great biological importance.

All these compounds (and the dyes also), despite their diverse chemical types, possess as common features a large hydrocarbon portion and a small polar group. These two parts differ to the extreme in their affinity for water, and it is this two-sided or amphipathic nature which leads to the formation of colloidal aggregates.

J. W. McBain and his co-workers showed that with aqueous solutions of the sodium and potassium salts of the fatty acids the higher members differed in certain physical properties from those with shorter chains. These higher members (*e.g.*, the palmitate or stearate) appeared to possess a smaller number of particles (as indicated by the freezing point or vapour pressure) but nevertheless a quite high electrical conductivity.

This combination led McBain to suggest that the paraffin-chain ions aggregated, forming a colloidal particle or ionic micelle, as shown in fig. 3.

In the case of sodium palmitate, for example, the size of the micelle, as determined from diffusion measurements, is about 40 Å and thus contains about 50 molecules, the molecular weight being about 14,000. In relatively dilute solutions the shape of micelles is spherical or slightly elongated. The opinions on the micellar form in concentrated solutions are conflicting and vary from a regular latticelike array of spherical micelles via very elongated rods or threads to flat structures.

Aggregation to micelles is caused by the tendency of the water to squeeze out the paraffin chains—the same factor that is largely responsible for the marked surface activity of soap solutions.

The characteristic features of soap solutions arise from the combination of surface activity and the peculiar properties of micelles in solution.

The power of soap solutions to dissolve (solubilize) organic compounds insoluble or only slightly soluble in water arises directly from the presence of micelles. As will be clear from fig. 3, micelles possess an interior closely resembling a droplet of liquid hydrocarbon, in which hydrocarbons, etc., can dissolve. One important application of this phenomenon is in connection with synthetic polymers, for it enables polymerization of relatively insoluble monomers such as styrene (see *Polymers*, above) to be carried out in aqueous solution or suspension.

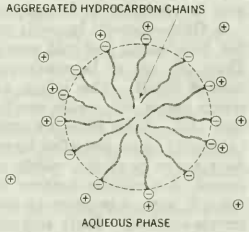


FIG. 3.—STRUCTURE OF A MICELLE FORMED BY THE AGGREGATION OF PARAFFIN-CHAIN IONS IN A SOAP SOLUTION

The characteristic and most widely used property of soap solutions is, of course, their detergent action. "Dirt," in general, consists either of greasy materials or of particles covered with a greasy film. Its removal involves three separate stages—access of the detergent to the dirty surface, the loosening or peptizing of the dirt and finally its removal into the bulk of the solution.

Because of its greasy surface, dirt is hydrophobic and not wetted by water, but absorption of the surface-active soap molecules makes its outer surface hydrophilic and therefore greatly increases its affinity for water. In addition, the detergent, because of its powerful tendency to adsorb on all surfaces, will tend to displace the grease from the surface.

The dirt, thus loosened, is detached by mechanical agitation and carried away into the solution by an emulsion or suspension, or solubilized in the interior of the micelles.

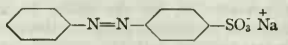
The chief drawback of fatty acid soaps (ordinary household soaps) arises from their ready precipitation with calcium or magnesium salts. This is why hard water is softened and why it is impossible to get a lather in sea water with ordinary soap. Many of the synthetic detergents do not suffer from this disadvantage and thus are used in "sea-water soaps."

Ordinary household soap is prepared by boiling natural fats, glycerides of the higher fatty acids, with strong caustic soda solution. After hydrolysis is complete the soap is salted out by addition of common salt.

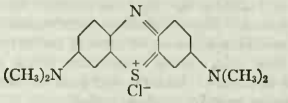
The potassium salts (soft soap) rather than the sodium are preferable for some purposes, since they have a higher solubility in cold water.

Dyes.—Dye molecules, although resembling the soaps in possessing a hydrophobic part and one or more polar groups, lack their comparative uniformity as regards the relative disposition of these constituent parts.

This results in the aggregation being much more specific and hence in a more varied colloidal behaviour. The structure of two of the simpler members is shown below.



Orange II



Methylene blue

Dyestuffs are usually classed as acidic or basic (corresponding to anionic or cationic soaps) according to whether the organic ion carries a negative or a positive charge.

The question of aggregation is of considerable importance in connection with the dyeing process. The size of the aggregates or micelles can be determined by the same methods as for soaps, diffusion being regarded as the best. The degree of association is increased by increasing salt content, which explains the influence of salts in dyeing.

The dyeing process has naturally excited considerable interest, although it is by no means fully understood. The materials to be dyed are usually of a fibrous nature, consisting of macromolecules of vegetable, animal or purely synthetic origin. Most vegetable fibres, such as linen and cotton, have cellulose as the fundamental constituent; wool and silk are the principal animal fibres and of the purely synthetic materials nylon is without doubt the best known.

In dyeing a fibre the coloured molecules have to diffuse into the interior, where they are held in position by precipitation or by some other reaction. The behaviour of wool and silk is probably the simplest, for the major factor in bringing about combination is believed to be salt formation between the dye anions $-NH_3$ groups on the fibre. With cellulose (cotton and rayon) the affinity of the dye for the fibre is probably due to Van der Waals's forces and hydrogen bonding.

Dyes also find an important use in the identification of biological materials (*e.g.*, bacteria) by staining methods. These depend upon the different affinities of the enveloping constituents for various dyes, the principles involved being closely related to those in ordinary dyeing. Dyestuffs of the basic type (*e.g.*, gentian violet) find use as antiseptics, resembling the cationic soaps in their bactericidal powers.

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COLLOT D'HERBOIS, JEAN MARIE (1749–1796), French revolutionary, a Jacobin, terrorist and opponent of Robespierre, was born in Paris on June 19, 1749, the son of a goldsmith named Collot. Educated by the Oratorians, he became an actor and began writing comedies (including *Le Paysan magistrat*, *Le Bon Angevin*, *L'Amant-loup garou*). After managing the Lyons theatre (1787), he settled in Paris (1789) and won success with his plays at the Théâtre Feydeau. Joining the Jacobin club, he served several times as its secretary in 1791. To spread constitutional principles, he composed his *Almanach du Père Gérard*, which made him famous. A member of the Paris commune of Aug. 10, 1792, he became president of the Paris electoral assembly

and then its deputy in the Convention. In Nov. 1792 he was sent to Nice to investigate the depredations committed by the Var army. He voted for Louis XVI's death without reprieve. Sent in March 1793 to the Nièvre and Loiret *départements*, he ordered that all priests be arrested. Having taken part in the overthrow of the Girondins (May–June 1793) and undertaken a mission to the Oise and Aisne *départements* (August), he was made a member of the committee of public safety on Sept. 6. Sent on Oct. 30, with Joseph Fouché, to suppress the revolt in Lyons, he accomplished the task with pitiless bloodshed. Recalled to Paris, he made a great show of energy and argued in favour of the Hébertists in the Jacobin club, emerging as a possible rival to Robespierre. An attempt on his life (May 23, 1794) enhanced his popularity. As president of the Convention he declared himself violently against Robespierre on 8–9 Thermidor (July 26–27, 1794), but charges were subsequently brought against him by the Thermidorians. After the abortive Jacobin rising of 12 Germinal (April 1, 1795), he was deported to Guiana, where he died on June 8, 1796.

(MA. BO.)

COLLOTYPE (PHOTOGELATIN), a photomechanical printing process capable of accurate facsimile reproduction. It differs from other methods such as letterpress, offset lithography and gravure in that no halftone screen is employed to break the images into dots. Collotype illustrations, therefore, resemble photographs more closely than do products of the other processes.

It is a planographic method; that is, the printing image is on the same plane as the rest of the plate. Collotype printing is based upon the principle that grease and water repel each other. The nonprinting areas of the plate contain the most moisture and therefore reject the greasy ink, while the printing areas hold little moisture and accept the ink.

Collotype is used where accuracy of detail is desired. The absence of screen pattern makes it suitable for large blowups and for reproductions of manuscripts, works of art and scientific illustrations. It is unexcelled for the reproduction of fine paintings. The process is used for small and medium editions, ranging from 100 to 10,000 copies.

The basic principle of collotype was described in Louis Poitevin's French patent of 1855. T. du Motay and C. R. Maréchal of France produced the first good results in 1865. It remained for Joseph Albert of Germany, however, to develop collotype as a practical process about 1868. It was improved in 1869 by Ernest Edwards of England, who added chromated alum (a mixture of alum and a chrome salt) to toughen the gelatin film. Edwards went to the United States in 1872 and was instrumental in making the process commercially successful. Edward Bierstadt, however, who was licensed to use Albert's process, produced the first collotypes in the United States in 1870. Edwards took out the first patent for colour collotype in England in 1869, but Albert invented the most practical early process, using three colours, in 1874.

Formerly, almost all collotype printing was done from glass plates inked by hand and printed on a flat-bed press. This method was largely superseded by the use of big rotary presses with automatic inking devices. In plate making, two negatives are made, one for the continuous-tone illustrations and another for the line copy (type, black-and-white copy). The plate, usually of aluminum, is coated in a whirling machine with a light-sensitive solution of gelatin, potassium bichromate and ammonia. It is exposed to light in a printing frame under each negative successively, or under a single negative made by combining both. The transparent parts of the negative allow light to pass freely, hardening the gelatin; darker areas retard light, preventing hardening in proportion to their opacity. The plate is then soaked in glycerin, which is absorbed most by the soft, nonprinting areas. In printing, the plate receives moisture from the air in the pressroom, which is kept at a relative humidity of 60%–80%. When the ink roller passes over the plate, the soft or nonprinting areas of gelatin, which hold moisture, repel the greasy ink. The hardened exposed areas, which cannot hold moisture, accept the ink. Intermediate areas accept ink in varying amounts.

Printing is done directly from the gelatin, which has a delicate natural grain. Tacky ink is used, and since this dries slowly, it is necessary to slip-sheet each impression; that is, a sheet of absorbent paper or other material must be placed over each printed sheet to avoid offsetting ink to the sheet above.

Flat-bed presses produce about 1,000 impressions in an eight-hour day; cylinder presses can turn out 5,000 in the same period. The life of a collotype plate is short; it will rarely last for 15,000 impressions.

For colour work, the separations can be made by hand as well as by photography. In the hand method a single negative is made. A handmade mask or stencil is prepared for blocking out the unwanted areas in each colour separation. The same negative with a different mask is exposed over each plate. By this process colour plates can also be made from monochrome copy.

Collotype is also known as albertype, *phototypie, Lichtdruck,* heliotype and photocollotype.

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COLMAN, SAINT (d. 676), the leader of the Celtic party at the synod of Whitby, was born in Ireland. He was a monk at Iona before becoming bishop of Lindisfarne in 661. After the Roman method of calculating the date of Easter was accepted at Whitby (663 or 664), he returned to Iona and then to Ireland with all the Irish monks of Lindisfarne and 30 of the English ones. He settled on Inishbofin, Connaught, where he built a monastery, but had to found a separate one at Mayo for the English monks. He was abbot of both until his death on Aug. 8, 676. His feast day is Feb. 18 in Scotland (diocese of Argyll and the Isles).

See *Butler's Lives of the Saints,* ed. by H. Thurston and D. Attwater, vol. i, pp. 369–370 (1956).

COLMAN, GEORGE, the Elder (1732–1794), one of the foremost English writers of comedy and theatre managers of his time as well as an agreeable essayist, was born in Florence in April 1732. His father, Francis Colman, envoy to the grand duke of Tuscany, died in 1733 and the child became the ward of his uncle, William Pulteney (later earl of Bath). He went to Westminster school and Christ Church, Oxford, where he founded with Bonnell Thornton *The Connoisseur* (1754–56), to which he contributed many essays. Called to the bar (1757), he traveled the Oxford circuit from 1758 to 1761, but relinquished law for literature and the theatre.

His first play, the afterpiece *Polly Honeycombe* (1760), satirizing the craze for romantic novels, was presented by David Garrick at Drury Lane. It was followed by *The Jealous Wife* (1761), one of the best comedies of its age, which remained a stock piece for nearly a century. In his early plays he mocked the vogue for sentimentalism, later seeking to revive the Elizabethan dramatists and adapting Beaumont and Fletcher's *Philaster* (1763) and *Bonduca* (1778) and Jonson's *Epicœne* (1776) and *Volpone* (1782). He translated Terence's comedies (1765) and Plautus' *Mercator* for Thornton's edition (1767) and also contributed essays to various newspapers and periodicals.

In 1764 Lord Bath died, leaving Colman an annuity. Colman's association with Garrick culminated in their collaboration in *The Clandestine Marriage* (1766), a comedy blending satire with sentiment, which still holds the stage. In 1767 Colman purchased a quarter share in Covent Garden, which he managed for seven years. In spite of quarrels with his partners, he raised the standard both of acting and of drama, himself contributing several comedies and afterpieces and adapting Shakespeare plays. In 1774 he sold his share to his partners and in 1776 purchased the Little Theatre in the Haymarket from Samuel Foote: under his direction for 12 years, this summer theatre reached the peak of its career. Colman had a stroke in 1785 and in 1789 his brain became affected. He died on Aug. 14, 1794.

His *Dramatick Works,* four volumes (about half his plays), were published in 1777 and his miscellaneous writings in verse and prose, as *Prose on Several Occasions,* three volumes, in 1787. He also translated Horace's *Ars poetica* (1783).

See Eugene Page, *George Colman the Elder* (1935). (S. M. R.)

COLMAN, GEORGE, the Younger (1762–1836), English dramatist and theatre manager, son of George Colman the Elder (*q.v.*) and the actress Sarah Ford, who were subsequently married in 1767. He was born in London on Oct. 21, 1762, and went to Westminster school and Christ Church, Oxford, but because of his contraction of debts was removed to King's college, Aberdeen. Though a student at Lincoln's Inn, he never completed his legal studies. His first play, *The Female Dramatist*, presented at his father's Little Theatre in the Haymarket in 1782, failed, but his comic opera *Two to One* (Haymarket, 1784) was successful. His comic opera *Inkle and Yarico* (1787) and his melodrama *The Battle of Hexham* (1789) became stock plays. In 1784 he married the actress Catherine Morris at Gretna Green.

After his father's mental breakdown in 1789 he took over the management of the Haymarket, which he purchased on his father's death in 1794. His management was marked by struggles against the encroachments of the patent theatres, by litigation and extravagance. Several of his melodramas and comedies held the stage for many years, notably *The Iron Chest* (1796)—based on William Godwin's novel *Caleb Williams* (1794); *The Heir at Law* (1797); *Blue-Beard* (1798); *The Poor Gentleman* (1801); and his most popular comedy, *John Bull* (1803). He wrote several of his heroines for Mrs. Gibbs (née Mary Logan), whom he is said to have eventually married. His outstanding comic creation was "Dr. Pangloss" in *The Heir at Law*. Colman disposed of part of his interest in the Haymarket in 1805 but continued to act as manager until 1820, when he sold his share to his brother-in-law, David Morris. He published books of verse, some very scurrilous. As a result of monetary difficulties he was compelled to reside in the rules of the King's Bench for many years but was released on his appointment as lieutenant of the yeomen of the guard in 1820. He was appointed examiner of plays in 1824, a post he retained until his death and in which he aroused resentment owing to his narrow severity and petty tyranny. He died in Kensington on Oct. 17, 1836.

See George Colman, *Random Records* (1830); R. B. Peake, *Memoirs of the Colman Family* (1842). (S. M. R.)

COLMAN, NORMAN JAY (1827–1911), U.S. farm journalist and the first secretary of agriculture, was born May 16, 1827, near Richfield Springs, N.Y. After a short law career, he moved in 1852 to St. Louis, Mo., where he became editor-publisher of *The Valley Farmer* (called *Colman's Rural World* after 1865). Through its pages, he advocated better farming methods and disseminated knowledge of new techniques, some of which he publicized on his own farm. Colman entered the Missouri legislature in 1865 and after 1874 served a term as lieutenant governor. He supported numerous farm organizations, helping to establish the Missouri Grange in 1870.

Appointed U.S. commissioner of agriculture in 1885, he authored the Hatch act of 1887 which set up federal-state agricultural experiment stations. Pres. Grover Cleveland named him secretary of agriculture in 1889, when the department of agriculture received cabinet status for the first time, but he served only briefly because of a change of presidential administrations in the same year. He returned to St. Louis to edit *Colman's Rural World* until his death on Nov. 3, 1911. His periodical was absorbed by the *Journal of Agriculture* in 1916.

See G. F. Lemmer, *Norman J. Colman and Colman's Rural World* (1953). (C. C. J.)

COLMAN, SAMUEL (1832–1920), U.S. landscape painter, whose landscapes of the early west remain popular, was born at Portland, Me., March 4, 1832. He was a pupil of Asher Durand in New York city, and in 1860–62 studied in Spain, Italy, France and England. In 1871–76 he was again in Europe. With James D. Smillie, he founded the American Water Color society (1860), becoming its first president, 1866–67. His own water-colour paintings are particularly fine. He was elected a member of the National Academy of Design in 1862. Among his works are "The Ships of the Western Plains," in the Union League club, New York city, and "The Spanish Peaks, Colorado," in the Metropolitan Museum of Art, New York. He died in New York city, March 27, 1920.

COLMAR, a town of France, capital of the Haut-Rhin (*q.v.*) *département*, stands on the Lauch and Logelbach, tributaries of the Ill, 67 km. (42 mi.) S.S.W. of Strasbourg by road. Pop. (1954) 45,453. Many notable Renaissance buildings surround the Roman Catholic St. Martin's church (13th and 14th centuries). They include the Kaufhaus (15th century), the Pfister house (1537) and several others. The former Franciscan church (13th century) is now Lutheran. The *Hôtel de Ville*, the Palais du Conseil and the college chapel of St. Peter are 18th century. Frédéric Auguste Bartholdi, sculptor of the Statue of Liberty erected at New York harbour, was born in Colmar in 1834; his home is a museum. The town library is in the former Dominican monastery. The Unterlinden Kloster, former convent of the Dominican nuns, was made into a museum containing fine 15th- and 16th-century paintings, including the masterpiece of Mathias Grünewald (*q.v.*), his Isenheim altarpiece.

Colmar is on the main railway from Strasbourg to Mulhouse and Basel. It is a centre of the textile industry and for tourism as well as marketing the products of the neighbouring vineyards and orchards.

Colmar (Columbaria) is first spoken of in a chronicle of the Saxon wars of Charlemagne, then mentioned in a charter of 823. In 1226 it was raised to the status of an imperial town by the emperor Frederick II and surrounded by walls. Civil rights (*Stadtrechte*) were granted to it by Rudolph of Habsburg in 1278. Colmar joined the league of imperial towns of Alsace and in 1476 and 1477 took a vigorous share in the struggle with Charles the Bold. It suffered in the wars of the 17th century, was occupied by the Swedes in 1632 and was gradually annexed to France during 1648–78 and to Germany in 1871, reverting to France in 1919. During World War II it was occupied by the Germans in 1940 and was liberated by the Allies on Feb. 2, 1945. (L. Ku.)

COLOCYNTH (Coloquintida or Bitter Apple), a plant, *Citrullus colocynthis*, of the family Cucurbitaceae (*q.v.*), whose fruit yields a very powerful cathartic. The fruit is round and about the size of an orange; it has a thick, yellowish rind and a light, spongy and very bitter pulp, which contains the active principle, colocynthin. The seeds, which number from 200 to 300 and are disposed in vertical rows on the three parietal placentas of the fruit, are flat, ovoid and dark brown; they are used as food by some of the tribes of the Sahara, and a coarse oil is expressed from them. The foliage resembles that of the cucumber, and the root is perennial. The plant has a wide range, being found in Ceylon, the Indian subcontinent, Iran, Arabia, Syria, north Africa, the Greek islands, the Cape Verde Islands and southeast Spain.

The commercial colocynth consists of the peeled and dried fruit. In the preparation of the drug the seeds are removed from the pulp.

COLOGNE (Ger. Köln), a city and river port of Germany which after partition of the nation following World War II was in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. Situated 295 mi. W.S.W. of Berlin, it lies mainly on the left bank of the Rhine in the fertile lowland plain below Bonn. Pop. (1959 est.) 780,124.

Cologne's historic importance arose from its location at the crossing of the route from England, France and the Netherlands to eastern Europe with that between Italy and northwestern Europe —a route accentuated by the great traffic artery of the Rhine. The medieval commercial centre which grew up there was also a patron of learning and the arts, a tradition which has persisted into modern times.

Despite the destruction suffered by the city during World War II, its appearance still reflects its history. Cologne lies principally on the left bank of the Rhine in the semicircle which it assumed in 1180, when several new parishes were brought within the town boundaries. The flat side of the semicircle is bounded by the Rhine, which is spanned by five bridges. The half circle is formed by a great ring road, the Ringstrasse, which in the 1880s replaced the medieval fortifications and along which a green belt was laid out. Remains of the old walls may still be seen and three surviving gates, the Eigelsteintor, Hahnentor and Severintor, are used as museums for zoology, history and antiquities, and geology, respectively. The Bayenturm, a medieval tower, stands near

AUTHENTICATED NEWS

THEATRE AND OPERA HOUSE OF COLOGNE, GER., OPENED IN 1957; AT UPPER RIGHT IS COLOGNE CATHEDRAL, BEGUN IN THE MID-13TH CENTURY

the Rhine. Beyond the Ringstrasse modern suburbs have projected spurs but the main shopping and business streets such as the Hohestrasse and Schildergasse, as well as the city's historic buildings, lie within it.

Not far from the Rhine is the cathedral, the largest Gothic church in northern Europe. It stands on the site of a church begun in the 9th century by Hildebold, metropolitan of Cologne, and finished under Willibert in 873. After a fire in 1248, rebuilding was begun by Meister Gerard. The choir was completed in 1322, and work on the cathedral went on until 1510 when it is said that Renaissance contempt for the Gothic style brought building to a halt. Work was resumed in 1820 and the building was completed, according to the original design, in 1880. It was badly damaged during air raids on Cologne in 1944. Though poorly proportioned, the cathedral is impressive in its vastness, being 468 ft. long and 275 ft. wide. Its great twin towers rise over 500 ft. above the centre of the city. The 14th-century stained glass windows in the choir are particularly beautiful. The cathedral is also notable for the art treasures which it contains. On the high altar are the relics said to be those of the Magi, brought to Cologne from Rome in 1164 and preserved in a solid gold shrine which is one of the finest medieval examples of the goldsmith's art. The painting above the altar is the centre panel of a triptych by Stephan Lochner (*q.v.*). Painted in the early 15th century, it depicts the Adoration of the Kings in clear, bright colours and gold.

At the south side of the cathedral lies a reminder of Cologne's more ancient past—the Dionysian mosaic, originally the floor of the banquet hall of a great Roman villa discovered during excavations near the cathedral in 1941. Other Roman remains are a 3rd-century tower, Roman-Frankish catacombs and a Roman mausoleum in Weiden, in the outskirts. The cathedral itself is ringed with noble churches, largely built in the prosperous middle ages. St. Gereon is of late Roman origin, although the building is 11th–13th century. St. Maria im Kapitol, which was severely damaged in World War II, is Romanesque and has a particularly fine crypt. Both St. Maria and St. Kunibert, which is Byzantine-Moorish in style, date from the 7th century although the actual buildings are 11th and 13th century, respectively. Other medieval churches include St. Severin (10th–15th century), St. Andreas (13th century) with the tomb of Albert Magnus, St. Aposteln (13th century), St. Georg (11th century), St. Ursula (11th–15th century), Gross-St. Martin (12th–13th century), the Minoritenkirche (13th century) and St. Maria Lyskirchen (13th century). The 13th-century Antoniterkirche, a secularized monastery church, was made over to the Protestants in 1802 and became the first public Reformed church in Cologne. It contains a war memorial, the "Angel of Death," by the sculptor Ernst Barlach.

Cologne's secular medieval buildings as well as its churches suffered in World War II, among those damaged being the Templerhaus and the Gothic Rathaus. The Gürzenich or Festhaus of the merchants of the city (1437–44), reconstructed as a concert and festival hall, and the 16th-century Zeughaus or arsenal, which contains a historical museum, were only outwardly restored in medieval form.

These ancient buildings share the crowded city centre with modern banking and insurance houses, shops and offices, a new theatre and opera house (opened 1957) and, immediately north of the cathedral, the great railway station and the radio station of the Nordwestdeutscher Rundfunk. Near the perimeter of the city is the new town hall. On the other side of the river are the Rhein museum and the Wallraf-Richartz museum, housing paintings and Roman antiquities. Two other important museums, both on the left bank, are the Schnütgen museum for ecclesiastical art and the Rautenstrauch-Joest ethnological museum. The University of Cologne, founded in 1388, was dissolved in 1798 during the Napoleonic Wars, and refounded in 1919. There are also teachers' training colleges and colleges for the study of music, engineering and administration. A sports stadium was built in the green belt just beyond the Ringstrasse. Among several parks are the zoological and botanical gardens to the north, the Stadtgarten and the Volksgarten, while on the other side of the river is the Rhine park with the Tanzbrunnen ("dancing fountain") and the halls where the many fairs and exhibitions are held.

Cologne's geographical position and commercial importance have combined to make it a focal point for communications. A great rail junction, it also has an airport in the Wahner Heide, and on the edge of the city centre there is a helicopter landing ground with services to Brussels, Liège, Maastricht and Bonn. The *Autobahn* connects Cologne with Aachen and with the Ruhr, Frankfurt and the south. The Rhine harbour, important since Roman days, is used even by small seagoing craft.

The city is still, as it was in the middle ages, a banking centre, and the wine trade and textile manufacturing remain prominent. In modern times, however, insurance became of great importance and engineering and electro-engineering, metals and chemicals came to the fore. Other manufactures include chocolate and the famous Eau de Cologne. The brown coal industry is the second largest in Germany and is the basis of an electricity plant which supplies not only large parts of west Germany but also Switzerland and the Tirol.

An annual festival, part of the Rhenisch pre-Lenten Carnival, is celebrated with great ceremony in Cologne. A folk festival, the Kölscher Fasteleer, is peculiar to the city.

History.—Cologne was originally the central point of the settlement of a tribe known as the Ubii. It was a Roman camp as early as 38 B.C., and the beginnings of a town may be traced back to about 12 B.C. In A.D. 50, at the request of Agrippina, the wife of the emperor Claudius, the title of Roman colony was conferred upon the town which was her birthplace. It was named Colonia Claudia Ara Agrippinensis, contracted later to Colonia. At first governed by the admiral of the Rhine fleet, it was later made the headquarters of the governor of Lower Germany. About 400 A.D. Cologne was conquered by the Franks and in 475 became the residence of the Frankish king Childeric.

A Christian community existed in the town probably as early as the 2nd century, a bishop first being mentioned in 313. Charlemagne created an archbishopric there and by the 12th century the archbishop dominated the city politically and commercially, receiving a wide range of tolls, customs duties and other payments. Cologne's industry goes back to Roman times when ceramics and glass were manufactured, and, with steadily growing commercial prosperity during the middle ages (especially from about the 10th century), an increasingly bitter conflict developed between the wealthy merchants and the archbishop, the former seeking commercial and political freedom, the latter the preservation of his temporal power. In 1074 Archbishop Anno was expelled but the revolt was put down. It was not until the battle of Worringen in 1288 that the archbishop was finally defeated and the city of Cologne secured full self-government. The battle was fought in the course of the struggle over the Limburg succession (*see* LIMBURG). From that time Cologne was in fact a free imperial city, although it was only officially recognized as such in 1475.

Until the end of the 14th century its government was in the

hands of the Richerzeche, an association of the wealthy patricians, but in 1396, after a bloodless revolution, a new municipal constitution was established (embodied in the Verbundbrief). Under this constitution the 22 branches of the guilds were the basis of the government. They in turn elected a council which had power over all the internal affairs of the town.

This medieval period was a splendid one for Cologne. It was a prominent member of the Hanseatic League (*q.v.*) and its merchants had probably the widest connections and the most varied trade of all the German towns. Crafts included the making of textiles and books and working in leather, enamels and metals, the work of Cologne's goldsmiths being particularly fine. The wine industry was well established. The arts flourished and the city had many beautiful churches. The three greatest of the later scholastics, Albertus Magnus, Thomas Aquinas and Duns Scotus, all taught in its schools. After the Thirty Years' War, however, the city declined, partly, no doubt, as a result of the exclusion of Protestants and Jews. As late as 1794, when the French occupied the city, public Protestant services were banned, and the city remained predominantly Roman Catholic in the 20th century. The Jewish community, which had existed in the time of Constantine, was expelled in 1424 and until 1794 no Jew was allowed to stay overnight in the city.

In 1801 Cologne was taken by France and when the archbishop elector died a year later the see was left vacant. The archbishopric was restored in 1821. In 1815 Cologne passed to Prussia and from that time a new era of prosperity began. Its industry showed as wide a variety as in medieval days, and when railways were introduced its geographical position made it a great railway centre. The interest in organization, shown in the days of the guilds, contributed in the early 19th century to the formation of a chamber of commerce, the oldest of its kind in western Europe. The population grew from 41,685 in 1801 to 372,529 in 1900 and 768,352 in 1939.

In World War II Cologne suffered 262 air raids; there were 20,000 casualties and the city was left in ruins, with nearly all the dwellings in the old town damaged and 91 out of 150 churches destroyed. In April 1945 the population had sunk to 69,000. By December, however, there were 447,000 in the city and the population continued to rise rapidly, while a vast work of clearance and reconstruction was undertaken.

See also references under "Cologne" in the Index volume.

For full account and detailed bibliographies *see* E. Keyser, *Rheinisches Städtebuch* (1956). (M. Kl.)

COLOMB, PHILIP HOWARD (1831–1899), British naval officer and historian, born in Scotland on May 29, 1831, was an innovator of tactics for steam warships and the inventor of an improved system of signals. He entered the navy in 1846, serving successively in the Mediterranean, China, Burma, the arctic and in the Crimean War, when he took part in the bombardment of Sveaborg. Among his later services was the suppression of the Arab slave trade when in command of the "Dryad" (1868–70), of which he left an account in his *Slave Catching in the Indian Ocean* (1873). His new system of signals was adopted in 1867, and his recommendations on the causes of collision at sea were adopted at an international conference in 1889, three years after his retirement from the navy. Colomb made a special study of naval tactics for steam vessels, and his biography of his friend Adm. Sir Astley Cooper Key is a valuable contribution to the history of that epoch of changing methods of sea warfare. In his *Naval Warfare* (1891) he came independently to many of the conclusions about the new meaning of sea power that later were publicized by Adm. Alfred Mahan. He died at Botley, Hampshire, on Oct. 13, 1899.

His younger brother, Sir John Colomb (1838–1909), an officer in the royal marines and a member of parliament, was also the author of a number of works on sea warfare and imperial defense, among which may be noted *The Defence of Great and Greater Britain* (1879), *The Use of Marine Forces* (1883) and *Imperial Federation: Naval and Military* (1886). (C. C. L.)

COLOMBE, MICHEL (*c.* 1430–*c.* 1512), an important (and also the last) Gothic sculptor in France, was born in Brittany (bishopric of St. Pol de Leon). Nothing is known about his early life and works, but by 1473 he had set up shop in Tours. His generally acknowledged masterpiece is the white tomb of Francis II of Brittany and his consort Marguerite de Foix (1502–07) in the cathedral of Nantes. The four corner figures of Virtues are particularly to be remarked. The only other certain work of Colombe is the marble panel of St. George and the Dragon (in the Louvre), commissioned by Cardinal d'Amboise for the chapel of his palace at Gaillon near Rouen. Italian influence on Colombe's work is very slight, and that only in details. He died in Tours after 1512.

See Paul Vitry, *Michel Colombe et la sculpture française de son temps*, with full bibliography (1901). (A. K. McC.)

COLOMBES, a suburb of Paris, Seine *département*, is situated on the left bank of the Seine in the Gennevilliers loop of the river, 13 km. (8 mi.) N.W. of Notre Dame cathedral by road. Pop. (1962) 76,849. Colombes is a working-class district and 15,000 of its inhabitants are employed in local factories making pneumatic and electrical equipment, measuring instruments, copper and sheet-metal work, cycles and motor scooters, plastics, ceramics, oil and vinegar. Colombes is on one of the suburban railways from St. Lazare station, Paris. The largest stadium in the Paris district was built there on the site of the old racecourse. (H. de S.-R.)

COLOMBIA (República de Colombia) is a republic occupying the northwestern angle of South America. It is bounded on the north by the Caribbean Sea and Venezuela; on the east by Venezuela and Brazil; on the south by Brazil, Peru, and Ecuador; and on the west by Ecuador, the Pacific Ocean, Panama, and the Caribbean Sea. The republic has an extreme length from north to south of 1,050 mi. and an extreme width of 860 mi. It has an area of 439,512 sq.mi. and a population (1964 est.) of almost 17,000,000.

This article is divided into the following sections and subsections:

I. Physical Geography
  1. Geology
  2. Physiography
  3. Climate
  4. Vegetation
  5. Animal Life
II. Geographical Regions
  1. Caribbean Coastal Lowlands
  2. Pacific Lowlands
  3. Eastern Plains (the Oriente)
  4. Andean Region
III. The People
  1. Physical Types and Languages
  2. Religion
  3. Customs and Culture
IV. History
  1. Preconquest
  2. Conquest
  3. Colonial Era
  4. Viceroyalty
  5. The Republic
  6. The 20th Century
V. Population
VI. Administration and Social Conditions
  1. Government
  2. Living Conditions
  3. Welfare Services
  4. Health
  5. Education
  6. Defense
VII. The Economy
  1. Production
  2. Trade and Finance
  3. Transport and Communications

There are separate articles on the departments and more important towns.

I. PHYSICAL GEOGRAPHY

1. Geology.—The Andes reach their northern end in Colombia, where they are divided into three principal ranges, of which the central one is the highest. This range, the Cordillera Central, which is separated from the western one by the valley of the Cauca and from the eastern one by the valley of the Magdalena, includes peaks rising to heights of approximately 18,000 ft. The highest of these, Nevado del Tolima (17,109 ft.), Nevado del Huila (18,701

ft.), and Nevado del Ruiz (18,340 ft.), are volcanic. The flanks of the igneous and metamorphic cores of these ranges are overlain by folded and faulted sedimentary rocks of Cretaceous age that are in turn covered in many places with thick deposits of volcanic ash.

The western chain, the Cordillera Occidental or Western Cordillera, extends northward from Ecuador nearly to the Caribbean Sea. In its southern part it is flanked on its west side by steeply tilted Paleozoic beds; in its northern part on both sides by Mesozoic beds. The eastern Andean range, known as the Cordillera Oriental, the Cordillera of Sumapaz, or the Eastern Cordillera, is composed mainly of folded Cretaceous beds. The Cordillera Central, which is the continuation of the Cordillera Oriental of Ecuador, consists chiefly of beds of Cretaceous sandstone and porphyritic rocks. The axes of folding in all these ranges conform in direction with the trend of the ranges. Along the Pacific coast of Colombia there is a lower range, composed mainly of Tertiary volcanic rocks, which are covered in places with soft Quaternary sandstones and marls containing the remains of species of marine animals such as inhabit the neighbouring ocean. The Magdalena Valley is a structural trough 560 mi. long and 9–56 mi. wide, outlined by faults and filled with Tertiary clay and sandstone which unconformably overlie Cretaceous beds. The Cúcuta Basin, which is a southwestward continuation of the Maracaibo Basin of Venezuela, is occupied by Cretaceous and Tertiary formations related to those in the Maracaibo Basin. In the part of Colombia that lies east and southeast of the Andes the surface deposits are mainly Tertiary and Quaternary sand, loam, and gravel.

2. Physiography.—The western and northwestern sections of Colombia are occupied by the terminal ranges of the great Andean system. The two closely parallel ranges of northern Ecuador unite to form the Macizo de Pasto as they enter southern Colombia. From this great mountain knot, in turn, the Western and Central cordilleras of the triple-spurred Colombian Andes emerge and stretch away side by side toward the north. The Eastern Cordillera originates in a secondary knot in the central range not far north of the Macizo de Pasto, and crosses the country in a northeasterly direction until it in turn splits asunder, sending one spur north into the Caribbean to form the Guajira Peninsula, and the other to the east to form the Sierra Nevada de Mérida south of Lake Maracaibo in western Venezuela.

The Eastern Cordillera sharply divides the mountainous district of northern and western Colombia from the low-lying plains of the interior which comprise slightly more than half the total area. To the south, a region covered by nearly impenetrable jungle growth is drained by the tributaries of the Amazon. Except along the principal rivers it is largely unexplored and inhabited mostly by uncivilized tribes of Indians. The northern part of these transmontane lowlands, the so-called llanos, is a region of open tropical plains, alternately flooded and parched with the changing seasons and drained by tributaries of the Orinoco. The approximate length of this region is 640 mi. and the average width 320 mi.

The Western Cordillera roughly follows the line of the Pacific coast, terminating in three low, wooded spurs which merge into the Caribbean coastal plain in the southern part of Bolívar and Córdoba. A short transverse range connects it with the Cordillera de Baudó, which extends from the mouth of the San Juan River north to form the highlands of Panama. The Western Cordillera is covered with vegetation, and its Pacific slopes are precipitous and humid. Its highest elevation, the Nevado de Cúmbal, is 16,043 ft. and stands near the Ecuador border. To the north, the range is lower, with summits of 13,300 ft. A low saddle between the Cauca Valley city of Cali and Buenaventura, on the Pacific coast, is an important transport route.

The Central Cordillera, also called the Quindío, is separated from the eastern and western Andean ranges by the Magdalena River on one side and its principal tributary, the Cauca, on the other. It terminates in low hills near the confluence of the two rivers. The Central Cordillera has a series of lofty volcanoes, some of them perpetually snowcapped. Its highest elevation is the Nevado del Huila. The cordillera is crossed at an elevation of 10,800 ft. by the Quindío road, historically the main route followed by travelers between Bogotá and the Cauca Valley and Buenaventura. The northernmost extension of this range is the granitic batholith of Antioquia, an old peneplained upland surface (average elevation, 7,000 ft.) which is shot through with gold-bearing veins. It supported the most important mining activity in colonial New Granada.

The Eastern Cordillera is the region of densest population and is distinguished by its large area of plateau and elevated valley lying within the limits of the vertical temperate zone. The *sabana* of Bogotá (8,660 ft.), with an area of 425 sq.mi., is a good illustration of the higher of these plateaus. Sogamoso lies in another. Mild in temperature and fertile, they have the varied production of the temperate zone. They are the beds of former Pleistocene lakes, some of them interconnected, that have dried up with the diminution in precipitation at these latitudes. From Bogotá or Sogamoso one may drop abruptly to the edge of the eastern llanos by road in a few hours.

The Pacific coastline, omitting minor convolutions, is about 800 mi. in length; that of the Caribbean is about 1,000 mi. The Caribbean ports are Barranquilla, Cartagena, Santa Marta, and Ríohacha. There are two commercial ports on the Pacific coast, Buenaventura and Tumaco. Because of its unhealthful character and the high mountain barriers, the Pacific coast has played only a slight role in the country's development. The Caribbean plain is hot and low except in the northwestern section of Magdalena Department, where the surface is elevated in the Sierra Nevada de Santa Marta whose lofty, snow-covered peaks reach 18,693 ft.

The Caribbean islands of San Andrés and Providencia, 300 mi. N of the South American mainland and 120 mi. E of the Central American shore, lie within Colombian jurisdiction, as does Malpelo Island off the Pacific coast.

Rivers.—For convenience of description the rivers may be divided into three general classes: those that find outlet in the Pacific, those that flow into the Caribbean, and those whose waters reach the Atlantic through the Orinoco and the Amazon. The most important rivers in Colombia are the Magdalena and its principal tributary the Cauca (*see* MAGDALENA RIVER; CAUCA RIVER). Both rise in the high plateau of the Andes adjoining Ecuador. The Magdalena empties into the Caribbean Sea near Barranquilla. It is about 950 mi. long and traverses 9° of latitude —nearly the entire country. In the lower reaches, throughout perhaps half its course, the waters of the Magdalena are dissipated over a wide area of swamp, lagoons, and lakes, and its course is continually changing through the wearing away of its alluvial banks. The Cauca unites with the Magdalena about 200 mi. from the sea through several channels. The Cauca is navigable in two widely separated stretches of 200 mi. each. The upper section, between Cali and Cartago, is no longer much used but there is still a considerable traffic on the lower river downstream from Cáceres. The lower Cauca and its right-bank tributary, the Río Nechí, have built up extensive deposits of gold-bearing gravels, especially in the vicinity of Pato and Zaragoza in Antioquia. These gravels were being dredged by U.S. and Canadian mining interests as early as 1909. Both the Río Atrato (*q.v.*) and Río Sinú flow to the north coast and are navigable by small steamers.

The rivers of the Pacific coast are numerous. They have short, precipitous courses with comparatively short navigable channels. From the downstream section of the Río Atrato the low passes to the west along the routes of the Río Truandó or the Río Salaquí provide easy access to the Pacific coast and have been suggested as possible routes for a second interoceanic canal.

The waters of the rivers of the great eastern plains pass to the Atlantic through the Orinoco and Amazon rivers. Some of them are navigable, which fact may be of great importance to the future development of this region, as yet only partially explored.

3. Climate.—Colombia lies almost entirely in the north tropical zone. The heat of the tropics is, however, modified throughout a large part of the area by the elevation of the surface and the action of winds. In general, high temperatures prevail in the lower areas, including the coastal plains and the valleys of the larger rivers. These regions are characterized by excessive mois-

ture and dense forests, except where agricultural colonization has been active. The health conditions in these lowlands have recently been much improved, especially by means of the successful campaigns against malaria. Above the tropical zone in the mountainous area are found all gradations of cooler climate. The subtropical districts comprise the valleys and slopes lying between 1,500 and 6,000 ft. of elevation. Some of them are among the most fertile and productive areas of the country. The temperate zone lies between 6,000 and 10,000 ft., and the cold, bleak paramos at from 10,000 to 15,000. Above these are wastes of ice and snow. Most of the principal cities are situated between 3,000 and 9,000 ft. above sea level in areas of temperate climate.

In general, the year is divided into a wet season called *invierno*, or winter, and a dry season called *verano*, or summer. In some sections there are two wet and two dry seasons. The time when these seasons occur and their duration vary greatly, however, in the different regions and even vary from year to year in the same location. The driest area of Colombia is probably the northernmost part of the Guajira Peninsula where the average annual rainfall is less than ten inches. Humidity, however, is relatively high. There are local pockets of aridity in the upper parts of the valleys of the Cauca and Magdalena rivers as, for example, the Dagua Valley on the Cali-Buenaventura route and the Neiva area in Huila. The rainiest area in Colombia, and probably in all of South America, is the Pacific coastal zone, especially near the San Juan-Atrato divide in the department of Chocó. There, average annual rainfall exceeds 400 in. (Andagoya, 415 in.) and there is no dry season.

4. Vegetation.—The Colombian vegetation is very rich, ranging as it does through all varieties from those of the tropics to the alpine species of the highest plateaus. A luxuriant forest growth covers a large part of the republic, including the foothills, slopes, and valleys of the cordilleras; a large part of the plains adjacent to the north coast; the entire surface of the Western Cordillera and coast; and the southern section of the eastern plains. There are many varieties of forest products, including vanilla and medicinal plants such as quinine, ipecac, sarsaparilla, gums, and balsams, also rubber, tanning agents and dyewoods, and the tagua nut, known as vegetable ivory. Forest products form a potential source of wealth as yet little exploited. Up to an altitude of 10,000 ft. the palm is abundant and varied, with incredibly numerous uses. There are extensive groves of the coconut palm on the Caribbean coast. Orchids are abundant in the forests and many valuable varieties have been secured in Colombia. Commercial production of orchids for export has centred in Medellín. The great stands of *guadua* or American bamboo, especially in the Valle del Cauca, provide an important and widely used construction material. Human activity in recent years has been converting vast tracts of the tropical lowlands, especially on the north coast, to artificial pastures, dominated by guinea grass, Para grass, and jaragua.

As the surface of the land rises the character of the vegetation changes. From 1,500 to 4,500 ft. there is a great variety of semitropical fruits. The temperate zone commences at 6,000 ft. and is a dairy and agricultural region. There practically all the cereals, vegetables, and fruits commonly found in the United States are produced. Above 10,000 ft. are the paramos with stunted vegetation. Farther up only alpine species are found. Colombia is especially rich in fine woods. The varieties include mahogany, lignum vitae, brazilwood, walnut, cedar, oak, and many others. One of the most useful trees of the temperate zone is the eucalyptus introduced from Australia. Extensive areas have been planted to *Inga*, *Albizzia*, and other leguminous trees to provide shade for coffee plants.

5. Animal Life.—The fauna of Colombia reflects in its composition the climatic variety within the country, from tropical lowland to the icy paramos of the high mountains; the isolation of the valleys by the three great ranges of the Andes; and the position of the country at the meeting of the two American continents. The rich, tropical Amazonian forest fauna ranges into Colombia from the south in the drainages of the Amazon and Orinoco. This group includes sloths, anteaters, opossums, and a variety of monkeys. The larger herbivores are the tapir, the two kinds of peccary, and the various deer, as well as large tropical rodents such as the paca and the agouti. The carnivores that prey on them are the puma and jaguar, a variety of smaller cats, foxlike canids, raccoons, and mustelids. The spectacled bear is almost entirely herbivorous.

Characteristically South American types of birds, such as toucans and hummingbirds, abound. More than 1,500 species and subspecies of birds are recorded. These include the many North American migratory forms that winter in Colombia. Reptile life is likewise rich, with a great variety of turtles, lizards, and snakes. The widespread American crocodile (which reaches the West Indies and the southern tip of Florida) is abundant in the Magdalena River. There are various smaller species of caymans. Among amphibians there are a few caecilians, a few species of salamander, and a multitude of frogs. The freshwater fishes are of South American types, including catfishes and characins in abundance, and also the electric eel and related forms.

The insect fauna of the country as a whole is extremely rich and far from being fully known. During and after World War II southern Colombia was a centre for the intensive study of mosquitoes, a necessary part of the campaign against malaria and jungle yellow fever. (Js. J. P.)

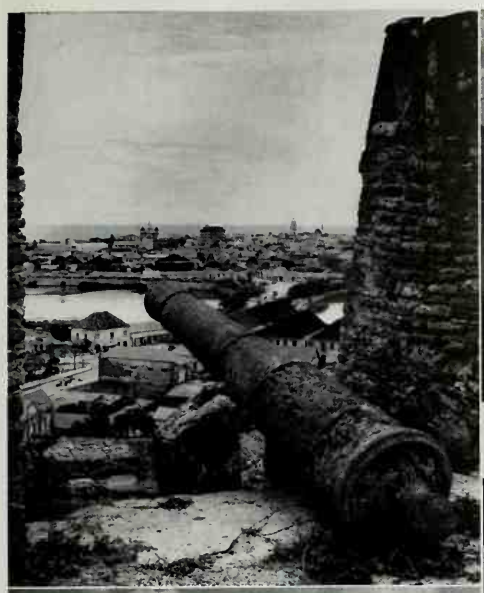
II. GEOGRAPHICAL REGIONS

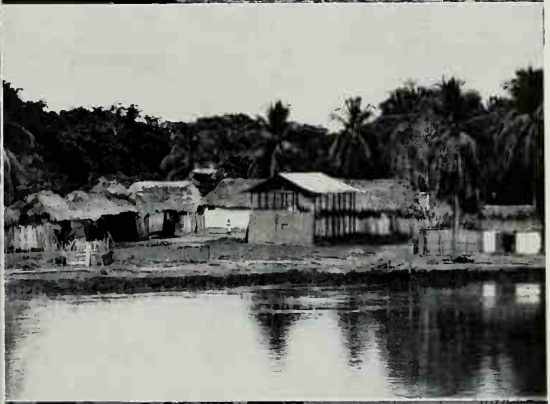
The exaggerated physical contrasts within Colombia and the relative difficulty of east-west movement have tended to compartmentalize economic and political life and to intensify regional distinctions. Unlike most Latin-American countries, Colombia has no single preeminent metropolis, but rather a series of regional capitals that are comparable in size and economic importance. The Andean or interior orientation of the economy has persisted since pre-Columbian times.

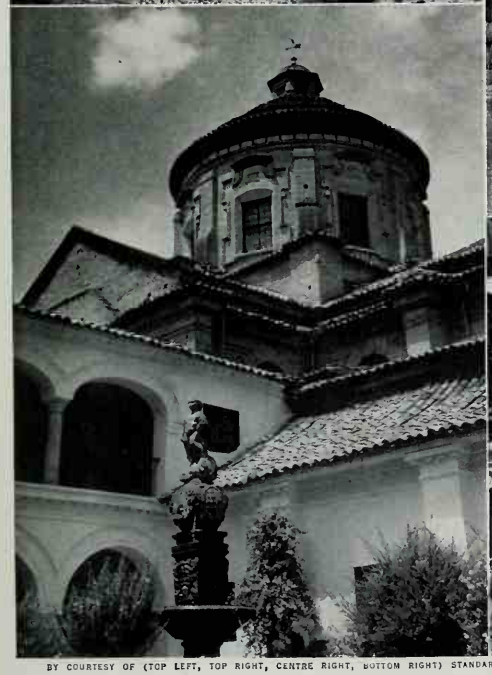
1. Caribbean Coastal Lowlands.—These comprise an extensive zone of low, rolling hills, marine terraces, and river alluvium lying between the northern Andes and the sea. Despite its early colonial importance (Santa Marta and Cartagena were the first permanent cities in Colombia), this coast has been an area of cultural lag. It supports about 17% of the population, most of whom live in the urban centres of Barranquilla, Cartagena, and Santa Marta. The low, forested spurs (Sierra de Abibe) of the Western Cordillera reach the coast between the Gulf of Urabá and the Sinú River. To the west lie the rain-drenched and nearly uninhabited lower Atrato River plains. To the east, in the Magdalena plains, the lowland zone widens to more than 200 mi. The granite Sierra Nevada de Santa Marta, which rises behind the port of Santa Marta, is probably to be thought of as an outlying peak of the Eastern Cordillera system. Beyond it, to the northeast, the low hills of the arid Guajira Peninsula extend in the shape of a closed fist, the northerly projection of the Sierra de Perijá, which forms the frontier with Venezuela.

The rivers of the coast are sluggish, meandering streams bordered by extensive areas of seasonally inundated swamps (*ciénagas*). The bordering *ciénagas* of the Magdalena and the Sinú provide pasturage and drinking water for livestock during the *verano* (January to May) when the upland grasses are seared with drought. The rich riverine alluvial soils are but little cultivated because of the difficulty of flood control and the unreliability of the rainfall. The Magdalena floodplain is of relatively restricted extent near the coast, where it is hemmed in on the west by the Tertiary hills of Atlántico, but upriver from Magangué it is joined by the San Jorge, the César, and the Cauca rivers in a vast area of ill-drained seasonal swamps and lakes. The Sinú, navigable for small vessels inland to Montería, also has extensive bordering swamps, of which the Ciénaga Betancí and Ciénaga Grande are of greatest extent.

The climate of the coast is warm and relatively dry. Aridity increases from west to east, in part because of the northerly trend of the coast which carries the Guajira into the subtropical trade-wind zone at latitude 12° N. The annual average precipitation, 45 in. in the lower Sinú, is 25 in. at Cartagena and less than 10 in. in the Guajira. Inland, however, the dry season becomes







BY COURTESY OF (TOP LEFT, TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) STANDARD OIL COMPANY (NEW JERSEY), (BOTTOM LEFT) COLOMBIAN EMBASSY

CITIES AND VILLAGES OF COLOMBIA

Top left: The city of Cartagena as seen from a battlement of the fortress of San Felipe
Top right: Street in the old section of Bogotá
Centre right: Jungle settlement along the banks of the lower Magdalena river
Bottom left: Courtyard of the Museum of Colonial Art, Bogotá
Bottom right: Street of Cali, showing the Club Colombia

COLOMBIA

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COLOMBIAN AGRICULTURE AND INDUSTRY

Top left: El Centro oil wells in the jungle near Barrancabermeja
Top right: Indian farmers planting potatoes in the Cordillera Oriente between Pamplona and Bucaramanga
Centre right: Farmer breaking ground on a hillside with a primitive wooden plow
Bottom left: Sugar cane entering a press at a refinery near Palmira
Bottom right: Cacao workers spreading beans to dry at a plantation in the Cauca river valley

everywhere less pronounced and total precipitation increases sharply. Near the confluence of the Cauca and Magdalena it exceeds 120 in. and supports luxuriant rain-forest vegetation.

Stock raising has been the traditional economic activity of the coast. Successful large-scale agricultural developments, with cotton and sesame as the principal crops, have taken place on the better-drained alluvial lands in the Sinú and César valleys. The extensive irrigated acreage in bananas in the lee of the Sierra Nevada de Santa Marta, and smallholder mixed farming on the hills between Barranquilla and Cartagena date back to an earlier period. At Turbo, on the Gulf of Urabá, bananas have become a major crop.

2. Pacific Lowlands.—These comprise the narrow, rain-drenched littoral between the Western Cordillera and the Pacific Ocean. By convention, they may include the physically and culturally similar Atrato River drainage, though the Atrato empties into the Caribbean. The Pacific lowlands thus comprise the department of Chocó and the forested, empty Pacific slopes of the departments of Valle del Cauca, Cauca, and Nariño. Because of the excessively high rainfall, generally more than 200 in. a year, this entire area is cloaked in a lush rain forest. Its deeply weathered red lateritic soils offer very limited agricultural promise. Rivers are the principal highways of communication and agricultural clearings and settlements are largely confined to their natural levees. The Pacific lowlands are scantily peopled. About 85% of the area's 335,000 population is of Negroid stock, descendants of escaped slaves who worked the gold and platinum placers during the colonial period. A proposal for the construction of an interoceanic canal in this area was made in 1540. It was still under consideration at mid-20th century.

3. Eastern Plains (the Oriente).—Although they comprise two-thirds of the area of Colombia, the eastern plains contain less than 2% of the country's population. They are the vast outwash surfaces and fans of the numerous streams that drain the eastern face of the Andes, among them the Arauca, the Casanare, the Meta, the Caquetá, and the Putumayo. In the past, malaria, banditry, and isolation have tended to retard their economic development. In the northern third of the region, which lies within the Orinoco drainage, the dry season is well marked, soils are better, and there are extensive areas of open savanna (llanos) which have long been exploited by stockmen. South of Villavicencio, within the Amazon drainage system, the savanna openings become less frequent. The vast *comisarias* of Vaupés and Amazonas and the *intendencias* of Caquetá and Meta are almost entirely cloaked with dense rain forest (selva), inhabited almost exclusively by primitive Indian groups. Colonization zones, however, have been established along roads of penetration from the Andean foothills, as at Florencia and Mocoa.

4. Andean Region.—This area, whose temperate climate, mineral wealth, and large Indian population originally exerted so strong an attraction on the Spaniards, still is the centre of political and economic power in Colombia. There live 78% of the population and there are the three largest cities—Bogotá (pop., 1961 est., 1,256,640 [mun.]), Medellín (651,240), and Cali (639,900). The Andean region may be broken down into numerous subregions or economic-physical areas, each with distinctive characteristics. The massive Eastern Cordillera has been the traditional centre of Chibcha, Spanish, and Colombian culture and government. The most dense rural settlement and largest cities are generally on the higher plateaus and interior basins of the *tierra fría* (*e.g.*, Bogotá, Chiquinquirá, Sogamoso, Tunja). To the north, in the Santanders, elevations are lower and sugar, cotton, tobacco, and coffee replace potatoes, wheat, and barley as the primary crops. Deep barrancas such as that of the Río Sogamoso cut into the flank of the cordillera and make north-south travel difficult except along the flattened Andean crest, but movement between the highlands and the Magdalena Valley is relatively easy. The peoples of the Eastern Cordillera are mostly ultraconservative subsistence farmers living on dispersed farmsteads. Extreme poverty and excessive parcelization of the land are found in this area. In some places, near the larger cities, dairying and truck farming have prospered. Tobacco is an important crop in Santander, as is coffee on the mid-slopes toward the Magdalena below 6,000 ft. elevation.

The middle and upper Magdalena Valley, a deep, grabenlike depression, stands apart as another distinctive land. Life on the windswept open plains of Tolima and Huila, where water is at a premium much of the year, contrasts sharply with that of the cordilleran slopes that rise abruptly on either side. Commercial agriculture (tobacco, cotton, sesame, artificial pasture) has become important, especially in Tolima, where irrigation waters are taken from streams such as the Coello as they flow eastward across a wide alluvial apron before joining the Magdalena.

The central and western Andean cordilleras are distinguished from the eastern highlands by their steep slopes, often of volcanic origin, and by the distinctive qualities of their people. In the far south the volcanic outwash slopes coalesce to form high intermontane valleys and plateaus with relatively flat surfaces, as at Ipiales, Pasto, and Popayán. There, and especially in Nariño, the rural population is dense and Indian ways survive. Northward from the Popayán district, commercial agriculture and the production of cash crops for sale become more important and cities become more numerous. The Valle del Cauca, the 120-mi.-long, flat-floored valley 3,000 ft. above sea level, is the floor of a former lake that was probably formed when the Cauca River was dammed by Pleistocene volcanic eruptions to the north. It is a clearly delimited physical and cultural subregion, centring on the flourishing commercial city of Cali (*q.v.*), headquarters for the Cauca Valley Development project, which was modeled after the Tennessee Valley Authority. The floor of the valley, alternately subject to flooding and drought, has been traditionally devoted to the raising of pasture grasses, sugar cane, tobacco, and rice. The mountains overlooking the valley on either side were colonized by Antioqueño settlers, the front wave of aggressive frontiersmen who began moving south onto the unpeopled mountainsides overlooking the Cauca gorge in southern Antioquia during the 19th century. These small Antioqueño farms, together with those in Caldas and western Tolima, produce the bulk of Colombia's exportable coffee. The department of Caldas, carved from the three states of Tolima, Cauca, and Antioquia in 1905 by Antioqueño homesteaders, produces one-third of the country's coffee crop though the roughness of the topography makes local farm-to-market roads impractical. An exception is in the rich Quindío district of southern Caldas where gentler slopes prevail.

The Antioquia granite batholith, the terminal rampart of the Central Cordillera, is a relatively flat surface of limited agricultural attraction, but the lower volcanic slopes to the south and west and the folded Tertiary ranges of the Western Cordillera beyond the Cauca trench are of superior productivity and soil erosion there has been contained. After 1800 these slopes were centres of intensive colonization and agricultural development as the surge of colonists southward from the Antioqueño core area around Medellín and Ríonegro got under way. Medellín remains the regional capital and cultural heart of this northern highland zone, its original importance as a mining centre having later been overshadowed by trade and industry.

III. THE PEOPLE

1. Physical Types and Languages.—Colombia is a mestizo country where the mixing of Indians and whites has been going on for four centuries. Persons of unmixed European descent may constitute 10–15% of the total population; they are represented chiefly by the upper classes of the larger cities and by a part of the rural population of Antioquia, Caldas, and the Santanders. An estimated 20% of the population is Negro or mulatto (see *Population*, below). The 1951 census recorded approximately 300,000 Indians, including the tropical forest tribes of Amazonas, the desert Guajiro, and the Páez of the Tierradentro country near the headwaters of the Magdalena River.

The Indian population of pre-Columbian New Granada was both numerous and culturally advanced (see *History*, below). The Tairona, Sinú, Quimbaya, and Chibcha and their relatives, while lacking the political sophistication of the Incas and Aztecs, were peoples of high culture for whom manioc (cassava), potatoes, and maize were the principal staples. The assimilation

of colonial Spanish culture by aboriginal tribes was curiously rapid and complete. This was favoured by the fact that most of the tribes were small in number and scattered, speaking different languages. In much of the land west of the Magdalena the Indian population seems to have been virtually exterminated within a few years of the first *entradas* by wars, epidemics, or forced exile. In the Eastern Cordillera and in Nariño the Indians survived in the largest numbers, usually on land reserves (*resguardos*) which had been first established by Spanish legislation at the end of the 16th century. Even there, however, the Spanish language was adopted, together with European dress and the Roman Catholic religion. It is in the southern highlands of Nariño and in the highlands of Boyacá and Cundinamarca in the Eastern Cordillera that the Indian element is most conspicuous in the rural mestizo population. On the Caribbean coast and in the Cauca Valley, especially, Negroes have intermingled with whites and Indians to form an ethnic stock of distinctive character. Wherever slave labour was employed extensively during the colonial period, as in the Antioquia mining camps, the Negro element is often still substantial. The principal Negro area of Colombia, however, is the Pacific coastal lowland. The tiny Colombian-owned islands of San Andrés and Providencia have a predominantly Negro population of Jamaican ancestry.

The modern Colombiano is not cut to any single mold. Perhaps because of the country's extreme physical diversity, cultural particularism is highly developed in the various departments and regions. Antioqueños, Santandereños, Tolimense, Nariñense, Bogotanos, and Boyacense are recognized by habits of speech, dress, and diet at home and abroad.

Most numerous and economically the most important of these groups are the Antioqueños, self-styled "Yankees of South America," who in the 19th century spilled out from the heartland of Antioquia to colonize southward along the flanks of the Central and Western cordilleras. This energetic and cohesive cultural group, long renowned for its high birthrate and colonizing genius, numbers more than 3,000,000 persons, or close to one-fourth of the population. It has been one of the most important forces behind the economic growth of the country during the 20th century. Wherever he has gone, the Antioqueño has transplanted his unique cultural heritage. Caldas has become a department "more Antioqueño than Antioquia." Antioqueño smallholders produce three-fourths of Colombia's coffee and control much of the country's trade, banking, and manufacturing. The popular belief that Antioquia was settled in part by Sephardic Jews recently converted to Christianity has never been substantiated. Among the other principal cultural groups of Colombia the Santandereños—physically, at least—most resemble the Antioqueños. They are a mountain folk of predominantly white stock. Bucaramanga is their principal urban centre. European immigration has been of relatively little importance in Colombia since the colonial period.

2. Religion.—The Roman Catholic faith was introduced into Colombia by the Spanish conquerors and until 1853 was the only religion permitted to Colombians. Until amended in 1936, the constitution provided that Roman Catholicism should be the national religion protected by the state, but a complete disestablishment was effected in that year. During the colonial period many churches were built and religious communities established, and the church was wealthy and powerful. Although under Pres. Tomás Cipriano de Mosquera (*q.v.*) most of the church property was transferred in 1861 to the state, the church remained quite strong. Its influence in matters of education was materially decreased by the policies followed under Pres. Alfonso López Pumarejo (1934–38). However, the Catholic Church is probably stronger in Colombia than in any other country in South America. Other forms of religion are permitted as long as they are "not contrary to Christian morals and to the law." Protestant missionary activities have not been lacking, but in 1953–57, during the internal strife associated with the rule of the dictator Gen. Gustavo Rojas Pinilla, Protestants complained of police persecution and religious disorders. Terrorism against Protestants has been openly condemned by the government and the Vatican.

3. Customs and Culture.—Isolation has tended to preserve the language, manners, and physical characteristics of the early colonists with less variation in Colombia than in any other Spanish American country. The traditional cultural ties of the upper classes have been with Europe, but during and after World War II the United States came to be of primary importance in this regard. Bogotá, "the Athens of South America," has always prided itself on being a centre of learning, with special emphasis on literature, poetry, and music. The writing and reading of poetry traditionally has had an especially important place in the Colombian hierarchy of values although few Colombian poets are known beyond the limits of their country. Regional literature has been developed to an extraordinary degree and reflects a keen appreciation of local history and geography. The study of anthropology developed notably during and after World War II, particularly at the Instituto de Antropología in Bogotá.

The conservative quality of Colombian life is a matter of frequent comment by visitors. The *ruana* or poncho cloak is everywhere worn by the country people. Among those with a more Indian culture the felt derby hat is worn by both sexes. In the cities, men in traditional black hats and suits still crowd the streets during the evening hours for long political debates over their *tinto,* or coffee demitasse. Women's life is traditionally centred in the home. Courting is still carried on through the iron grills that frame the street windows of private houses.

See also INDIAN, LATIN-AMERICAN; SOUTH AMERICA: *Anthropology;* ARAWAK; CARIB; CHIBCHA. For Colombia's literary development *see* IBERO-AMERICAN LITERATURE. (Js. J. P.)

IV. HISTORY

1. Preconquest.—Even before the Spanish conquest the western mountainous part of Colombia attracted the bulk of the population. The higher Indian cultures were found in this region, and the most favourable location for the growth of civilization was the high plateau in the Eastern Cordillera of the Colombian Andes. The present capital city of Bogotá is located near the southern terminus of the plateau, which extends northward to the mountains dividing it from the drainage of the Río César. There the Spanish found the major concentration of the Chibchan-speaking peoples, who were divided into several tribes. (*See* CHIBCHA.) At the time of the Spanish conquest the Chibcha were in the process of consolidation by warfare. They had not achieved firm union and political institutions, and their other cultural traits had not attained the solidity and refinement needed to resist cultural conquest.

Except for the invading Carib peoples in the deep mountain valleys, there was a considerable similarity among the Chibcha, subandean, and circum-Caribbean cultures of Colombia. They were all characterized by intensive agriculture, fairly dense populations, living in villages, organized religion, class divisions, and matrilineal inheritance of political and religious offices. The subandean culture in the Central Cordillera and the narrower portions of the Cauca Valley generally lacked the feature of large villages because of the unsuitability of the terrain. The more advanced Chibcha made war for political ends, using large forces armed with the dart and dart thrower, shields, and wooden clubs.

Geographic and climatic conditions placed limits to the development of the Chibcha and other cultures in Colombia. Of the total Indian population at the time of the conquest, probably about one-third were Chibcha. None of the larger domesticated animals and their wild related species found in the central Andes existed in Colombia, where only the dog and the guinea pig were domesticated. The Chibcha were adequate craftsmen, but their work shows more interest in utility or in the expression of ideas than in the attainment of the skilled workmanship striven for among the subandean peoples such as the Quimbaya of the Cauca Valley. No significant use of stone in construction was made and the famed stone ruins at San Agustín in the upper Magdalena Valley date from a much earlier period.

2. Conquest.—Exploration of the Colombian coastline was the work of Rodrigo de Bastidas, who in 1500–01 ran out the Caribbean coast from Cabo de la Vela to Nombre de Dios in Panama, and of Francisco Pizarro, who sailed the Pacific coast in 1525.

Effective conquest of Colombia began in 1525 with the founding of Santa Marta on the north coast by De Bastidas. In 1533 Pedro de Heredia founded Cartagena, which became one of the major naval and merchant marine bases of the empire. By the end of 1539 all but one of the major inland colonial cities had been founded, as well as the most important communications centres along the routes connecting them. The capital city of Santa Fe de Bogotá was founded by Gonzalo Jiménez de Quesada in 1538. By mid-century the era of the conqueror drew to an end.

3. Colonial Era.—Establishment of the *audiencia* of Santa Fe de Bogotá in 1550 opened the colonial era. The conquerors had organized local governments in accordance with the terms of their contracts with the crown. The crown then rapidly repossessed the broad powers granted the conquerors and formed its own institutions to rule the empire. The governments of Popayán, Antioquia, Cartagena, Santa Marta, Ríohacha, the New Kingdom of Granada (Bogotá), and the llanos of Casanare and San Martín were made subject to the new *audiencia*. The president of the *audiencia* was the executive head of government, subject to the viceroy of Peru in administrative matters. The difficulties of travel, however, impeded communications and checked centralized control.

The area declined in population after the conquest as a result of disease and the economic demands made upon the Indians. As elsewhere in the empire, the downward trend seems to have reversed itself at the end of the 17th and the beginning of the 18th century. Acculturation and intermarriage rapidly destroyed most of the special cultural traits of many remaining Indians. Subordinate political jurisdictions developed strong regional characteristics as a result of isolation, which fostered intense local loyalties and rivalries. The economy was based on mining and agriculture but a small yet important textile industry had grown up in Socorro, north of Bogotá, by the mid-18th century. Slavery was introduced during the conquest and became common in the placer-mining areas of the Chocó and western Antioquia and in the agricultural regions of the Cauca Valley, the lower Magdalena Valley, and the coastal lowlands. Indians were subject to the encomienda tribute, but by 1700 most of the privately held encomiendas had reverted to the crown and they were rarely granted thereafter. During the era of the *audiencia*, from 1550 to 1740, the population was politically quiet. The Roman Catholic Church played a very important role in the life of the people, providing most of the welfare services and operating most of the schools. The church was an effective instrument of the crown, since the latter controlled appointments to church offices, intervened in church administration, and censored official church documents.

4. Viceroyalty.—Creation of the viceroyalty of New Granada, which included present-day Colombia, Venezuela, and Ecuador, temporarily in 1717–23 and permanently in 1740, opened a new era. In the next decades the crown introduced political and economic measures to reorganize and strengthen the empire by greater centralization of authority, improved administration and communication, and freer development and movement of trade within the empire. These changes coincided with and were an effect of new, important trends in western Europe. Population grew, trade increased, and prosperity touched the colonial subjects. There was a spurt of intellectual activity and the formation of a corps of Creole intellectuals and professional men, many in government positions. (*See* CREOLE.) The Creole officer corps, small though it was, came into being when Charles III authorized militia defense units in the colonies. A relatively large group of wealthy landowners and merchants constituted the economic community that supported these new groups. Between 1785 and 1810 in New Granada the outlook of the Creole upper and middle groups changed from resistance toward political and economic change introduced by government to a quest for specific changes in imperial policies. Thus in the Comunero Rebellion of 1780–81 the Socorrans opposed change, while in 1809 they proposed new policies leading to the free-enterprise system, the abolition of slavery, restrictions on government, and worldwide freedom of trade. The intendancy system (*see* INTENDANT) of administration was not established because of the Comunero Rebellion and all subsequent viceroys found it inexpedient to attempt it, although much of the terminology and some of the spirit of the system became a part of government.

Educational reforms played an important role in the changing outlook of the Granadines. Archbishop Caballero y Góngora as viceroy (1782–88) made education one of his main interests. He modernized the program of studies in the schools, opened a school of mines, and initiated the botanical expedition under the able guidance of naturalist José Celestino Mutis. The new institute greatly improved scientific education and trained many of the major figures of the independence movement. The 1790s were the decade in which the first newspaper and the theatre became features of Bogotá life. A new interest in writing developed and intellectual gatherings for discussion were introduced. In 1808 the allegiance of the Granadines to the crown remained unquestioned except for a few individuals. The once warm loyalty of the Creole middle and upper classes, however, was cooling under the pressure of economic interests, scandals in the royal family, and persistent social tension between Creole and European Spaniards.

The French invasion of Spain in 1808 caused an outburst of loyalty to king and country and excited grave concern for the church. Profound Granadine anxiety over the fate of the empire and conflicting courses of action attempted by colonial and peninsular subjects over control of government during the captivity of Ferdinand VII led to strife in New Granada and to declarations of independence. In 1810 the subordinated jurisdictions in New Granada threw out their Spanish officials, except in Santa Marta, Ríohacha, modern Panama, and present-day Ecuador. The uprising in Bogotá on July 20, 1810, is commemorated as independence day in Colombia. These new governments swore allegiance to Ferdinand VII and did not begin to declare independence until 1811. To restore unity, all levels of government above the municipality had to be reconstituted by negotiation and agreement. Idealists and ambitious provincial leaders desired federation. Creole leaders who had been in Europe sought to centralize authority over the new governments. A series of civil wars ensued, facilitating Spanish reconquest of the United Provinces of New Granada between 1814 and 1816. A remnant of republican forces fled to the llanos of Casanare where they reorganized under Francisco de Paula Santander, who remained a prominent figure in Granadine politics until his death in 1840.

Any remaining loyalty to the crown was alienated by the punitive arbitrary conduct of the European and partisan troops whose officers ignored the Spanish civil authorities. Their conduct gave validity to the attack on Spanish civilization that began late in 1810 and continued throughout the 19th century. The forces in Casanare joined those of Simon Bolívar (*q.v.*) in the Orinoco Valley of Venezuela. By 1819 arrangements for a regular government were completed and a constitutional convention met at Angostura (now Ciudad Bolívar, Venez.) with delegates from Casanare and some Venezuelan provinces. In that same year Bolívar invaded New Granada and decisively defeated the Spanish forces on Aug. 7 at Boyacá. There followed the decisive battle of Carabobo, Venez., in 1821 and that of Pichincha, Ecuador, in 1822. Mopping-up operations were completed in 1823, while Bolívar led his forces on to Peru.

5. The Republic.—The congress at Angostura laid the foundation of the Republic of Colombia (1819–30), generally known as Gran Colombia because it included Colombia, Venezuela, and Ecuador. The republic was definitively organized by the congress of Cúcuta in 1821. Prior to that time the government was highly military and strongly centralized with direct executive power exercised by regional vice-presidents while President Bolívar was campaigning. Organized as a centralized representative government, the republic had Bolívar as president and Acting President Santander as vice-president. Gran Colombia had a brief, virile existence during the war. Subsequent civilian and military rivalry for public office and regional jealousies led in 1826 to a rebellion in Venezuela led by Gen. José Antonio Páez. President

Bolívar returned from Peru to restore unity, but secured only the acknowledgment of his personal authority. As discontent spread it became clear that no group loved the republic enough to fight for its existence. By 1829 Bolívar had divided the land into four jurisdictions under Venezuelan generals possessing civil and military authority. Meanwhile the convention of Ocaña had failed to reorganize the republic, and the brief dictatorship of Bolívar (1828–30) had no better success. Bolívar then convoked the convention of 1830 which produced a constitution honoured only in New Granada (Colombia). During this convention Bolívar resigned and left for the northern coast where he died near Santa Marta on Dec. 17, 1830. By that time Venezuela and Ecuador had seceded from Gran Colombia.

New Granada, after several changes of title, assumed the name of the Republic of Colombia in 1886. The many changes of constitutions in the republic's early history were related to three basic problems of Colombian society: the proper organization and powers of national and local government in relation to the needs and aspirations of the people; the adjustment of church-state relations to the constitutional principles of liberal republican government; and the hostility between the Liberal and Conservative parties, whose delineation took place in the 1830s. The constitution of 1886, which was still in use during the latter half of the 20th century, provided for a centralized form of government with provision for local autonomy. It represented a Colombian consensus formed of traditional practice, both legal and *de facto,* profound regionalism, and strong national feeling. Prior to 1855 both major parties were moderately centralist, and had been giving greater recognition to the demand for local autonomy. Thus, the number of units of local government with an alcalde, a town council, and a court of first instance increased from fewer than 200 to about 816 between 1832 and 1853. The number subsequently declined and in the mid-20th century the number of alcaldes was scarcely greater than in 1853. The alcalde has always held executive and judicial functions, and has taken part in the legislative process as chairman of the town council. His powerful position in the locality is easily convertible to tyranny. Responsible for enforcement of national, departmental (province, state), and municipal laws and ordinances in his area, he may interpret them in his own interest. In the 19th century, municipal officials generally received no salary. Alcaldes and judges were full-time officials whose offices had to support them if they had no other income.

Beginning with the civil war of 1840–42, relations between the parties remained on a basis of hostility, sometimes active and always latent. Party hostility led to the division of the country into federally related states (party strongholds) between 1855 and June 1857, and resulted in laws that limited the national government to minor functions with no provision for interstate or state-national governmental relations. The constitution of 1858 creating the Granadine confederation restored a national government. Liberal denial of that constitution led to the "organized anarchy" of the 1863 document under Liberal governments. A segment of the Liberal Party under Rafael Núñez then sought constitutional reform, and had to ally with the Conservatives to do it. The constitution of 1886 was the result, and the Conservatives retained control of the government until 1930.

The Liberal and Conservative parties were loosely knit associations generally led by extremists representing little more than two separate bodies of defined opinion. In the locality, political bosses known as *gamonales,* later caciques, provided leadership and determined the conduct of government through the alcaldes. From the *gamonales* and the intellectuals came the provincial and national leaders of the parties. The parties have frequently split and reunited, and they have made common cause against any individual who threatened to become an authoritarian military ruler as in 1854, 1909, and 1957. The highly organized status of the parties after World War I was not proof against division. Both parties still represented a complete cross section of the population.

Church-state relations were a crucial point in interparty relations. Until about 1840 both parties supported retention of the old powers of the Spanish crown over the church, but the Conservatives favoured easing the controls. Thereafter they tried to use the church as a political weapon in return for a protected status. The Liberals adopted a Benthamist approach in which, under "separation" of church and state, the church is regulated and deprived of property and its clergy are elected and paid as government officials. A number of leading Liberals were actively hostile to organized religion, and the party, hampered by the church's hostility to the basic philosophy of Liberalism, sought to limit its influence. The extraordinary bitterness of party hostilities was largely a product of the struggle over religion and the associated problem, control of education. Under the leadership of President Mosquera the power of the church was reduced in 1861 and most of its property appropriated by the nation. The settlement of 1886 and the concordat of 1888 quieted these issues until 1936.

6. The 20th Century.—Civil war (1899–1902) opened the 20th century at a cost of about 100,000 lives and economic ruin for the country. The government, victorious over the Liberal rebellion, was then confronted by the secession of Panama. In 1878 a French company had been given a concession to construct a canal across the isthmus of Panama. Although much of the excavation was accomplished in the 1880s, the problems of disease in Panama and of graft in Paris wrecked the enterprise. Subsequent efforts to revive the work failed, despite the cooperation of the Colombian government in extending the concession. As a result of experience in the Spanish-American War, the United States decided to build a canal either in Nicaragua or in Panama. The latter route was selected, the Colombian government liked the idea, and the French company hoped to recover some of its losses. Negotiations broke down between the two governments and, threatened by the loss of the canal, Panamanian leaders in concert with the French company organized a rebellion and declared the independence of Panama in 1903. Using the treaty of 1846 with Colombia, the United States prevented the landing of Colombian troops but ignored the clause in which it guaranteed Colombian sovereignty over Panama. The United States then recognized Panamanian independence, negotiated a canal treaty, and began construction. Subsequently, under the terms of the Thompson-Urrutia Treaty ratified by Colombia in 1921, the United States made reparations for the loss suffered by Colombia, including a $25,000,000 payment. Colombia then recognized Panama's independence. (*See* PANAMA CANAL.)

Forty years of political peace followed the loss of Panama. The disrupting effects of World War I on the economy were followed by fiscal and banking reforms in 1922 and the entry of foreign investment capital. Inflation followed. Wages of urban and rural workers lagged far behind the rising cost of living, and serious rural social disturbances occurred in several sections from 1925 to 1929. In the cities, modern labour organizations of a class character began to replace the old mutual associations. Division in the Conservative Party and popular unrest enabled the election of a moderate Liberal to the presidency in 1930. The new Liberal era lasted until 1946. Under the goad of the traditional spoils system and local vengeance, the harassed Conservatives were on the point of return to violence in 1932 when a conflict with Peru (1932–34) ended the internal struggle.

Pres. Enrique Olaya Herrera (1930–34) took initial steps to reform public health and education, public housing, and land distribution. A moratorium on debts was declared to counter effects of the depression. Pres. Alfonso López Pumarejo (1934–38) hastened the pace of reform. Labour enjoyed the patronage of government and the National Confederation of Workers became an important arm of the Liberal Party. Taxes on capital and income were effectively collected, an ineffective agrarian reform law was passed, and the government took on the philosophy of a welfare state. The social functions of property were established in law; public assistance was declared a function of the state; and the protected status of the church was terminated along with its control of education. Eduardo Santos Montejo, who succeeded López, did little more than maintain the work of his predecessor. During his second administration (1942–45) López was crushed between the opposition of his party's right wing to further reform

and the necessities of the working class who looked to him to ease the impact of inflation and improve their standard of living. To this was added the pressure of an ever larger propaganda attack by the Conservatives as unrest grew among the people. López was driven to resign in July 1945, and Alberto Lleras Camargo filled his post until Aug. 7, 1946. In the 1946 elections the Liberals were so deeply divided that they ran two candidates: Jorge Eliécer Gaitán, who had made himself the leader of the working classes with a social reform program, and Gabriel Turbay, the candidate of the right wing. Moderate Conservative Mariano Ospina Pérez won the election, but his party did not win control of the congress until he imposed a state of siege on the country in 1949. This state of siege was partially lifted in 1958.

Ospina attempted until 1948 to govern with a coalition cabinet, hoping to restore peace and order to the country. Meanwhile his party began to move into the offices of government under the spoils system. Early in 1948 Gaitán was recognized as the leader of the Liberals only to be assassinated in Bogotá on April 9. The capital exploded into the worst riot in Colombian history and similar, less serious incidents occurred in other cities. The country had gradually moved into full-scale violence during the 1940s, a condition caused by interparty hatreds and social unrest. It was serious enough by 1944 to warrant extending the jurisdiction of military courts over certain crimes by civilians in areas where violence erupted. By August 1957 an estimated 260,000 persons had been killed and 750,000 had become refugees.

Laureano Gómez, extremist head of the Conservative Party, became president in August 1950 and proceeded to eliminate Liberals from government payrolls. By 1951 Conservatives were split over his policies and evinced growing opposition to the authoritarian constitutional reforms he planned to impose in 1953. Gómez, inactive after November 1951 because of bad health, resumed direct control of the presidency on June 13, 1953, but was overthrown on the same day by Gen. Gustavo Rojas Pinilla, Conservative chief of the military forces. The constitutional assembly, called for 1953 by Gómez, approved Rojas as provisional head of government and then elected him president for the 1954–58 term.

Rojas, nationally welcomed as a harbinger of peace, justice, and liberty, forgot his promises and merely replaced the dictatorship of Gómez with his own. Gradually the Liberal and Conservative parties reconciled their differences and formed the National Front to restore civil constitutional government. The coalition, based on a 50–50 split of government offices and rotation of the presidency, was later given an expiration date of 1974. Arrest of the National Front presidential candidate on April 30, 1957, started a series of demonstrations capped by a national economic strike. The armed forces acted as broker between president and National Front and on May 10, 1957, Rojas resigned after appointing a military junta to oversee transition to a popularly elected government. The junta faithfully fulfilled its assigned role. The agreements establishing the National Front were made part of the constitution by a plebiscite on Dec. 1, 1957. On July 20, 1958, Congress met for the first time since 1952 and Alberto Lleras Camargo, Liberal leader and major architect of the National Front, took office as president on Aug. 7, 1958. President Lleras ended the state of siege (1949–58) in most of the country, violence was sharply reduced, and the grave socioeconomic condition of the country improved.

During the Lleras administration an agrarian reform law was enacted. It provided for the breaking up of large estates on which the land was inadequately used and for the redistribution of this land in smaller plots to landless peasants. In May 1962 Guillermo León Valencia, candidate of the National Front, was elected president of the country. While Valencia was on a state visit to Venezuela in August 1963, government troops arrested former President Rojas and several of his supporters, charging them with plotting to seize control of the government. Rojas was removed to a remote military base.

Late in 1963, President Valencia's administration underwent a period of crisis caused mainly by a deterioration in the domestic economy. The situation forced Congress to grant limited decree authority to the president from August to December 1963 in financial, budgetary, and administrative matters. During this period, President Valencia issued decrees on taxation and judicial reform and created a monetary board, which took over control of bank credit policy and the monetary system on Nov. 1, 1963.

(R. L. Ge.)

*Area and Population of Colombia by Major Civil Divisions**

Political subdivision and capital city	Area square miles	Population 1951 census	Population 1962 estimate
Departments			
Antioquia (Medellín)	24,324	1,570,197	1,971,710
Atlántico (Barranquilla)	1,333	428,429	634,120
Bolívar (Cartagena)	13,386	646,101	797,760
Boyacá (Tunja, M.E.)	23,217	801,436	849,390
Caldas (Manizales)	5,905	1,068,180	1,399,590
Cauca (Popayán)	11,863	443,439	529,040
Chocó (Quibdó)	18,327	131,101	149,100
Córdoba (Montería)	9,945	345,357	426,420
Cundinamarca (Bogotá, D.E.)	8,934	1,624,044	2,121,680
Huila (Neiva)	7,656	293,692	377,120
Magdalena (Santa Marta)	18,071	407,731	511,450
Meta (Villavicencio)	32,903	67,492	83,920
Nariño (Pasto)	12,499	547,323	620,670
Norte de Santander (Cúcuta)	7,796	387,450	421,230
Santander (Bucaramanga)	11,706	747,706	872,640
Tolima (Ibagué)	8,646	712,490	882,650
Valle del Cauca (Cali)	7,888	1,106,927	1,823,230
Intendencias			
Arauca (Arauca)	9,973	13,221	15,100
Caquetá (Florencia)	41,052	40,950	80,970
La Guajira (Riohacha)	8,108	102,008	119,360
San Andrés y Providencia (San Andrés)	21	5,675	4,950
Comisarías			
Amazonas (Leticia)	48,008	7,619	8,730
Putumayo (Mocoa)	10,226	28,105	41,410
Vaupés (Mitú)	58,861	9,169	10,440
Vichada (Puerto Carreño)	39,764	12,330	15,830
Total	439,512	11,548,172	14,768,510

*Political subdivisions as of July 1, 1960; adjustments of data made where necessitated by reorganizations subsequent to the 1951 census.

V. POPULATION

The census of 1951, taken during a period of violent internal strife, reported the population of Colombia to be 11,548,172, a density of 26.3 persons per square mile; pop. (1963 est.) 15,097,640. The majority of Colombia's population lives in the western one-third of the country and is concentrated on the slopes and in the valleys of the central and eastern ranges of the Andes, which run from north to south throughout the western portion of the country, and along the Caribbean coastal plain. On the other hand, the hot, humid areas along the Pacific coastal plain are sparsely populated, and the vast areas of plains and jungle that lie east of the Andes are practically uninhabited.

Persons of the white race, or intermixtures of the white and Indian or white and Negro, in which white features predominate, constitute the majority of Colombia's population. Negroes and mulattoes probably make up about 18% of the total, and mestizos another 57%. The Negroid elements are concentrated in the settlements along the Caribbean coastal plain, in the Magdalena and Cauca valleys, and in the extensive lowland areas along the Pacific. The largest proportion of Indians and mestizos is found in the southernmost department of Nariño, on the Guajira Peninsula, and at the highest elevations in the mountains throughout the country. They are also present in substantial numbers in Bogotá, Tunja, Pasto, and some of the other capitals, and they constitute almost the sole inhabitants of the more remote sections east of the Andes. The white and predominantly white population is heavily represented in all of the cities, throughout the densely populated mountainous districts that lie north of Bogotá, and in most portions of the departments of Antioquia and Caldas.

Because of its high birth and death rates, Colombia's population is concentrated in the younger ages, about 43% being less than 15 years of age; 54%, aged 15 to 64; and only 3%, 65 or over.

In 1938, 29% of the population was urban (*i.e.*, living in towns of 1,500 or more inhabitants). By 1951 this percentage had risen to 39. After that date the trend toward urbanization continued, speeded up by the wave of violence that began about 1948 and which cost hundreds of thousands of lives.

After 1938 Colombia's population increased by about 2.5% annually. Since immigration is a negligible factor in Colombia,

the rate of natural increase appears to be very high. Estimates place the birthrate at about 42 and the death rate at approximately 13 per 1,000 population. (T. L. Sh.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Government.—Under the constitution of Aug. 5, 1886, which was revised and codified in 1945, the executive branch is formed by the president and 13 cabinet ministers and the governors of the departments, who are appointed by the president, as well as other administrative authorities directly or indirectly controlled by him. The president is elected by the people for a term of four years, and he may not succeed himself. Attached to the president is a seven-member consulting body known as the Council of State.

The legislative power, according to the constitution, is vested in Congress, consisting of the Senate and the House of Representatives. The Senate is composed of three or more members from each department (one for each 190,000 population), popularly elected for four-year terms. The House of Representatives is composed of three or more members from each department (one for each 90,000 population), popularly elected for two-year terms. All Colombians over 21 years of age are citizens; women were expressly barred from voting and holding elective office under the constitution until an act passed Aug. 25, 1954, by the national constituent assembly gave them the right to vote.

The judicial power is vested in the Supreme Court at Bogotá and a superior court in each judicial district. The Supreme Court has appellate jurisdiction in judicial matters and original jurisdiction in impeachment trials and in matters involving constitutional interpretation. There are various lower courts.

The country has been divided for many years into departments, *intendencias* (intendancies), and *comisarias* (subdelegations). The departments have popularly elected assemblies; the *intendencias* and *comisarias* are administered directly by officials appointed by the central government.

2. Living Conditions.—The cost of living in Colombia rose only 9% between 1953 and 1956, but by 1960 was up 69% over 1953. The gross national product was computed at U.S. $206 per person. Slightly more than 3,000,000 Colombians were gainfully employed and of this figure, approximately half were occupied in agriculture, hunting, and fishing. Labour conditions were a major political issue in Colombia during the 1930s, when unions played significant roles in national politics. In the 1960s about 10% of the country's workers were members of unions affiliated with the Confederation of Colombian Workers (C.T.C.).

3. Welfare Services.—Colombia's social security programs, many of which date from the administrations of President López, include provision for health and maternity benefits, compensation for workmen injured during the course of their employment, and allowances for persons unable to work.

4. Health.—In general, the coast and lower river valleys are unhealthful but there are regions that form exceptions, including the cities of Barranquilla and Santa Marta. In the low country, malaria and dysentery are prevalent. The Magdalena Valley is particularly unhealthful because of the vast swamp areas and the resultant mosquitoes. Hookworm is common.

Colombia lacks many sanitary facilities, but in many communities this situation, aggravated by the rapid growth in population, was being corrected in the latter half of the 20th century. The ports are generally free from yellow fever and similar diseases. In coping with these problems Colombia, since the early 1940s, participated in many of the bilateral technical assistance programs of the United States.

5. Education.—The constitution provides that public education shall be organized and directed in agreement with the Roman Catholic religion and that primary education, paid for out of the public funds, shall be free but not obligatory. Primary education is under the control of the departments, and the status of education varies in the different departments. At the end of the 19th century the proportion of illiterates was authoritatively estimated at 90%. By the 1960s this figure had been reduced to about 35%. Higher education is provided by the National University of Bogotá (founded 1573), and also by 13 universities in the capital and 14 elsewhere.

6. Defense.—Military service for one year is compulsory between the ages of 21 and 30. Peacetime strength of the Army varies between 12,000 and 15,000. The Navy consists of destroyers, frigates, river gunboats, and various smaller vessels. The Air Force has a considerable number of aircraft of various types. Colombia was the only South American country to participate in the Korean War, contributing an infantry regiment. Also, its frigates participated in the Korean blockade. (X.; G. I. B.)

VII. THE ECONOMY

About 70% of Colombia's export trade is dependent on one crop, coffee, with the result that lower prices in the world market give rise to balance of payments crises. Under quota agreements with coffee-producing and consuming countries in the early 1960s, Colombia's export of coffee was limited. In spite of efforts to diversify the economy, the dominance of one crop remained and an increasing amount of small domestic industry did not appreciably change the situation. Economic development has also been hindered by inadequate means of transport resulting from the difficulty of the terrain. To facilitate problems of production, tariffs, and trade, Colombia joined the Latin American Free Trade Association in October 1961.

1. Production. *Agriculture.*—The larger part of the population lives by farming and cattle herding. Coffee production is the principal source of wealth. Only about 2% of the land was under cultivation in the mid-1960s and there were still vast tracts of virgin land in all the departments. The largest proportion of cultivated land is at elevations of 3,000 to 10,000 ft. (900–3,000 m.), where altitude modifies the climate to give a temperate zone. Hand methods of cultivation, principally use of the machete and hoe, are predominant, but mechanization has made some progress, particularly on larger farms. One-crop farming is widespread. A considerable acreage of land is under irrigation, almost entirely by privately developed systems, mostly using diversion canals.

Coffee is grown principally in the temperate zone between 3,000 and 6,000 ft. Production greatly increased at the beginning of the 20th century and Colombia came to be second in importance only to Brazil as a world producer. Colombian coffee is known as "mild" and is blended with Brazilian and "robusta" types. It is grown under shade trees, largely on mountain slopes, predominantly by small growers. The departments of Caldas, Antioquia, Tolima, Cundinamarca, and Valle del Cauca are the principal producing regions. Wide control over the industry is exercised by the Federación Nacional de Cafeteros (National Federation of Coffee Growers), a cooperative association founded in 1927, which provides easy credit and large central warehouses.

Bananas grow easily in nearly all regions of the tropical and temperate zones in a great number of varieties and, besides being an increasingly important export, are one of the principal foods of the people. Other agricultural exports are sugar, cotton, tobacco, and timber, but their export value is insignificant. The tropical zone produces rubber, coconuts, tobacco, bananas, sugar cane, corn (maize), cotton, cacao, beans, rice, etc. The subtropical zone, in addition to coffee, produces a great variety of fruits, such as bananas, pineapples, mangoes, papayas, alligator pears (avocados), pears, and citrus fruits. The temperate zone is most favourable for agriculture and produces, besides coffee, wheat, barley, potatoes, oats, corn, and most of the fruits and vegetables known in the United States and Europe. Exports of bananas declined during World War II because of restricted markets and the ravages of Sigatoka disease. A steady recovery took place after the war, while some of the diseased banana lands were converted to the cultivation of cotton and African palm. Banana exports rose appreciably as a result of an important banana development program which was begun in Urabá in September 1962.

The largest rural properties are those devoted to cattle raising, and in the eastern llanos at the subtropical altitude there are vast areas suitable for this activity. It is estimated that with adequate development the country could support 50,000,000 head. Both cattle and hides are exported.

Mining.—Gold, formerly the principal source of mineral wealth, has been supplanted by petroleum. The main petroleum concessions are those of De Mares, Barco (Colombia Petroleum Company), and Yondo (Shell). The De Mares concession, granted in 1921 to the Tropical Oil Company, a subsidiary of Standard Oil Company (N.J.), reverted to the Colombian government upon its expiry in August 1951 and was taken over by Empresa Colombiana de Petróleos, a government-sponsored enterprise. There is a refinery at Barrancabermeja which serves the De Mares field, and a double pipeline 325 mi. (523 km.) long runs from Barrancabermeja to Mamonal near Cartagena. Another line extends from Oru in the Barco field to Coveñas on the Caribbean. Two additional lines, one running from Puerto Berrío at the southern end of the main pipeline to Medellín and the other from Puerto Salgar to Bogotá, were built in the 1950s. An oil pipeline from Cúcuta to Santa Marta came into service in 1964.

Gold and silver are still produced in Colombia, mainly in the Antioquia region. Colombia has the largest known platinum deposit and is the world's chief source of fine-quality emeralds from the mines of Muzo and Cosquez in Boyacá Department.

Colombia's coal reserves are estimated at 20,000,000,000 tons, the largest in Latin America. The production of iron ore increased with the stimulus provided by the Paz del Río steelworks, completed in 1954. Other mineral reserves include salt, sulfur, limestone, zinc, mercury, antimony, and manganese.

Industries.—At the beginning of the 20th century, Colombia had only about 100 industrial establishments. Two world wars and the encouragement of a protective tariff adopted in 1930 led, however, to extraordinary industrial development, and by 1950 national production met almost all the domestic requirements for textiles, footwear, cement and other building materials, some industrial chemicals, foodstuffs and beverages, and tobacco. In the early 1960s the manufacturing industry expanded at an annual average rate of 6–7%. The census of manufactures listed more than 11,000 enterprises. Geographically, industry was concentrated in and about the cities of Bogotá, Medellín, Cali, and Barranquilla. Industrial development continued to be hampered by inadequate transport and a lack of power facilities.

2. Trade and Finance.—Colombia, by reason of its geography, has a wide range of potential exports, but in the mid-1960s its export trade was confined within such narrow limits as to put it on the edge of the one-crop country group. The leading exports were coffee, petroleum, bananas, tobacco, platinum, and sugar, and the principal destination was the United States, which took about 60% of the total exports. Machinery, metals and metal goods, vehicles, chemical products, textile goods, vehicles and equipment, and paper and its manufactures were the main imports, about 60% from the U.S., in the same period.

The semiofficial Banco de la República was inaugurated in July 1923 as a central bank and the sole bank of issue. Under its contract it paid to the government a fixed royalty and 75% of its profits. The bank's organization and relation to the commercial banks of the country are based on the U.S. federal reserve system. The monetary unit is the peso, with a par value of $0.512825 U.S. currency, or 0.455733 gr. of fine gold, as fixed by the International Monetary Fund on Dec. 17, 1948. This parity is equivalent to 1.95 pesos to U.S. $1. However, the exchange reforms of June 17, 1957, created a free market for funds other than those connected with trade operations, and in 1958 the free market quotation averaged 7.59 pesos per U.S. $1. In the period January 1963 to September 1964 the Banco de la República intervened in the free market and maintained the rate at about 10 pesos to U.S. $1. On March 26, 1958, a system of auctions was introduced for the sale by the Banco de la República of exchange certificates, export earnings being purchased at a controlled rate and certificates offered at auction.

3. Transport and Communications.—The transport problem in Colombia is one of peculiar difficulty. With few exceptions, the more densely populated districts are in the interior, isolated from the coast by mountain chains, and communications in the 1960s were still inadequate. Most of the railroads run from the Magdalena River to interior points. Navigation on the river is slow and open only to vessels of small draft, necessitating transshipment at Barranquilla, where the harbour was improved with extensive port works in the 1930s. A peculiar feature of Colombian transport is the use of aerial cables for handling merchandise and passengers. Three of these, with a total length of 88.2 mi. (142 km.) are in operation between Gamarra and Ocaña, Manizales and Mariquita, and in the department of Caldas. The distance between stations averages 2.9 mi. (4.7 km.).

Roads.—Three main highways run from north to south: the Tronco Occidental, Tronco Oriental, and Tronco Central. Most important is the Oriental, the Colombian section of the Pan-American and Simón Bolívar highways. Other roads of varying quality connect Bogotá with other interior cities. In the 1950s and 1960s Colombia was engaged in a program to extend and improve its national highway network, in particular the 1,860 mi. (2,993 km.) providing connections between the main cities and the principal ocean and river ports.

Railways.—The railway system in the early 1960s comprised 17 distinct, and in many cases unconnected, lines which were built to link the Caribbean and Pacific ports and the Magdalena River ports with the interior centres of population and production. Two lines running north from Bogotá were narrowed from metre to three-foot gauge in 1952. In January 1954 nationalization of all railroads was agreed upon. A new railway 418 mi. (673 km.) long was opened in 1961 to connect Santa Marta on the Caribbean with the interior of the country. In 1963 the International Bank for Reconstruction and Development granted a loan to help finance a ten-year program of railway modernization.

Shipping.—Barranquilla, at the mouth of the Magdalena, is the country's largest port. Others include Cartagena and Santa Marta on the Caribbean and Buenaventura on the Pacific, which increased in importance during the 1950s. Frequent and regular ship service by several lines is available to Panama, New York City, New Orleans, and European ports. In 1946 Colombia, Ecuador, and Venezuela formed the Flota Mercante Grancolombiana, which operates a fleet of oceangoing vessels, but in 1953 Venezuela withdrew; Colombia owns 80% of the assets.

Air Transport.—Colombia was the first South American country to develop air transport on a commercial scale. In 1920 a concession was granted to the German-Colombian Company, Sociedad Colombiana-Alemana de Transportes Aéreos (known as Scadta), which was taken over after the outbreak of World War II by Aerovías Nacionales de Colombia (Avianca). After the war, expansion was rapid, and Colombia is now covered by a network of air routes with excellent international connections. In the mid-1960s more than 25 companies were operating in the country with Avianca flying most of the internal routes. The airport at Bogotá is capable of handling jet transports. The number of airfields exceeded 400.

Telecommunications.—Both telegraph and radio systems are government-operated. The larger cities have local telephone services owned by private companies or the municipalities. The national government owns long-distance telephone lines connecting most of the larger cities. External cable communication is through Buenaventura and Cartagena.

See also references under "Colombia" in the Index.

(Dd. H.; R. B. Le.)

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COLOMBIÈRE, CLAUDE DE LA (1641–1682), French Jesuit, who assisted St. Margaret Mary Alacoque (*q.v.*) in establishing the devotion to the Sacred Heart (*q.v.*), was born Feb. 2, 1641, at St. Symphorien d'Ozon in Dauphiné. He received his early education from the Jesuits of Lyons, and entered their novitiate at Avignon in 1658. He distinguished himself in the study of philosophy and literature, winning some renown as a preacher even before ordination. He studied theology at the Collège de Clermont in Paris.

After ordination his first appointment was to the chair of rhetoric in the Collège de la Trinité at Lyons (1670–73). In 1675 he was appointed superior of the small Jesuit college at Paray-le-Monial. There he may be said to have earned his greatest claim to renown by his enlightened spiritual direction of St. Margaret Mary Alacoque. In 1676 he was appointed court preacher to Mary of Modena (Maria Beatrice d'Este), who had become duchess of York by her marriage with the future James II, and in October took up his residence in St. James's palace, London. He remained at this post until falsely accused by a former protégé of complicity in the Titus Oates affair. After an imprisonment of five weeks he was released but was obliged to return to France, where he died on Feb. 15, 1682, of a disease of the lungs contracted before his imprisonment. He was beatified on June 16, 1929.

Colombière's complete works were published in six volumes at Grenoble in 1900–01; they include four volumes of sermons, one of sermon notes and one of correspondence. (W. J. Y.)

COLOMBO, MATTEO REALDO (1516?–1559), Italian surgeon and anatomist, was one of several Renaissance figures who anticipated William Harvey in the discovery of the pulmonary circulation (the flow of blood from the heart to the lungs and return).

He was born in Cremona, studied philosophy and liberal arts in Milan and was then apprenticed to a Venetian surgeon for seven years. Following this, he studied medicine at the University of Padua (1540).

Andreas Vesalius, founder of modern anatomy and then professor of surgery (which included anatomy) at Padua, was impressed with Colombo's skill and appointed him prosector. When Vesalius left Padua in 1543, Colombo succeeded him to the chair. He turned bitterly against his former teacher and was among the most violent of the enemies and detractors whose attacks crushed the spirit of Vesalius.

From Padua, Colombo went to Pisa to become the first professor of anatomy there, and subsequently to Rome. In the capital he taught at the Sapienza, became surgeon to Pope Julius III and prepared his book *De re anatomica* (1559), in which his views on the pulmonary circulation are clearly expressed. This subject had been dealt with in a Spanish publication by Juan Valverde, a pupil of Colombo, who gave full credit for the discovery to his teacher.

Colombo died in 1559.

See E. A. Cappola, "The Discovery of the Pulmonary Circulation: A New Approach," *Bulletin of the History of Medicine*, 31:44–77 (1957). (L. M. Z.)

COLOMBO, the capital and principal seaport of Ceylon, lies on the west coast of the island just south of the mouth of the Kelani river. Pop. (1953) 423,481. It is also the administrative centre of Western province and of Colombo district. The environs of the city are low lying and considerable protective works have been constructed against floods. The climate is warm and humid, the mean temperature being 80.8° F. and the mean annual rainfall 91 in. The oldest part of the city is the *pettah*, where much commercial development took place after World War II. The administrative and commercial buildings are centred in the site of the Fort, built by the Portuguese at the southern end of the present harbour. Queen's house, which is the residence of the governor general, and the main block of government offices are in this area. The law courts stand in the suburb known as Hultsdorf which during the Dutch occupation formed, with Wolfendahl, the principal European quarter. The latter suburb contains the Dutch church. An important Buddhist temple is at Kotahena, and the Ponnambalavanesar Hindu temple is at Kochchikade. The city is well served with several primary and secondary schools. In 1942 the Ceylon University college and the Medical college were merged to constitute the University of Ceylon, and all the faculties except those of engineering and medicine were moved to Peradeniya, near Kandy. In 1959 the Vidyodaya and Vidyalankara *pirivenas* (seats of Buddhist learning) were raised to university status. Vidyodaya university is within the city while Vidyalankara is at Kelaniya, 4 mi. outside. Kelaniya is also the site of a Buddhist temple and is a place of pilgrimage. In the city are the Pasteur institute, the Medical Research institute, the Scientific and Industrial Research institute and a museum. Following Ceylon's attainment of independence in 1948 Independence hall was built in Kandyan style in Independence square. The modern residential part of the city stretches south along a strip of land between the sea and the low-lying land parallel to the coast. Besides the Galle Face esplanade, south of the Fort, the main open spaces are Victoria park, Campbell park, Havelock park, the Havelock racecourse, the Ridgeway golf links and the Colombo oval, the best known of the cricket fields. Mount Lavinia is a favourite sea-bathing and pleasure resort. The suburb of Kotte, 5 mi. from the port, was one of the former capitals of the Sinhalese kings, and the suburb of Mutwal, north of the harbour, is chiefly inhabited by fishermen, many of whom are Roman Catholics.

Colombo is connected by rail with most of the larger towns in the island, including Jaffna and Trincomalee. The Kelani river is spanned by the Victoria bridge, from which roads lead north to Negombo and Jaffna and northeast to Kandy. The New Kelani bridge carries six lanes of traffic. To the south main roads follow the coast to Hambantota and the Kelani valley to Avissawella. The airport at Ratmalana links Colombo daily with several provincial towns and with India, and almost daily with the rest of the world. The Katunayaka airport, used by larger aircraft, is 18 mi. away.

The Port.—Until 1874, when the building of the breakwater and other harbour works were begun in Colombo, Galle (70 mi. S. by rail) was Ceylon's chief port. Although it is one of the biggest artificial harbours in the world (602 ac. at low water), Colombo lacked many of the facilities essential for a large port until 1950, when modernization was begun. By 1957 four quays (Queen Elizabeth, Prince Vijaya, Delft and Mutwal, with a fisheries harbour), an oil dock and an articulated oil boom had been completed. Vessels drawing 34 ft. can enter by the western channel and vessels drawing 29 ft. can enter by the northern channel. Berthing accommodation is available for 45 vessels during the northeast monsoon and 39 vessels during the southwest monsoon. Beira lake and the canal connecting it with the harbour are an integral part of the port. The canal is navigable by 100-ton barges. Colombo is one of the busiest ports in the commonwealth. Its chief exports include tea, rubber, cacao, coir, copra and coconuts; its main imports are rice, cotton piece goods, sugar, milk foods and manures.

Colombo District has three municipal councils, Colombo,

Negombo and Mount Lavinia. Its population was 1,708,726 in 1953 and its area is 808 sq.mi. (M. J. T.)

COLOMBO PLAN, an arrangement for discussing national economic development plans, providing technical assistance and financing particular developmental projects for south and south-east Asia, established at Colombo, Ceylon, in June 1951 following discussions by the governments of India, Pakistan, Ceylon, Australia, New Zealand and Great Britain. Later the United States, Japan and a number of countries in southeast Asia joined the organization.

The basic work is done at one annual meeting. A continuing body deals with technical assistance. Financing of development projects is arranged bilaterally between individual governments or with the International Bank for Reconstruction and Development. *See* Foreign Aid Programs. (C. P. K.)

COLÓN, department on the Caribbean sea in eastern Honduras. Pop. (1961) 40,570; area 3,426 sq.mi. It consists mainly of lowlands, with an annual rainfall of well over 100 in. Most of the population is concentrated in the fertile and less rainy Aguán valley and coastal plain in the northwestern part of the department. Pine savanna on poor soils in the east and mixed hardwoods elsewhere provide lumber for domestic use and for export. Crop production, mostly in the northwest, includes rice, manioc (yuca, cassava), sweet potatoes and bananas, which are exported through the port of Trujillo, the departmental capital (pop. 3,460), and Puerto Castilla. (C. F. J.)

COLÓN, a province on the northern coast of Panamá, lying both east and west of the Canal Zone. Pop. (1960) 103,738; area 2,861 sq.mi. The population, which is about 58% urban, is concentrated in areas near the Canal Zone, where there are also important agricultural districts and some manufacturing establishments. Twenty miles to the east of Colón city, the provincial capital, is Porto Bello (*q.v.*), which during the colonial period was a strongly fortified town at the northern end of the Old Gold road. (C. F. J.)

COLÓN, the second city of Panamá and the northern gateway to the Panama canal. The port of Cristóbal, which is within the Canal Zone, is virtually a suburb of Colón. The great port works and docks built by the U.S. government at Cristóbal make Colón one of the most important ports of the Caribbean sea. A considerable portion of the freight for neighbouring coastal points in Central America and northern South America is transshipped there and other goods are unloaded for storage in the large bonded warehouses within the Canal Zone.

Colón had a population (1960) of 59,032, not including the residents of the Canal Zone, but about 40% of the gainfully employed persons of Colón work in the Canal Zone. Colón is the northern terminus of the Panama railroad, 48 mi. from Panamá city, and is on the modern Trans-Isthmian highway. It is the seat of a customhouse and of consuls of various countries, and is the capital of the province of Colón.

Colón is one of the busiest tourist centres in the world and its streets are lined with shops owned by peoples of all nationalities selling varied products from all over the world. Front street is a well-known shopping centre. The population is largely Negro, chiefly descendants of labourers imported from the British West Indies during the various periods of construction on the Panama canal. The residents include a wide range of racial mixtures and the languages of three continents are heard on the streets.

The town was founded in 1850 at the Atlantic terminus of the original Panama railway, and was first called Aspinwall after William H. Aspinwall (1807–75), one of the builders of the railway. Colón is the Spanish form of Columbus, and the name of the twin city of Cristóbal is Spanish for his Christian name. On the completion of the railway in 1855, Colón attained outstanding importance as compared with the older Caribbean ports of Panamá, and with the first plans for the isthmian canal it took on additional prestige. Prior to the beginning of work on the canal Colón, built on swampy Manzanillo Island, was notoriously unhealthful, and one of the provisions of the canal treaty of 1903 gave the United States full sanitary control over the cities of Panamá. Much of the work of Col. William C. Gorgas (*q.v.*), the sanitary genius of the canal construction, was done in and about Colón, which was given a new system of waterworks and sewerage as well as complete drainage of the surrounding swamps in the triumphant fight against yellow fever and malaria. Colón thus became one of the most healthful tropical cities in the world. Most of the streets of Colón are paved and kept clean.

Colón has large public buildings, several modern hotels, several churches, three modern hospitals and three theatres. *See* Panama Canal. (W. Tho.; W. Ft.; C. F. J.)

COLÓN, ARCHIPIÉLAGO DE: *see* Galápagos Islands.

COLON, in anatomy, the portion of the large intestine that extends from the caecum to the rectum.

See Gastrointestinal Tract.

COLONEL, traditionally the commanding officer of a regiment, is the highest officer rank below the general officer grades in most armies, or below brigadier in the British services. In air forces that use the same titles of rank as the army, such as the U.S. air force, a colonel's command is usually a group; the comparable grade in the Royal Air Force is group captain. When not exercising command of a regiment, group or equivalent formation, a colonel is generally placed in a senior staff or administrative post.

In a U.S. army reorganization announced in 1957 infantry regiments were eliminated as combat units and reformed into battle groups (*see* Regiment), each under the command of a colonel. In an armoured division a colonel's command was called a combat command; it consisted of a variable number of units of mixed forces, including infantry, armour, artillery and supporting services. In the U.S. artillery a colonel's command was called a group and was made up of three or four separate battalions.

A further reorganization of the U.S. army in 1961 called for elimination of the battle group, making the brigade (*q.v.*) the tactical unit between the division and the battalion. The brigade was to be a colonel's command in peacetime, a brigadier general's command in wartime. Divisional support commands and various nondivisional units, usually referred to as groups, were also to be commanded by colonels.

In the 17th and 18th centuries the colonelcy of a British regiment of infantry or cavalry implied a proprietary right in the organization (*see* Officers). Whether or not the colonel commanded the regiment in the field, he always superintended its finances and interior economy, usually to his profit. In time of war the sovereign invariably selected the generals for his armies from among the proprietary colonels. Meanwhile, active field command of such a regiment was exercised by its lieutenant colonel. As the grade of general became permanent, many generals retained their proprietary colonelcies.

All British regiments have a senior officer (serving or retired), styled "colonel of the regiment." His duties are confined to certain specified domestic matters of purely regimental concern. He may be any rank above lieutenant colonel, but is usually a general. (Some corps and regiments have a colonel in chief, who is always a member, male or female, of the British or a foreign royal family. His duties are formal and confined mostly to ceremonial and social occasions.) (T. N. D.)

COLONIA, a department on the Río de la Plata in southwest Uruguay, is important historically and economically. Pop. (1954 est.) 149,386; area 2,378 sq.mi. Its capital, Colonia (pop. [1954 est.] 15,000), the first permanent settlement in Uruguay, was founded by Portuguese soldiers from Brazil in 1680. The Spanish eventually captured Colonia and then moved their defense headquarters to a more strategic location, Montevideo, founded in 1726.

Colonia city, the Uruguayan port closest to Buenos Aires, is a tourist centre and a railroad terminus. Truck farming, dairying, first introduced by Swiss colonists, and textiles make Colonia one of the richest and most densely populated departments in Uruguay. (M. I. V.)

COLONIAL ARCHITECTURE refers, broadly, to the architecture of any people transplanted from a country but remaining subject to it. The peculiar characteristics of colonial architecture result from the attempt to reproduce as closely as

possible the architecture of the mother country in places where labour may be limited, untrained or influenced by native tradition, materials may be different and climate and environment may be unfamiliar. This article is confined to a discussion of North American colonial architecture.

The colonial architecture of early North America was as diverse as the peoples who settled the new continent: English, Dutch, French, Swedish, Spanish, German, Scotch-Irish. Each group brought the style and building customs of the mother country, adapting them as best it could to the materials and conditions of a new land. Thus there were several colonial styles. The earliest buildings of all but the Spanish colonists were medieval in style: not the elaborate Gothic of the great European cathedrals and manor houses, but the simple late Gothic of village houses and barns. These practical structures were well adapted to the pioneer conditions that prevailed in the colonies until about 1700, and few changes were needed to adapt them to the more severe climate. The styles were frank expressions of functional and structural requirements, with only an occasional bit of craftsman's ornament. So far as is known, no single new structural technique or architectural form was invented in the American colonies.

There were seven reasonably distinct regional colonial styles: (1) The New England colonial, visible in almost a hundred surviving 17th-century houses, was predominantly of wood construction with hand-hewn oak frames and clapboard siding; its prototypes are to be found chiefly in the southeastern counties of England. (2) The Dutch colonial, centring in the Hudson valley, western Long Island and northern New Jersey, made more use of stone and brick, or a combination of these with wood; its prototypes were in Holland and Flanders. The style persisted in this region until after the Revolution. (3) The Swedish colonial settlement, established in 1638 along the lower Delaware river, was of short duration, but it contributed the log cabin (in the sense of a structure with round logs, notched at the corners and with protruding ends) to American architecture. (4) The Pennsylvania colonial was late in origin (the colony was not founded until 1681) and rapidly developed into a sophisticated Georgian mode, based on English precedents. A local variant, often called Pennsylvania Dutch, evolved in the southeastern counties where Germans settled in large numbers after 1710. (5) The Southern colonial flourished in Maryland, Virginia and the Carolinas. Story-and-a-half brick houses, sometimes with large projecting end chimneys and decorative brick masonry, prevailed. (6) The French colonial, stemming from medieval French sources, evolved in the maritime provinces and the St. Lawrence valley. The earliest impressive structure was Champlain's Habitation built at Port Royal, Nova Scotia, in 1604. Most of the surviving early houses of New France are to be found in the province of Quebec. The French settled the Illinois country in 1695 and later, using the Quebec style. Far to the south, Louisiana was established as a colony in 1699, and New Orleans became the capital in 1718. There grew up a distinctive regional style in the close-packed streets of the *Vieux Carré* of New Orleans and in the quiet plantations of the bayou country. (7) The Spanish colonial extended geographically and chronologically from St. Augustine in 1565 to San Francisco in 1848. The five great mission fields were in Florida, New Mexico (1598 on), Texas and Arizona (1690 on) and California (1769 on). Unlike other colonial styles, which were medieval, the Spanish colonial followed the Renaissance and baroque styles of Spain and of early Mexico. (*See* IBERO-AMERICAN ARCHITECTURE.)

By 1700 the colonies of the Atlantic seaboard were united under English rule, and the architectural style of the 18th century was completely different from that of the 17th century. *See* GEORGIAN ARCHITECTURE; *see* also references under "Colonial Architecture" in the Index volume.

See Hugh Morrison, *Early American Architecture* (1952).

(HH. M.)

COLONIAL DEVELOPMENT CORPORATION, a British public corporation established under the Overseas Resources Development acts, 1948–58, for the purpose of assisting British colonial territories in the development of their economies. It has borrowing powers to a maximum of £150,000,000 long-term and £10,000,000 short-term outstanding at any one time. It is a commercial organization and is required to pay its way, but there is no share capital; the loan money has been borrowed from the U.K. treasury; interest has to be paid over the life of each loan at the rate current at the time of each advance. On long-term loans interest payments are postponed for the first seven years; loans and interest are repayable by 33 annuities starting in the eighth year.

At the end of 1957 there were 76 projects in hand in 23 territories, covering agriculture, animal products, factories, fisheries, forestry, hotels, minerals, property and housing, electric power, transport and communications. Some were managed by the corporation directly, others by private enterprise associates; some were loans made to industrial concerns and public corporations. Total capital approved for these projects was £80,468,000.

The corporation prefers to arrange for financial participation and management by experienced private enterprise rather than to finance and manage projects on its own. Association with territorial governments is also sought, and fullest possible use is made of local experience and capital.

Corporation directors are appointed by the secretary of state for the colonies and serve part time. Under the general manager are five controllers at the head office, and there are six regional controllers in the Caribbean, far east, east Africa, central Africa, high commission territories and west Africa.

See also BANK FOR RECONSTRUCTION AND DEVELOPMENT, INTERNATIONAL; EXPORT-IMPORT BANK OF WASHINGTON.

(C. W. DN.)

COLONIAL OFFICE: *see* GOVERNMENT DEPARTMENTS: *Great Britain.*

COLONIAL PREFERENCE: *see* IMPERIAL PREFERENCE.

COLONNA, a noble Roman family of great antiquity and foremost in importance, is descended from the 10th-century counts of Tusculum. The first to take the name Colonna ("de Columna") was Piero, the son of Gregorio, count of Tusculum, who on Gregorio's death (*c.* 1064) received the castle of Colonna in the Alban hills, together with Palestrina and other places, as his share of the inheritance. Like other Roman families, the Colonna gained power and wealth through papal favour and by the 13th century were already providing cardinals and senators of Rome. Thereafter the Colonna are so consistently prominent in the politics of the church and the city of Rome that even the most distinguished are far too numerous to name; a detailed record of the family would almost amount to a history of Lazio and of Rome itself. Throughout the middle ages they figure among the most unruly and potent of the Roman baronial dynasties; their feuds with the Caetani and Orsini dominate the local history of a region where feudal power long remained unsubdued. Of more than local importance, however, was their bitter quarrel with the Caetani pope, Boniface VIII, who tried to extirpate the family and drove them into alliance with his enemy, the French king Philip IV the Fair; Sciarra Colonna led the armed attack on Boniface at Anagni on Sept. 7, 1303. On the pope's death the Colonna recovered their lands and influence, and for many years subsequently Rome was harassed by their struggle for power with the Orsini, which divided the nobility into two contending factions. These conditions gave rise to Cola di Rienzi's popular dictatorship, which was a check to all the Roman magnates and notably the Colonna, over whom the tribune won a bloody victory at Porta San Lorenzo in Rome on Nov. 20, 1347. The check, however, was temporary; Colonna power was undiminished and not long after was signally increased by the election at Constance of Cardinal Oddone Colonna as Pope Martin V. During his pontificate (1417–31) Martin obtained the grant of fiefs for his family in southern Italy and enriched them with vast estates in papal territory, which included Frascati, Paliano, Genazzano and many other places. Their power was challenged by Martin's successor, Eugenius IV, and for well over a century the fortunes of the Colonna continued to be disturbed by conflict with the popes; but from the later years of the 16th century they lived in unbroken peace with the papacy, and many members of the family rose to eminence as prelates,

soldiers and statesmen in the service of the church as well as other powers, particularly Spain.

The surviving branches of the family comprise the Colonna di Paliano, the Colonna di Stigliano and the Barberini-Colonna di Palestrina, who took the surname Barberini in consequence of the marriage of Giulio Cesare Colonna, prince of Carbognano, with Cornelia Barberini in 1728.

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COLONNA, VITTORIA (1492–1547), Italian poet whose contemporary reputation derived more from her personal than her literary gifts, and whose permanent fame is assured by her friendship with Michelangelo (*q.v.*), was born in Marino, near Rome, the daughter of Fabrizio Colonna, grand constable of the kingdom of Naples, and Agnese di Montefeltro, daughter of Duke Federigo d'Urbino. In 1509 she married the marquis of Pescara, who died in 1525. A lady of intelligence and learning, much given to meditation and possessing a deeply emotional nature (held in check by her aristocratic education), she was ranked during her lifetime above all other contemporary women writers. Both her religious and her love poems, written according to the Petrarchan pattern, are, however, disappointingly conventional. Even her letters are uninteresting, although, except for those addressed to distinguished people, such as the two to Charles V, they were not originally meant for publication (only ten were published during her life). She owes her lasting renown to her Platonic friendship with Michelangelo and to her interest in such religious reformers as Juan de Valdés and Bernardino Ochino. After having retired to live in the Benedictine convent of Sant' Anna de' Funari, she died in the Palazzo Cesarini, Rome, on Feb. 25, 1547.

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COLONNADE: *see* COLUMN; ORDER.

COLONSAY AND ORONSAY, islands of western Scotland within the Jura and Colonsay district, lie 35 mi. S.W. of Oban, Argyll, facing the open Atlantic ocean. Population of the district in 1961 was 420. The islands (area 17 sq.mi.) are named for Saints Columba and Oran and are rich in archaeological and medieval Christian remains. They are separated by a narrow sound and are joined at low tide. Although the surface is generally rough, there are several farms and the tillage ratio to total area is 1: 56. Soil is derived from the lower, more fertile strata of the Torridonian sandstone. There is still some natural scrub woodland, a rare phenomenon in the Hebrides. The garden of Colonsay house (1722), of great beauty, enjoys such shelter that many exotics are grown. A large and old-established colony of Atlantic seals occupies the southwest of Oronsay. A weekly steamer from Oban stands by if the weather allows. (F. F. Dg.)

COLONY is a term having two distinct meanings. Sometimes it is used to describe the compact settlement of a group of nationals of one country within the territory of another while the settlers remain loyal to the mother country. Thus writers refer to German colonies in Brazil and Chinese colonies in Indonesia. More frequently, however, colony refers to a nonself-governing territory and has become a term denoting disapproval and impatience among critics of European overseas policy with the political status of certain such territories in Asia, Africa and the Caribbean. This status is said to be the result of colonialism or imperialism, processes increasingly considered immoral and illegal by many nations and the subject of constant bitter debate among governments after World War II.

Definitions of colony differ appreciably according to the political opinions held. The modern colonial powers—Great Britain, France, the Netherlands, Belgium, Portugal, Australia and the U.S.—prefer a definition derived from their national laws. A colony, also described as a dependency without full self-government, is considered by the various governing powers to be a territory under the administrative jurisdiction of the mother country, prevented by social, economic and political backwardness from being fully in charge of its own decisions. Laws are made by the mother country and enforced by officials sent out from there, even though the colony may enjoy representation in the home legislature (the French and Portuguese practice). Critics of modern colonialism, and especially the peoples of Asian, African and Latin-American countries, on the other hand, prefer a more sweeping definition. They consider a colony any territory that is under the overwhelming economic or political influence of another country. Thus they considered China between 1900 and 1930 as a colony of the west because of the economic dominance of certain European and American countries and the impotence of the central Chinese government, sovereign though it was in law; and they demand the progressive eradication of such conditions of influence. Further, they insist that colonial status involves the imposition of decisions by one people upon another, regardless of whether the territory inhabited by the subject people has been formally annexed or not.

Independent observers prefer a third definition. A colony is any territory in which the conditions of life—social, economic, political—are defined in considerable measure for the whole population by a minority different from the local majority in culture, history, beliefs and often race. This definition would include the bulk of the territories considered legally as colonies but would exclude some of the more sweeping claims of anticolonists. It covers the relationships established by the Soviet Union over central Asia and the Baltic littoral, by Nazi Germany over the bulk of Europe during World War II and by Japan over east Asia between 1931 and 1945.

History.—The establishment of colonies is as old as the recorded political history of man. Ancient Egyptian, Persian, Indian, Greek and Roman conquests usually involved the establishment of colonial relationships with the conquered, though the forms and intensity differed considerably. Later, Arab, Mongol and Chinese expansion into neighbouring countries had similar results. The period of western colonialism had its origins with the European Renaissance, the development of modern science, the great voyages of discovery and the concurrent existence in Spain, Portugal, England and France of soldiers, nobles, priests and merchants eager for foreign action, trade and missionary efforts. The period began about 1450 and reached its climax around 1900, when the last independent nonwestern territories were parceled out. Following World War I the reverse process of developing colonial resentment and desire for independence manifested itself in the growth of nationalism in Africa and Asia, with the result that colonial empires shrank rapidly.

However, even before the climax was reached, important changes occurred in colonial relations. The European powers fought many wars among themselves for trading monopolies with colonies and for the staking out of exclusive claims. When the Industrial Revolution overtook Europe after 1800, the technological advantage of the west made colonial conquest and rule in Africa and Asia much simpler, and it added the desire for markets, sources of raw materials and investment outlets to the previous motives for expansion. Between 1770 and 1820 certain colonies settled largely by emigrants from Europe grew increasingly impatient with government imposed from the mother country and successfully revolted; this resulted in the independence of the United States and of the Latin-American countries, and incidentally the virtual end of the Spanish colonial empire, and removed most of the western hemisphere from direct European control. British statesmen during the 19th century profited from the lesson and adopted a policy of granting self-government and independence to all European-settled colonies as rapidly as practicable. Thus Canada, Australia, New Zealand and the Union of South Africa by 1926 had evolved from colonial status, via full internal self-government, to complete sovereignty. At the same time they consented to accept the ruling monarch of Britain as their own and to remain closely allied militarily and commercially with the other country. Thus was

born the Commonwealth of Nations, a voluntary association of independent countries formerly colonies of Britain and unwilling to sever the imperial tie entirely. (*See* also COMMONWEALTH OF NATIONS.)

Colonial Policies.—*Great Britain.*—The hope of persuading its restive non-European colonial subjects to remain affiliated with Britain through the commonwealth at mid-20th century dominated British colonial policy. Long-range aims of policy included: (1) education designed to train a class of native leaders capable of manning the institutions of self-government and a modern economy; (2) economic development and foreign investment to raise living standards and to develop agricultural, mining and simple industrial facilities sufficient to assure the colony an income from world markets when it achieved independence; and (3) the gradual introduction of political self-government, progressing from self-rule at the village and district level to the creation of colonial legislatures with elected majorities and increasing autonomous powers, and ending with the choice of a native cabinet from among the freely elected parliamentarians. At that stage independence has been attained; the former colony is free to decide whether to remain in the commonwealth; thus Burma and Ireland declined, others accepted. Britain sought to export its values and institutions but permitted native groups to adapt these to their needs as they saw fit. Colonial reforms were sometimes hastened by unrest in the colonies and by pressures from the United Nations.

France.—French practice was different. For many years France denied the possibility of adaptation and autonomous development for its colonies and insisted on the full assimilation of colonial inhabitants and their territory into the French cultural and political system. There was no local self-government. Administration was controlled centrally from Paris, and educational policy was designed to train a small elite of colonial subjects as good Frenchmen. After 1945, however, "assimilation" as a goal gave way to "association." France in the period following World War II conceded full independence to Indochina, Morocco and Tunisia, though the concession came about only as a result of war or the threat of it. France also admitted that more extensive self-government within the federal French union was desirable and accordingly widened the franchise in colonies, reduced the privileges of French-identified natives and increased local legislative and executive powers. Wishing to avoid full independence for its remaining colonies, France preferred a federal tie through colonial and metropolitan representation in the purely advisory organs of the French union, special military and economic ties with Morocco and Tunisia and the closest possible relations with Algeria. As in the case of Britain, the severest cases of colonial conflict occurred when the metropolitan government sought to mediate between nationally self-conscious natives and sizable groups of European immigrants unwilling to adjust to African nationalism.

The constitution of the fifth republic of France, promulgated Oct. 4, 1958, provided for self-determination on the part of Overseas Territories. Of the 18 existing at the time only Guinea chose complete independence with no association with France. Five voted to remain as Overseas Territories and the remaining 12 (all African) voted to become autonomous republics within the new French Community. These, while continuing their association with France through the community, became independent by the end of 1960. (*See* also FRENCH COMMUNITY.)

Others.—Portugal insisted that its colonies were provinces of the mother country and in no sense subordinate to it; it maintained intact a doctrine and policy of assimilation characterized by little education, economic development or political evolution. Belgium fostered the rapid industrial and commercial development of the Congo but did not begin a process of technical and political education for the native population until some five years before independence was granted in 1960. The United States contemplated that its principal possessions should either be admitted to the union (as occurred with Alaska and Hawaii in 1959) or achieve self-government accompanied by commercial, military and foreign policy links with Washington (Puerto Rico). For its Pacific ocean possessions and trust territories, on the other hand, the United States had no plans for independence. As for the Soviet Union, it denied having colonies and insisted that culturally non-Slav areas were freely federated with the totality. Its policy in central Asia combined systematic communization of tribal and Islamic socioeconomic institutions with a shifting policy of encouraging, alternately, local cultural autonomy and russification.

Soviet control in eastern Europe is not usually so exercised as to make these countries fall under this definition of colony.

International Supervision.—With the establishment of the United Nations, colonial policy was declared a matter of interest to the entire world; concurrently the term nonself-governing territory was substituted for colony in official discussion. In the case of the former Italian colonies in Africa, for instance, the United Nations itself decided on the independence of Libya and Somalia and the federation of Eritrea with Ethiopia; it subsequently supervised the political and economic development of those countries to full nationhood. According to the United Nations charter, colonial powers must administer all their possessions so as to stress the progress of the indigenous population. Further, they must report annually to the general assembly on steps taken to implement the obligation. The duty to report gradually was extended as a result of pressures of the anticolonial nations to include the submission of information not initially required and even the hearing by the general assembly of petitioners from the colonies.

The UN charter permitted the voluntary placing of territories under the trusteeship system (*q.v.*), by which the administering country promised, in terms of specific agreements, to advance the colony to self-government or independence, to administer it in accordance with internationally defined standards, to permit visiting United Nations missions to inspect progress, to report annually and to submit to questioning and to grant colonial subjects the right to petition the UN. Seven colonies in Africa and four in the Pacific ocean, with an aggregate population of about 20,000,000, were at one time under the system. Several subsequently achieved independence or joined neighbouring colonies that had attained statehood, in all cases under close UN supervision. However, no colonial power by the early 1960s had voluntarily placed under the trusteeship system any colony that had not been previously seized from another colonial power as a result of war, and it had not proved possible to extend the system to other tension areas.

There can be no doubt that the United Nations supervisory system, articulated by the majority of anticolonial nations even when specific recommendations of the United Nations were ignored, spurred steps toward colonial self-government and independence by France, Britain, Belgium and the United States. *See* EMPIRE; IMPERIALISM; MANDATE; UNITED NATIONS; *see* also references under "Colony" in the Index volume.

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COLOPHON, an ancient city of Ionia, situated inland about 15 mi. N.W. of Ephesus. Its port was at Notium. The site lies near Degirmendere. Excavation of the ancient city (by the American School of Classical Studies at Athens and the Fogg Art museum, Harvard university) began in 1922. Colophon was a very flourishing city in the 8th and 7th centuries B.C., a great period of Ionian commercial enterprise. It was the mother city of Smyrna; it was ruled by a timocracy; and it provided a famous troop of cavalry. It was famous for its luxury, imitated from the Lydians. It claimed to have produced Homer, but its greatest genuine literary names were Xenophanes and Antimachus (*qq.v.*).

The first shock to its prosperity was the assault by Gyges of Lydia *c.* 665 B.C. Lysimachus, one of Alexander the Great's generals, transferred the population to his new city at Ephesus; but the Colophonians returned after his death in 281 B.C. Subsequently the old city declined in favour of Notium (New Colophon). Near Notium was the important shrine of the Clarian Apollo, whose temple and oracle were being excavated in the early 1960s.

See *Art and Archaeology,* vol. xiv, pp. 256–260 (1922); *American Journal of Archaeology,* 2nd series, vol. 27, pp. 67–68 (1923).

COLOPHON, a final paragraph giving particulars of title, authorship and other matters, sometimes found, from the 6th century onward, in medieval and Renaissance manuscript texts, and frequently in early printed books. In manuscripts a colophon was occasionally added by the scribe, giving his name, the date and place of completion of the work and a pious expression of thanksgiving for the end of his task. In printed books the author's colophon, when present, is sometimes separate from, and sometimes incorporated in, the printer's colophon, which may give some or all of the following information: the date and place of printing, the names of the printer and, when applicable, of his partner, financial backer, patron, publisher, editor or proofreader, and other circumstances connected with the printing of the work. At its fullest the colophon thus gives considerably more information than the title page which later took its place; moreover, although first found in a printed book in 1463, the title page is infrequent before the 1490s and does not normally replace the colophon until after 1520. The colophon is therefore one of the chief primary sources of information, not only for the printing of individual books, but for the whole history of early printing. Its lack is felt in those 15th-century books (approximately one-third) which do not contain a colophon, and which must therefore be laboriously assigned to printer, place and date by examination of their type.

The first printed colophon, which also contains the first printed date of completion, occurs in the 1457 Psalter produced by J. Fust and P. Schöffer at Mainz:

> The present copy of the Psalms, adorned with beauty of capital letters and sufficiently picked out with rubrics, has thus been fashioned by an ingenious method of printing and stamping without any driving of the pen, and to the worship of God has been diligently completed by Johannes Fust, citizen of Mainz, and Peter Schoeffer of Gernsheym, in the year of the Lord 1457 on the Vigil of the Assumption [*i.e.,* Aug. 14].

The use of the colophon has often been revived in modern times, for the sake of its convenience, pleasant appearance and historical links with the golden age of early printing, by fine printers such as William Morris at the Kelmscott press and C. H. St. John Hornby at the Ashendene press. The word colophon is borrowed from the Greek for "a summit," and hence came to mean a finishing touch. It is first used in English in the latter sense in Robert Burton's *Anatomy of Melancholy* (1621), and with its full bibliographical meaning by Joseph Ames in his *Typographical Antiquities,* p. 20 (1749).

See A. W. Pollard, *An Essay on Colophons* (1905); R. S. Grannis, "Colophons," in *The Colophon,* part 1 (1930). (G. D. P.)

COLORADO, a tribe of South American Indians, so named because of the unusual amount of red paint (Spanish, *colorado,* "red") with which they decorated their bodies.

Although traditions depict the highlands as their original home, their way of life indicates a long period of adjustment to their present habitat, the lowland tropical forests of northwestern Ecuador. Deriving their subsistence from agriculture and from hunting and fishing, they devote considerable effort to collecting forest products which are traded for steel tools and other manufactured goods.

There are no true villages, and although there is some economic co-operation among neighbouring families, in most respects the inhabitants of the scattered homesteads are independent of one another. Converted to Christianity at an early date, the Colorado practise many Roman Catholic rituals. However, they also believe that disease is due to witchcraft, and treatment is based on magical procedures.

See John Murra, "The Cayapa and Colorado," *Handbook of South American Indians,* ed. by Julian H. Steward, Bureau of American Ethnology, Bulletin 143, vol. 4, pp. 277–291 (1948). (SE. L.)

COLORADO, known as the "Centennial state" because of its entrance into the union in 1876, 100 years after the signing of the Declaration of Independence, a state of the United States, is bounded on the north by Wyoming and Nebraska, on the east by Nebraska and Kansas, on the south by Oklahoma and New Mexico and on the west by Utah. It is the 8th largest state, having an area of 104,247 sq.mi., and was the 38th state admitted to the union. The state capital is Denver. The state flower is the Rocky mountain columbine; the state tree, the Colorado blue spruce; and the state bird, the lark bunting. The state motto is *Nil Sine Numine* ("Nothing Without the Deity").

PHYSICAL GEOGRAPHY

Physiography.—Colorado, which is situated between approximately 37° and 41° N. lat. and 102° 3′ and 109° 3′ W. long., consists of three topographic zones—mountains, plains and plateaus. The mountains are the dominating feature of the state. They gather the snows to feed the rivers that irrigate the land, and they hold the gold and silver veins that attracted the first settlers; their majestic beauty draws thousands of visitors to the state annually. Fifty-five named peaks rise above 14,000 ft., and more than 1,000 reach above 10,000 ft. The mean elevation of the state is 6,800 ft. The mountain zone, running north and south through the middle of the state, is a complex system of ranges and cross spurs. The Front range, running from Wyoming to Pikes peak, continues to New Mexico as the Sangre de Cristo (Blood of Christ) range. Longs peak (14,255 ft.), Mt. Evans (14,260 ft.), Pikes peak (14,110 ft.) and Blanca peak (14,317 ft.) are outstanding along this chain. West of the Front range is the Park range, extending from near Wyoming to the head of the Arkansas river. West of the upper Arkansas is the Sawatch range, containing Mt. Elbert, the highest peak in the state (14,431 ft.), and the Collegiate range—Mts. Harvard (14,420 ft.), Yale (14,196 ft.), Columbia (14,073 ft.), Princeton (14,197 ft.) and Oxford (14,153 ft.). West of the Sawatch range are the Elk mountains, from which rise Maroon (14,158 ft.) and Snowmass (14,077 ft.) peaks. The San Juan mountains are a massive rugged group in the southwest portion of the state. They contain many high and precipitous peaks, among which are Uncompahgre (14,301 ft.), Sneffels (14,150 ft.) and Wilson (14,246 ft.).

The plains stretch eastward from the base of the Rocky mountains. This region was for centuries a treeless, grass-covered area, dotted here and there with isolated buttes and ribboned with the white sandy beds of intermittent streams. The shallow valleys of the Platte and the Arkansas rivers, and the low divide between them, are the most prominent features. The region is a part of the land once known as the "great American desert," inhabited by vast herds of bison and tribes of nomad Indians. By mid-20th century, however, six lines of railroads and hundreds of miles of excellent highways crossed the region; thin threads of irrigation ditches wound out from the river channels onto the uplands, enclosing irrigated areas rich with sugar beets and alfalfa; and scientific dry farming had made a checkerboard of the wheatfields and cornfields on large areas of the high plains.

The plateau region of western Colorado consists of a series of mesas or plateaus that decline gradually toward the western border of the state. The White River, Yampa, Roan and Uncompahgre plateaus, the Grand and the Battlement mesas and the Danforth hills are the most notable elevations. Cut by numerous deep valleys and canyons, the plateau country has a comparatively small area suitable for agriculture, but the broader valleys are peculiarly adapted to fruit growing, and horticulture ranks high among the industries of the region. Large areas of stratified plateau consist of vast oil-shale deposits, portions of which have been set aside as an oil reserve for the needs of the U.S. navy.

Colorado is called the mother of rivers. From the snowbanks of the continental divide, great streams radiate like the spokes of a wheel. One system of streams ultimately reaches the Mississippi river, another courses southward through the Rio Grande to the Gulf of Mexico, while a third flows westward through the

Colorado to the waters of the Pacific. The principal rivers of the eastern slope are the North Platte, South Platte and Arkansas; those of the western slope are the Colorado and Green and their tributaries—the Yampa, White, Gunnison, Dolores and San Juan. All of these streams, in the mountainous region near their sources, have cut deep and rugged canyons through upland ranges and spurs. The Royal gorge of the Arkansas river is spanned by one of the highest suspension bridges in the world. The Black canyon of the Gunnison river, Gore canyon, Yampa canyon and others are equally majestic. Although the rivers are not navigable, they have determined the routes of land transportation, the areas of irrigated agriculture and the location of cities and towns.

Climate.—Colorado is noted for its climate and atmosphere. The normal atmospheric pressure in Denver, at 5,280-ft. elevation, is 12.2 lb. per square inch, considerably lower than average for the U.S. The average annual humidity there, at noon, is 38%. There is a wide variation in the normal monthly and annual mean temperatures in different parts of the state because of the altitude. Through a 62-year period Colorado's mean temperature was 45.2° F.; the highest was 115° and the lowest −54°. Winter temperatures are usually mild, with extreme cold seldom lasting more than a few days.

Colorado is a semiarid state, the average precipitation being about 17 in.; but there is a wide variation, 7 to 60 in., in different sections. The winter snowfall varies almost directly with the altitude, five times more snow falling on the 14,000-ft. peaks than on the 5,000-ft. plains. There are active glaciers and permanent snow beds in the north central part of the state. As a result of the high altitude and low humidity, there is a great range of temperature. In summer there is a marked difference between the temperatures in the sun and in the shade; the nights are always cool.

Plant and Animal Life.—The great differences of altitude have caused wide variations in vegetation and animal life. In the high mountains are plant species typical of the far north; in the arid south and southwest, desert types exist. Variations of life types, caused by altitude, are especially noticeable in the belts of trees at various elevations in Colorado mountains—from the cottonwoods on the plains, through the yellow pine, aspens and Engelmann spruce, up to the treeless region above timber line. Animal life is not completely stratified, but it shows considerable variations with the elevation.

Buffalo and beaver are animals that particularly affected the history of the region. Until replaced by range cattle, the American buffalo (bison) provided the food supply for the Indians and meat for early settlers. The beaver attracted the trappers who became the first explorers of the region. Deer have continued from the beginning as important game animals; fish also lure sportsmen.

Parks and Monuments.—There are two national parks and six national monuments in Colorado. The Rocky Mountain National park (*q.v.*) contains a 35-mi. chain of giant peaks within its 405-sq.mi. expanse. More than 350 cliff dwellings, 400 mesa-top pueblos and several hundred pit dwellings are included within the more than 50,000 ac. of Mesa Verde National park (*q.v.*). The remains of prehistoric dwellings are preserved in Hovenweep and Yucca House National monuments. Colorado National monument, an 18,000-ac. area, contains beautiful canyons, monoliths, petrified woods and prehistoric remains. Rich fossil beds have been preserved in Dinosaur National monument (*q.v.*).

More than 80 sq.mi. of sand dunes were incorporated in the Sand Dunes National monument, and the spectacular Black canyon on the Gunnison river was placed under the administration of the national park service in Gunnison National monument. Two former national monuments, Wheeler and Holy Cross, were incorporated in national forests.

The national forests, embracing most of the mountain region, cover one-fifth of the state.

HISTORY

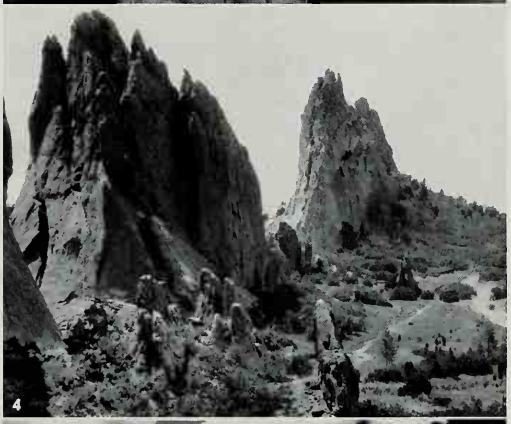
Colorado was acquired by the United States in three successive waves of westward expansion. The portion north of the Arkansas river and east of the meridian of its head was acquired by the Louisiana Purchase (*q.v.*) in 1803, but its exact boundary was not established until 1819, when the western boundary of the United States was incorporated in the treaty with Spain. The boundary of the United States was extended farther westward in 1845, with the admission of Texas. By a boundary adjustment between that state and the federal government in 1850, a strip of territory between the Rio Grande and the present boundaries of Texas became a part of the public domain. The territory west of the Rio Grande was included in the Mexican cession of 1848.

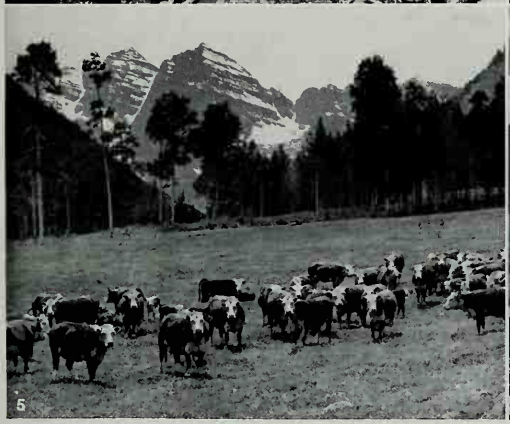
Prehistory and Exploration.—Before the arrival of the first explorers Pueblo Indians lived in southwestern Colorado, and impressive ruins of their communal houses (originally constructed within the caves by their predecessors, the Basket Makers, as early as 500 B.C.) are preserved in Mesa Verde National park and adjacent areas. When the first white men arrived from Mexico, nomad Indians occupied the land: Cheyennes and Arapahoes roamed the region east of the mountains and Utes inhabited the mountain and plateau areas. (*See* also INDIAN, NORTH AMERICAN: *Culture Provinces: The Southwest.*)

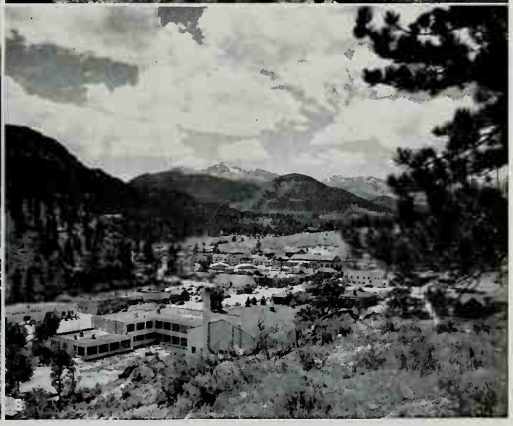
Francisco de Coronado appears to have touched the southeast corner of Colorado on the return journey of an expedition (1540–42) that pushed as far as Kansas vainly seeking the fabled Seven Cities of Cibola. Failure to find treasure checked exploration for a time but after Juan de Oñate started a colony in New Mexico in 1598 occasional prospectors and herders entered the Colorado region. More than a century later (1706) Juan de Ulibarri pursued runaway Indians into eastern Colorado and took formal possession of the country for the king of Spain. The Silvestre de Escalante-Francisco Dominguez expedition, seeking a route to northern California, first explored western Colorado in 1776. It was the fur trade that took the first American, James Purcell, into the Colorado region in 1803. In 1806 Lieut. Zebulon M. Pike followed the Arkansas river into Colorado, incidentally sighting the famous peak that bears his name. Maj. S. H. Long led a government expedition up the Platte river and to the Rockies in 1820. Unimpressed with the high plains country, he labeled it the "Great American desert."

Other official expeditions, led by Henry Dodge (1782–1867), Lieut. John C. Frémont (*q.v.*) and Capt. John Gunnison (1812–53), explored the region. Even more important pathfinders, perhaps, were the trappers and traders. Kit Carson, Jim Bridger, Tom Fitzpatrick and their daring companions first thoroughly learned the geography of Colorado. But the development of the Colorado region was slow until the discovery of gold in 1858. From 1804 to 1854 the whole or parts of Colorado were included, nominally, in about six territories carved successively out of the trans-Mississippi country; but not one of these had any practical significance for an uninhabited land. In the 1830s fortified trading posts were established in the region. Named for their founders, these adobe posts—Ft. Bent, Ft. Lupton, Ft. Vasquez and Ft. Robidoux—were the first white habitations in Colorado. Then in 1846–47 the Mormons settled temporarily at the old Mexican town of Pueblo. Frémont had explored the region in 1842–43 and 1845 (and unofficially in later years for railway routes), and gave more trustworthy reports of the country than had his predecessors. Commerce in these years centred in the (New) Mexican town of Taos. Upon some Mexican land grants in southern Colorado the beginnings of permanent settlement were made; San Luis in 1851 was the first.

From the Gold Rush to Statehood.—A party of Cherokees on their way to California found a little gold near the site of Denver in 1850; but not until the coming of a large prospecting party in 1858 did real development begin. The company, led by Green Russell of Georgia, discovered the first paying placer; and news of this caused the gold rush of 1858. At first there was grave disappointment among the gold seekers, but on May 6, 1859, John H. Gregory found the first gold-bearing vein. Julesburg, in the extreme northeast corner, at the intersection of the Platte valley and the overland wagon route, became transiently important during the rush of settlers that followed. Emigration from the east was stimulated by the panic and hard times following 1857. During 1860–62 there was a continuous stream of immigration. Denver (under its present name), Black Hawk, Golden, Central City, Mount Vernon and Nevadaville were all founded in 1859; Breckenridge, Em-





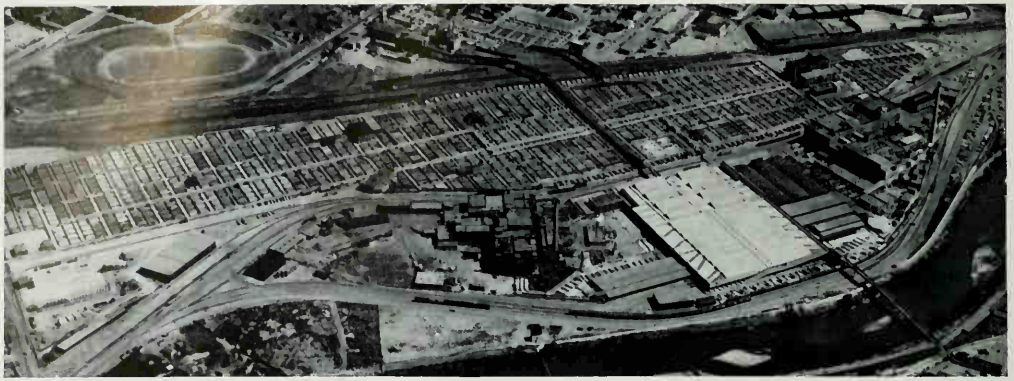


BY COURTESY OF (1) THE COLORADO STATE PLANNING COMMISSION, (2, 3, 5, 6) DENVER CONVENTION AND VISITORS BUREAU; PHOTOGRAPHS (1) JOHN WHEELER, DENVER, (3, 5, 6) O. L. HOPWOOD, (4) EWING GALLOWAY

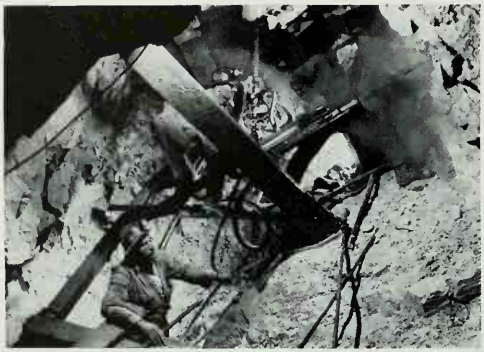
SCENES IN THE COLORADO ROCKY MOUNTAINS

1. Mountain stream in Lake county, bordered by aspen and pine trees, typical of Colorado mountain scenery
2. The columbine, adopted in 1899 as the state flower of Colorado. It is found in profusion at elevations of 6,000 ft. and higher
3. Pikes Peak in the Front range of the Rocky mountains, El Paso county; the elevation is 14,110 ft.
4. Sandstone spires in the Garden of the Gods, near Colorado Springs, 70 mi. S. of Denver. This tract, owned by the city of Colorado Springs, includes about 500 ac. of ridges and grotesque shapes of brightly coloured sandstone
5. Hereford cattle grazing on a mountain range near Aspen
6. Estes Park village (foreground) at the east gateway to Rocky Mountain National park. In the background are the snow-capped peaks of the continental divide

COLORADO



Union stockyards at Denver, the largest sheep market in the U.S., and one of the largest cattle markets



Mining molybdenite at Climax, the world's principal producing source of this mineral which yields the element molybdenum, used in steel and iron alloys

Stockpiling gilsonite at refinery after receiving it through pipeline from mine. Gilsonite is a solid—an asphaltite—which yields high-grade coke and gasoline when refined. The mines are on the Colorado-Utah border

Stacks of wheat on Colorado prairie lands, with the Rocky mountains in the background. Wheat is the chief agricultural crop of the state

ASPECTS OF THE ECONOMY OF COLORADO

BY COURTESY OF (TOP, BOTTOM) COLORADO DEPT. OF PUBLIC RELATIONS, (CENTRE LEFT) CLIMAX MOLYBDENUM COMPANY, PHOTO BY R. Y. RICHIE, (CENTRE RIGHT) AMERICAN GILSONITE COMPANY

pire, Gold Hill, Georgetown and Mill City were founded in 1860 and 1861.

The political development of the next few years was complicated. "Arapahoe county," including eastern Colorado, was organized as a part of Kansas territory in 1858, but a delegate was also sent to congress to work for the admission of an independent territory (later called Jefferson). The next year a movement for statehood was inaugurated, a constitution being framed and submitted to the people, who rejected it, adopting later in the year a constitution of territorial government. Accordingly the territory of Jefferson arose, claiming to extend over 6° of latitude (37°–43°) and 8° of longitude (102°–110°). There was the Kansas territorial government also, under which a full county organization was maintained.

Finally claims clubs and miners' and peoples' courts, organized by the pioneers and acting wholly without reference to Kansas, and with little reference to the local "provisional" legislature, secured justice in the mining country. Finally the U.S. congress established the Colorado territory, Feb. 28, 1861. Abraham Lincoln appointed William Gilpin as the first governor and the first legislature divided the territory into 17 counties, enacted civil and criminal codes and passed needed legislation. Colorado City, the first capital, was replaced by Golden in 1862. In 1867 Denver was made the temporary seat of government (in 1881 permanently, by vote of the people).

During the 1860s the development of Colorado was slow. The American Civil War drew men away; the deepening mines encountered refractory ores and a mining slump occurred. In 1862 some Texas forces were defeated by Colorado forces in an attempt to occupy the territory for the Confederacy. From 1864 to 1870 there was trouble with the Cheyenne and Arapaho Indians and a general Indian war threatened the settlements. An attack by federal troops on an Indian camp in Kiowa county in 1864 became known as the Sand Creek massacre. This was the darkest period in the state's history. In the 1870s conditions rapidly improved. The Indians were removed; successful smelting of refractory ores was devised; the first railroads came (1870); farming increased; and agricultural colony towns were founded. New mining regions were opened in the San Juan area and at Leadville, and the population increased nearly fivefold in the decade.

By 1867 the Republican party had prepared for the admission of Colorado as a state, but the enabling act was vetoed by Pres. Andrew Johnson. Finally, under a congressional enabling act of March 3, 1875, a constitution was framed by a convention at Denver (Dec. 20, 1875 to March 14, 1876) and adopted by the people July 1, 1876. The admission of Colorado to the union was thereupon proclaimed on Aug. 1, 1876.

In the 1880s the railroads were extended into the mountains and trunk lines were built. Dry farming was developed on the eastern plains. Iron production was begun at Pueblo and manufacturing plants were constructed in Denver. Most of the Utes were removed from the state in 1881 and the western slope was opened to settlement. Aspen was added to the mining areas. Then came the demonetization of silver with a resultant mining slump in all the silver-producing states in the 1890s and the nationwide panic of 1893. However, the discovery of gold at Cripple Creek in 1891 and the opening of a great mining camp there promised revived confidence and improved conditions.

After Statehood.—For a considerable time the history of the state was identified with that of its great mining camps. After 1890 industrial conditions were confused and development retarded by strikes and lockouts in the mines, particularly in 1893–94, 1896–97 and 1903–04, when martial law was several times necessary. Questions of railways, franchises, union wage scales and sheep and cattle interests entered into the political and economic troubles of these years. The Colorado labour wars were among the most important struggles between labour and capital, and afforded one of the most sensational episodes in the story of all labour troubles in the United States in those years. Following the repeal of the Sherman act in 1893 (*see* BIMETALLISM) the silver question became the dominant issue in politics, resulting in the success of the Populist-Democratic fusion party in three successive elections and permanently and greatly altering prior party organizations. In the first half of the 20th century the two major parties became rather equally balanced in strength, control of the state administration alternating between the Republicans and the Democrats. In 1899 the cultivation of sugar beets, made practicable by extensive irrigation, was introduced and soon became an important agricultural occupation (see *Agriculture*, below).

The eastern plains of Colorado have been affected by periodic droughts. The severity of the drought of 1932–37 was such as to develop a large "Dust bowl" region and cause the abandonment of some areas. The introduction of the automobile caused a great transformation of social and economic life, brought in new services and added the important industry of highway construction. The mechanization of farming released labour from rural areas, while the growth of manufacturing, trade and the professions drew increasing population to the cities. World Wars I and II caused far-reaching transformations. The great depression of the 1930s affected every citizen by its widespread unemployment and the slump in trade and industry. The prosperous times at mid-20th century restored general prosperity to the state and its people. Denver especially experienced business expansion and booming real-estate growth, as it developed into a regional distributing point and business-management area and a headquarters of federal governmental agencies.

GOVERNMENT

Executive, Legislative and Judicial.—The constitution of the state of Colorado, adopted in 1876, provided for the three departments of government—executive, legislative and judicial. The executive officials—governor, lieutenant governor, secretary of state, treasurer, auditor and attorney general—were to be elected for two-year terms. By constitutional amendment in 1959 the terms were extended to four years. The superintendent of public instruction was at first an elected political official, but in 1948 a constitutional amendment provided for the election of a five-member board of education to choose a nonpartisan commissioner of education.

The legislature is composed of two houses: the senate with 35 members elected for four-year terms; and the house of representatives of 65 members elected for two-year terms. In 1963 the house was reapportioned by population, and in July 1964 the senate also was reapportioned on that basis; the four congressional districts had been reallocated by population earlier in 1964. The legislature met biennially until 1951; thereafter annually. Women's suffrage was adopted in 1893. Initiative and referendum measures were added to the constitution in 1910.

The judicial department comprises a supreme court of seven members, elected for staggered terms of ten years, and district, county and justice courts.

Finance and Taxation.—After mid-20th century the state's annual receipts from all sources amounted to more than $350,000,000. In addition, about $60,000,000 annually came from the federal government. Principal sources of state revenue included taxes on property, sales, income (including corporate income), liquor, inheritances, gifts and motor fuel. The state's expenditures totaled more than $350,000,000 annually, but the state had no bonded debt. In the 1960s approximately 35% of the state's revenues was spent on education, about 20% on highways, about 15% on public welfare and about 5% on health and hospitals. By the 1960s the state's income was about five times as great as it had been prior to World War II. Over the same period per capita income increased about 400%, and approached $2,000, just below the national average.

POPULATION

In 1860, the year before its incorporation as a territory, Colorado had a total population of 34,251, of which 86.1% was classified as rural. The population grew only slightly during the next decade, but from 1870 to 1880 (the first census after Colorado's admission as a state) it increased almost 500%. The total population was 194,327 in 1880, 68.6% rural and ranked 35th among the 38 states and territories that then comprised the union. By 1900

*Colorado: Places of 5,000 or More Population (1960 Census)**

Place	Census of Population				
	1960	1950	1940	1920	1900
Total state	1,753,947	1,325,089	1,123,296	939,629	539,700
Alamosa	6,205	5,354	5,613	3,171	1,141
Arvada	19,212	2,359	1,482	915	—
Aurora	48,548	11,421	3,437	983	202
Boulder	37,718	19,999	12,958	11,006	6,150
Brighton	7,055	4,336	4,029	2,715	366
Canon City	8,973	6,345	6,690	4,551	3,775
Colorado Springs	70,194	45,472	36,789	30,105	21,085
Commerce Town	8,970	—	—	—	—
Cortez	6,764	2,680	1,778	541	125
Denver	493,887	415,786	322,412	256,491	133,859
Derby	10,124	2,840	—	—	—
Durango	10,540	7,459	5,887	4,116	3,317
Englewood	33,398	16,869	9,680	4,356	—
Fort Collins	25,027	14,937	12,251	8,755	3,053
Fort Morgan	7,379	5,315	4,884	3,818	634
Golden	7,118	5,238	3,175	2,484	2,152
Grand Junction	18,694	14,504	12,479	8,665	3,503
Greeley	26,314	20,354	15,995	10,958	3,023
Ivywild	11,065	2,849	—	—	—
La Junta	8,026	7,712	7,040	4,964	2,513
Lakewood	19,338	—	—	—	—
Lamar	7,369	6,829	4,445	2,512	987
Littleton	13,670	3,378	2,244	1,636	738
Longmont	11,489	8,099	7,406	5,848	2,201
Loveland	9,734	6,773	6,145	5,065	1,091
Montrose	5,044	4,964	4,764	3,581	1,217
Pueblo	91,181	63,685	52,162	43,050	28,157
Security	9,017	—	—	—	—
Sterling	10,751	7,534	7,411	6,415	998
Thornton	11,353	—	—	—	—
Trinidad	10,691	12,204	13,223	10,906	5,345
Walsenburg	5,071	5,596	5,855	3,565	1,033
Westminster	13,850	1,686	534	235	—
Wheat Ridge	21,619	—	—	—	—

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

the state's population was 539,700, 51.7% rural, and ranked 29th. From the beginning of the 20th century Colorado remained the largest of the mountain states. In 1920 the population totaled 939,529, 51.8% rural and ranked 29th. Growing slowly thereafter, the population reached 1,123,296 just before World War II (1940) and was more urban (52.6%) than rural; total population ranked 33rd among the states. During the following decade the population continued to grow and take on a more decidedly urban character. By 1950 the total population was 1,325,089, 62.7% urban and ranked 34th in the union. The two standard metropolitan statistical areas (Denver and Pueblo) in 1950 contained almost half of the total population. By 1960 these metropolitan areas housed 59.7% of the population. In 1960 the standard metropolitan area of Colorado Springs was created. The three standard metropolitan areas contained 67.9% of the population. In 1960 Colorado had a population of 1,753,947, an increase of 428,858 or 32.4% over 1950; the population ranked 33rd among the states.

The population per square mile in 1950 was 12.8, as compared with 50.6 for the U.S. In 1960 it was 16.7, as compared with 49.7 for the U.S. as a whole. The 1960 urban population was 1,292,790 or 73.7% of the total, continuing the national trend toward increasing urban residence.

Colorado's population has always been predominantly native-born. Foreign-born accounted for 20.4% of the total population in 1880, and declined steadily thereafter, accounting for only 3.4% by 1960. Distribution by colour and nativity, according to the 1960 census, was as follows: 93.7% native white; 3.2% foreign-born white; and 3.1% nonwhite (only Negroes accounting for more than 1%). The number of households in 1960 was 594,522, as compared with 391,517 in 1950.

EDUCATION

The first school in Colorado was started by O. J. Goldrick in a rented cabin at Denver in the fall of 1859. A log house in Boulder in 1860 was the first structure built for a schoolhouse. Tax-supported schools came in 1862; high schools in the 1870s. The Opportunity school at Denver has become nationally famous for the character and scope of its offerings to adults.

After mid-20th century Colorado had seven state-owned universities and colleges, seven privately owned institutions and six public locally supported junior colleges. In the first group were: the University of Colorado (founded in 1877) at Boulder, with its college of medicine at Denver; Colorado State university (agriculture) at Fort Collins; Colorado State college (education) at Greeley; Colorado School of Mines at Golden; Western State College of Colorado at Gunnison; Adams State College of Colorado at Alamosa; and Fort Lewis Agricultural and Mechanical college at Durango. The private institutions were: Colorado college at Colorado Springs and, all in Denver, the University of Denver, Colorado Woman's college, Regis college, Loretto Heights college, Iliff School of Theology and St. Thomas seminary. The junior colleges were located at Grand Junction, Pueblo, Trinidad, Sterling, Lamar and La Junta.

The U.S. Air Force academy is located near Colorado Springs (*see* COLORADO SPRINGS; MILITARY, NAVAL AND AIR ACADEMIES).

ECONOMY

Agriculture.—The development of water resources for irrigation and soil conservation has been of vital interest to Colorado. However, because of the scarcity of water, less than 3,000,000 ac. have been irrigated. Larger areas, totaling about 40,000,000 ac., comprise grazing and dry farms. The principal crops of irrigated lands are sugar beets, alfalfa and potatoes; dry farms yield wheat, corn, broomcorn and beans. Much of the high country is excellent cattle and sheep range. The valleys of the western slope are good fruit country, producing peaches, apples and pears.

In total value, the crops produced usually rank in the following order: hay, wheat, corn, sugar beets, potatoes, barley and beans. Colorado's usual rank in production among the states is: second in sugar beets, peas and broomcorn; fifth in potatoes and onions; eighth in barley and pears; and ninth in spring wheat, wild hay, cantaloupes and peaches. In total value, the livestock usually rank in the following order: cattle, sheep, hogs, poultry and horses. After mid-20th century, crop and livestock sales averaged about $500,000,000 annually and comprised the state's leading industry.

Water Resources.—Because the origins of so many major rivers are in Colorado (see *Physiography*, above) the utilization of its surface-water supplies created many interstate questions. Under the principle of equitable apportionment of the use of the waters of interstate rivers, Colorado became a party to more interstate litigation over water controversies before the U.S. supreme court than any other state.

The total water precipitated on the 66,718,080 ac. within the boundaries of Colorado, at the weighted average rate of 17.8 in., amounts to approximately 99,000,000 ac.-ft. in a year of normal climatic conditions. The surface-stream flows originating in the state, measured or estimated at the points where the streams leave Colorado at the state boundaries, aggregated 12,440,000 ac.-ft. in an average year of the period 1914–45. Stream-flow depletions, chargeable to man's activities in the use of water for domestic, irrigation and related purposes in the state, were estimated to average about 4,200,000 ac.-ft. annually over the same period. Thus the surface-water yield in Colorado, over and above natural losses, available for utilization, amounts to 16,640,000 ac.-ft. in an average year. Western Colorado, with 37% of the total state area, has 69% of the state's surface-water yield, and that part of the state east of the continental divide, with 63% of the total area, has but 31% of such water resources. Furthermore, western Colorado is so mountainous and broken that it contains only a small part of the state's cultivable land, while the eastern slope has a vast area that is tillable but lacking in water. One of the state's major projects has been the transporting of water through tunnels from the western to the eastern slope. The largest transmontane diversions are by Adams, Moffat and Twin Lakes tunnels.

Related to and complementing this conservation are the numerous dams constructed for the storage of water. The principal resulting reservoirs are: John Martin, capacity, 645,700 ac.-ft.; Lake Granby, 539,800; Bonny, 170,200; Cherry Creek, 185,000; Green Mountain, 154,600; Horsetooth, 151,000; and Pine River, 177,520. Some of these water projects serve the purpose of flood control or hydroelectric power generation as well as water conservation. Interstate compacts have been made by Colorado with its sister states providing for the apportionment of the waters of the various streams which rise in Colorado and flow into other states.

Minerals.—In its early history Colorado was primarily a min-

ing region. In the 1880s and until 1900 the state mined millions of dollars worth of gold and silver, the two valuable metals which made the state famous. The total production of gold since its first discovery in 1858 was valued at almost $1,000,000,000. Production of gold reached its peak in 1900, when the annual value was $28,762,036, and declined thereafter. Silver production reached a maximum value of $20,948,401 in 1891; the total production of silver has been in excess ot $600,000,000. The total value of zinc produced in Colorado has amounted to about $350,000,000; of lead, about $325,000,000; and of copper, about $100,000,000. The output of precious metals reached its maximum of $50,614,424 in 1900, and declined thereafter, with particular rapidity after World War I. That war, however, stimulated the production of rare metals, such as molybdenum and vanadium which are used in the hardening of steel. Colorado remained the nation's leading supplier of molybdenum after mid-20th century. The annual value of molybdenum production in the 1960s was greater than that earned by precious metals in their peak year, 1900.

The production of coal averaged about 10,000,000 tons annually from 1905 to 1930, but had declined to less than 4,000,000 tons after mid-20th century. Oil production, on the other hand, increased after World War II. The United States has reserves of oil shale that dwarf known reserves of petroleum, with the principal deposits in the Green river formation, located in Colorado, Utah and Wyoming. The richest deposits are located in Colorado. Of the known 2,592 sq.mi. of oil shale in Colorado (in Garfield, Mesa and Rio Blanco counties in the western part of the state), a 1,000-sq.mi. area had been fairly well defined by mid-20th century, and it was estimated that this area contained about 300,000,000,000 bbl. of oil in a 500-ft.-thick measure assaying at 15 gal. per ton of shale. Natural-gas production showed an outstanding increase after mid-20th century, with this flexible fuel being piped as far away as southern California and the northwest. Uranium production in southwestern Colorado first assumed important proportions in the 1950s. The total value of mineral production in Colorado increased from less than $80,000,000 to more than $320,000,000 annually in the decade following the end of World War II.

Industry and Trade.—The major trade and industrial groups in Colorado are retail trade, manufacturing, service industries, public utilities, wholesale trade and construction. The leading manufacturing groups are food products, primary metals and printing and publishing. While the number of persons engaged in manufacturing and trade has increased steadily, farming has required fewer employees. The percentage of the state's population engaged in farming decreased from about 30% in 1900 to nearly 10% in the 1960s. Tourism has become a major industry, with about 4,000,000 visitors to the state annually and expenditures exceeding $200,000,000 per year.

Transportation.—In 1870 the Denver Pacific linked Denver to Cheyenne, Wyo., and the first transcontinental railroad. The Kansas Pacific came in from the east the same year; and the Denver and Rio Grande began construction in 1871. Many of the early railroads, especially those to the mining camps in the mountains, were narrow gauge (3-ft. wide). The Santa Fe railroad in 1873, the Burlington in 1882, the Missouri Pacific in 1887 and the Rock Island in 1888, all came westward to the foot of the Rockies. The Rio Grande crossed the Rockies in 1882, but the shortest line westward was made possible by the 6-mi. Moffat tunnel, completed in 1927. Railroad mileage increased to a peak of 5,739 mi. in 1914. Thereafter a decline began because of the decrease in mining and the increase of motor traffic. After mid-20th century there were less than 4,000 mi. of rails in Colorado.

Road building kept pace with motorcar increases, the first tax for the purpose being levied in 1914. State gasoline and other taxes for highway construction and maintenance mounted until they totaled more than $50,000,000 after mid-20th century. Highways were rapidly constructed and improved. Good paved roads traverse high mountain passes—Berthoud pass (11,314-ft. elevation), Loveland (11,992 ft.), Tennessee (10,424 ft.), Wolf Creek (10,850 ft.) and Independence (12,095 ft.).

Airmail service came to Colorado in 1926 and Denver's first municipal airport was opened in 1929. With seven large airlines serving Denver, the city's airport ranked seventh among those of the nation in amount of traffic.

See also references under "Colorado" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (L. R. HA.)

COLORADO DESERT, an arid region of southeastern California and northwestern Mexico that extends from San Gorgonio pass southeastward to the Colorado river delta and occupies the northwestern end of the same structural trough which is filled further south by the Gulf of California.

The region includes the Salton sink depression (235 ft. below sea level) and is separated from the Mojave desert (*q.v.*) to the north and northeast by the San Bernardino, Cottonwood, Chuckawalla and Chocolate mountains. On the west it is bordered by the Peninsula range.

In maximum extent the Colorado desert is about 164 mi. long and 98 mi. wide. Shifting sand dunes lie in the northwest and in the Algodones sand hills on the east. The Salton sea, a brackish water lake, occupies the Salton sink near the middle of the region. Its primary sources of water are the Colorado delta in floodtime and overflow irrigation water. Soils of the Imperial valley (*q.v.*), to the southeast of the Salton sea, are highly productive when irrigated. Water is conducted by canal from the Colorado river, after which the desert was named, for this purpose.

Rainfall varies considerably from year to year, but the annual average is between three and four inches. Mean daily temperatures are high from May through September, averaging about 90° F., and occasionally reach extremes of over 125° in the shade (*see* CALIFORNIA: *Climate*). The typical natural vegetation is the creosote bush desert shrub association found in Mexico in the Sonoran desert.

See Edmund C. Jaeger, *The California Deserts* (1955) and W. C. Mendenhall, *Ground Waters of the Indio Region, California, With a Sketch of the Colorado Desert*, U.S. Geological Survey *Water Supply Paper, No. 225* (1909). (T. M. G.)

COLORADO POTATO BEETLE, an agricultural pest (*Leptinotarsa decemlineata*), commonly known as the potato bug, which attacks the leaves of potato plants. This leaf beetle (family Chrysomelidae), native to the western United States, originally fed upon a wild plant of the potato family, *Solanum rostratum*, abounding in the Rocky mountain region. With the westward movement, the cultivation of potatoes was brought to the beetle's

LYNWOOD M. CHACE

COLORADO POTATO BEETLE (LEPTINOTARSA DECEMLINEATA)

neighbourhood, and the insect at once took to the cultivated plant and began an eastward spread. By 1864 or 1865 it had crossed the Mississippi river into Illinois, and in 1874 it reached the Atlantic seaboard. As it progressed, certain predatory insects and various birds became accustomed to it, and as early as 1869 the insecticide paris green was used against it; so that by the time the beetle reached the Atlantic, potato growers in the midwest were able to control it. From 1945 the annual loss caused by the Colorado potato beetle has ranged about $40,000,000.

Upon the advance of this pest great alarm was expressed in Europe. The German government early in 1875 issued a decree against the importation of U.S. potatoes. Similar action was taken the same year by Belgium, Spain, France, Russia, Italy, Hungary and Austria, and by Portugal and Sweden the following year. In spite of the German decree, the beetle was discovered in a potato field near Hamburg, but was exterminated by radical measures.

In 1922 the beetle was found to have been introduced near Bordeaux, France, in a region where there had been large numbers of American troops. From that region it has since spread, rather slowly, and infestation by the Colorado potato beetle is now general in France, the Netherlands, Luxembourg, Germany and Spain. It also occurs in much of Portugal and Switzerland and in parts of Austria, Yugoslavia, Czechoslovakia and Poland. It has been found sporadically in England, but repressive measures are believed to have exterminated the species.

The adults are oval shaped, about ⅜ in. long, and are orange coloured with black stripes running lengthwise along the wing covers. Both the adult beetles and the larvae feed upon potato leaves. The extensive work of the insect on the foliage may often affect the quality of the tuber, and at one time it was difficult to obtain potatoes that were not watery when cooked. The adult beetles pass the winter underground, and in the spring emerge about the time that potato plants come through the ground. Females lay from 300 to 500 eggs over a five-week period on the undersides of leaves; there are one to three generations per year, depending on the latitude.

The leaf-feeding larvae always descend to the ground to turn into pupae. The insect feeds on nearly all plants of the potato family, including eggplant, tomato and tobacco. The tender-leaved varieties of potato are most affected however.

Many chemical mixtures such as DDT or arsenical compounds control the adults and larvae. Some growers apply DDT in combination with the recommended fungicide for their area. Resistance of the beetle to DDT has been reported in some localities.

Information may be obtained from the U.S. department of agriculture or agricultural experiment stations in affected areas.

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COLORADO RIVER, a stream in south central Argentina, rises on the eastern slopes of the Andes and flows generally east-southeast to the Atlantic, where it discharges through several channels of a delta below Bahía Blanca. Its length is 534 mi., with about 200 mi. up to Pichi-Mahuída navigable for light vessels.

Usually described as being formed by the confluence of the Grande and Barrancas, the Colorado river is better described as a tributary of the Grande. Its main tributary, the Curacó, is considered part of the ancient outlet of the now closed lacustrine basin of southern Mendoza. The river traverses a wide range of distinct geographical areas. Its name is derived from the reddish colour it acquires crossing lengthy clay beds. (C. E. Mc.)

COLORADO RIVER. The Colorado river and its upper tributaries rise in the mountains of Wyoming, Colorado and Utah, where precipitation, especially in the form of snow, is heavy. The Colorado river flows about 1,440 mi. to the Gulf of California. Its drainage basin covers 244,000 sq.mi. and includes parts of seven states—Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona and California. The river forms for 17 mi. the boundary between Arizona and Mexico and then flows 80 mi. through the republic of Mexico to the Gulf of California. Its discharge varies from about 3,000 sec.-ft. at low water to a flood discharge of more than 200,000 sec.-ft. Its water supply, with storage, is estimated to be equivalent to a uniform flow of 19,300 sec.-ft. at Lees Ferry, 22,600 sec.-ft. at the lower end of Black canyon and 21,100 sec.-ft. at Parker. When development in the upper basin is completed and the canyon section and the lower river are developed these quantities will be reduced. With an average annual flow at Yuma of 17,000,000 ac.-ft. and an average silt content of 0.62% by volume, the annual load of silt brought to the delta region by the Colorado and Gila averages 105,000 ac.-ft., or 170,000,000 cu.yd.

The region traversed by the Colorado and its tributaries was the home of the early Pueblo people of whom there is almost no record except the hieroglyphics on the rocks, the ruins of their irrigation systems, and the cliff dwellings by which they are most widely known; in this region were Spanish missions whose history extends back nearly to the days of Balboa and Cortez; there is the Grand canyon of the Colorado, whose grandeur cannot be described; and there is the extremely remote and the most spectacular system of natural bridges of the world.

For more than 1,000 mi. along its course the Colorado has cut a deep, narrow gorge or canyon, but at some points where lateral streams join it the canyon is broken and these narrow transverse valleys divide it into a series of canyons. Virgin, Kanab, Paria, Escalante, Fremont, San Rafael, Price and Duchesne rivers on the west and the Little Colorado, San Juan, Grand, White and Yampa on the east have also cut narrow, winding gorges or deep canyons. Each river entering these has cut another canyon; each lateral creek has cut a canyon; and each brook runs in a canyon; so that much of the upper part of the basin of the Colorado is traversed by a labyrinth of deep gorges. The longest unbroken trunk canyon through which the Colorado runs is the Grand canyon between the mouth of the Paria and the Grand Wash.

The Grand canyon is 218 mi. long and at one place is 15 mi. wide and nearly 6,000 ft. deep. All the scenic features of this canyon are on a grand scale. Low plateaus, dry and treeless, stretch back from the brink of the canyon. In some places the rock is composed of richly coloured and variegated marls, and there the surface is a bed of loose, disintegrated material through which one walks as though in a bed of ashes. In other places the rock is a soft sandstone, the disintegration of which has left broad stretches of drifting sand, white, golden and vermilion. Where this sandstone is a conglomerate, a paving of pebbles has been left—a mosaic of many colours, polished by the drifting sands.

On the California side of the lower portion of the river in the United States a vast desert, known as the Colorado desert or the Salton basin, stretches northwestward from the head of the Gulf of California, a distance of 150 mi. At one time the Gulf of California extended a long distance farther to the northwest, above the point where the Colorado now enters it, but this stream brought its mud from the mountains and hills above and bore it into the gulf, across which it gradually erected a vast dam until the waters on the north were separated from those on the south. Then the Colorado cut a channel into the lower gulf. The upper waters, being cut off from the sea, gradually evaporated. The bottom of this ancient upper gulf has come to be known as the Salton sink. It is now land about 235 ft. below the level of the sea. On the Arizona side of the river there are similar desert plains, but these are interrupted by mountains.

In the year 1905 there occurred, about 3 mi. below the California-Mexico line, a break which diverted all the waters of the Colorado into the Salton sink and created the Salton sea, with a maximum depth of 79 ft., a length of 50 mi. and a width of 10 mi. to 15 mi., a total water area of 300 sq.mi. The break threatened inundation of the entire Imperial valley (*q.v.*) and permanent blocking of the Southern Pacific route. Because of this latter

danger the Southern Pacific company stopped the crevasse and completed, in 1907, a line of protective levees, a project involving a great deal of engineering skill and an outlay of $2,000,000.

Under existing treaties neither the United States nor Mexico can take action along the common boundary line which might impede navigation on the Colorado river. The language of the treaties does not, however, appear to prevent the taking of water for navigation purposes from the Colorado in the United States above the point where it forms the boundary line between the two countries.

The Colorado river is one of the remarkable rivers of the world in its value for irrigation and water power. It combines, in proper sequence for complete use, a large quantity of water, great concentrations of fall, reservoir sites for the control of flow, sites for power plants, and several million acres of irrigable land below the stretch where power may be developed. More than 5,000,000 prime horsepower can be developed. The flood menace is a serious one; the silt brought down annually to Yuma produces dangerous meandering in the leveed sections in the delta and causes the river to seek new outlets. These threats necessitate large expenditures for revetment and the steady raising of levees to prevent further disasters such as occurred in 1905.

For the purposes of controlling floods and regulating the flow of the lower Colorado river and for interception of silt, providing for storage and delivery of water for irrigation purposes and for the generation of power, congress provided for the construction of a dam in the Colorado river at Black canyon or Boulder canyon. As the project entailed an adjustment of the water rights claimed by Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, a commission comprised of representatives of each of these states and of the United States prepared, in 1922, a plan for the distribution of the waters, giving 7,500,000 ac.-ft. annually to the upper states (Colorado, New Mexico, Utah and Wyoming), and 7,500,000 to the lower states. A disagreement between Arizona and California delayed ratification of this compact until 1928 when all but Arizona ratified by agreeing to an amendment that the ratification of any six of the states would make it effective. Congress followed by passing the Boulder Canyon Project act on Dec. 21, 1928, and Pres. Herbert Hoover issued a proclamation the following June authorizing construction. Construction was not formally begun until Sept. 17, 1930, but the rapid completion of four huge diversion tunnels, each 56 ft. in diameter, during the next three years, providing a dry bed on which to construct the dam, and the erection of a city to house 600 workers high above the waters of the projected dam and the construction of 53 mi. of railway and 40 mi. of improved highway completed the early stages of the project and attracted national attention to that great engineering feat. The acceleration of public works projects under the Franklin D. Roosevelt administration speeded construction, and the dam was completed in 1936. It is 726 ft. high and contains 3,245,612 cu.yd. of concrete. Lake Mead, its man-made reservoir, is 119 mi. long and stores 29,287,000 ac.-ft. of water. The hydroelectric plant has an ultimate capacity of 1,322,300 kw., and the income from the sale of electric power is applied toward repayment of funds advanced by the federal government for construction. The project is operated by the bureau of reclamation under the provisions of the Boulder Canyon Project act of 1940; the power plant is operated by the city of Los Angeles and the Southern California-Edison company as agents of the United States under the supervision of the bureau of reclamation.

The project opened a new area for colonization provided with an adequate hydroelectric power supply and irrigation. On April 30, 1947, Pres. Harry S. Truman signed a bill under which its official name became Hoover dam. In 1956 a law was passed by congress authorizing the construction and operation of the following units, power plants and transmission facilities of the Upper Colorado river basin: Glen canyon, Flaming gorge, Navajo and Curecanti dams; with the Emery county, Central Utah, Florida, Hammond, La Barge, Lyman, Paonia, Pine river extension, Seedskadee, Silt and Smith Fork as participating projects.

See also GRAND CANYON.

See F. P. Farquhar, *Books of the Colorado River* [and] *the Grand Canyon* (1953); Frank Waters, *The Colorado,* "Rivers of America Series" (1946). (E. JA.; M. J. L.)

COLORADO SPRINGS, a city of Colorado, U.S., 75 mi. S. of Denver, at the confluence of Monument and Fountain creeks; at the eastern base of Pikes peak, it stands on a mesa 6,008 ft. above sea level. It is the seat of El Paso county. From a population of 45,472 in 1950, the city grew rapidly to 70,194 according to the 1960 census.

Colorado Springs is one of the most popular tourist centres of the Rocky mountains because of its fine climate and its many scenic attractions. It is also a military centre of great importance. The North American air defense command has headquarters at Ent air force base in Colorado Springs. Fort Carson (established 1942, made permanent, 1954) is situated on a 60,000-ac. reservation 5 mi. S. and the U.S. Air Force academy (authorized 1954, occupied 1958) is located on a 17,800-ac. reservation 10 mi. N. of the city.

The Colorado college, a private, nonsectarian, coeducational school of liberal arts, was established in 1874. Its enrollment is drawn from all parts of the U.S. Another cultural influence in the community is the Colorado Springs Fine Arts centre (established 1936). Still other institutions are the Colorado School for the Deaf and Blind, the International Union Printers home and the Myron Stratton home, founded by the will of the Cripple Creek gold miner, W. S. Stratton.

Colorado Springs standard metropolitan area, comprising all of El Paso county, had a 1960 population of 143,742. Manitou Springs 6 mi. W. is a summer resort and the site of famous mineral springs. Between the two cities lies the Garden of the Gods, well known for its fantastic outcroppings of bright-coloured sandstone and forming a part of the city park system of 3,164 ac. Other points of scenic interest include the North and the South Cheyenne canyons, the Cave of the Winds and Pikes peak. On nearby Cheyenne mountain are the Mountain Zoological gardens, established in 1921, and the Shrine of the Sun, a 100-ft. rose-pink granite tower dedicated as a memorial to Will Rogers on Sept. 5, 1937.

The site of Colorado Springs was favourably noted by many explorers and travelers long prior to settlement. The historic town of Colorado City, which sprang up during the 1859 gold rush, was consolidated with Colorado Springs in 1917. The latter was founded and laid out as a model city in 1871 by Gen. W. J. Palmer, president of the Denver and Rio Grande railroad. It has had a city-manager form of government from 1921. The water supply was increased in 1953 by Blue river water brought by tunnel from the western slope of the continental divide. (HY. L. C.)

COLORATION: *see* ANIMAL COLORATION; PLANT COLORATION.

COLORATURA, a musical term for florid vocal passages and for the voice that can perform them. In the early 16th century the standard units were the semibreve (𝅝) and the minim (𝅗𝅥); vocal or instrumental decoration was therefore in the shorter notes, which were black, or "coloured," hence the term.

COLORIMETRY, the measurement of wave length and of the intensity of electromagnetic radiation in the visible region of the spectrum. It is used extensively for identification and determination of concentrations of substances which absorb light. Two fundamental laws are applied, the one of Pierre Bouguer (also known as Lambert's law), which relates the amount of light absorbed and the distance it travels through an absorbing medium, and Beer's law, which relates light absorption and concentration of absorbing substance. The two laws may be combined and expressed by the equation $\log I_0/I = kcd$, where I_0 = intensity of the incident beam of light, I = transmitted intensity, c = the concentration of absorbing substance, d = the distance through the absorbing solution, and k = a constant, dependent upon the absorbing substance, wave length of light used, and on units of c and d.

A simple application of this expression is found in comparing intensities through layers of different thicknesses of solutions of known and unknown concentrations of the same absorbing substance. If, when the same incident intensity is used, the transmitted intensities are equal, then $c_1d_1 = c_2d_2$. The concentration

of unknown (c_2) can be expressed by the ratio d_1/d_2 times the known concentration (c_1). In this visual method, Nessler tubes or a Duboscq-type colorimeter may be employed. If a photoelectric cell instead of the eye is used to compare intensities, the instrument is called a photoelectric colorimeter.

In colorimetry frequently the entire visible spectrum (white light) is used, and consequently the complementary colour of the one absorbed is observed as transmitted light. If monochromatic light or a narrow band of radiation is used, the instrument is called a spectrophotometer. It is not limited to the visible spectrum and is often employed to make measurements in the ultraviolet and infrared regions. The spectrophotometer has largely replaced the colorimeter.

Most of the chemical elements and a large number and wide variety of organic compounds may be determined colorimetrically or spectrophotometrically, frequently at concentrations down to one part of the constituent in several hundred million parts of solution. *See* also COLOUR: *Spectrophotometry; Colorimetry.*

(J. H. Y.)

COLOSSAE, once a great city of southwest Phrygia, the site of which lies 10 mi. E. of the modern town of Denizli in the Denizli *il* of Turkey. It was famous for the black woolen fabrics which were dyed and woven there and was a large and prosperous city (Herodotus, vii, 30; Xenophon, *Anabasis* i, 2, § 6). Colossae was the seat of an early Christian church to the congregation of which St. Paul's epistle to the Colossians was addressed. The church became associated with the worship of St. Michael who was said to have delivered the place from a flood. Colossae lasted until the 7th and 8th centuries A.D., when it was gradually deserted under pressure of the Arab invasions and supplanted by the nearby fortress of Khonae (Honaz). (WM. C. B.)

COLOSSEUM, the Flavian amphitheatre in Rome, begun by Vespasian, on the site of part of Nero's famous Golden House, and inaugurated by Titus in A.D. 80. The upper part was damaged and repaired several times in antiquity. It is elliptical in plan, measuring 620 by 513 ft., its arena 287 by 180 ft., height to top of outer wall about 160 ft. The materials are travertine and concrete. The outer wall is of four stories, three arcaded with attached Doric, Ionic and Corinthian orders, the top solid with Corinthian pilasters and windows. The seats within are supported on concentric and radiating vaulted corridors. It probably seated from 40,000 to 50,000 persons. *See* AMPHITHEATRE.

COLOSSIANS, EPISTLE TO THE. This writing is included among the Epistles of Paul in the New Testament, and, claiming to be written by him (i, 1; i, 23; iv, 18) while a prisoner (iv, 3, 18), it belongs, with Philemon, Ephesians and Philippians (*qq.v.*), to those known as the "captivity Epistles." The determination of its date depends on decisions as to its authenticity and to the imprisonment in question.

Polemic Against False Teaching.—The main concern of Colossians is with the false teaching that had invaded the Christian congregations of this area of Asia Minor. Colossae stood on the banks of the upper Lycus (a tributary of the Maeander), about 12 mi. from Laodicea and about 13 from Hierapolis. Christian congregations had been founded in all three towns (Col. iv, 13), without a visit from Paul himself, perhaps (in the case at least of Colossae) by one Epaphras. It was Epaphras who, on this occasion, had brought news from Colossae and was now with the apostle (*see* Col. i, 7–9; ii, 1; iv, 12).

Other links between Paul and the Lycus valley churches were Philemon and his runaway slave Onesimus (Philem. *passim;* Col. iv, 9). The church at Laodicea is mentioned again in Rev. iii, 14 ff., and at Hierapolis Papias was bishop *c.* A.D. 130.

The false teaching in question appears to have been "dualistic" (in the sense that it regarded matter as evil), and to have regarded Christ as only one among a whole hierarchy of angelic powers and not as supreme (Col. i, 15–23; ii, 9, 14). The cult of angels, the observance of some ritual calendar, food laws and ascetic practices, and perhaps also circumcision were included in the system (Col. ii, 11, 16–23). It is impossible to determine the precise nature and origin of this amalgam (it is of a type often called gnostic, though this was not its contemporary name; *see* GNOSTICISM). But the Dead sea scrolls (*q.v.*) from Qumran have demonstrated the existence, even on Palestinian soil, of non-Christian Jewish sectarians with a comparable outlook, and a syncretism or amalgam that was partly Jewish (and perhaps Essene), partly pagan, partly Christian is not surprising in Asia Minor.

The reply in Colossians to this false teaching is specially notable for its daringly high claims for Christ, relating him to all creation as its agent or medium, its goal and its reconciler (i, 15–17, 19), and to the church as its head and reconciler (i, 18, 21). Christ is called God's "mystery" (Gr. *mysterion,* ii, 2; *cf.* i, 27; that is, God's secret plan now divulged), and in Christ the "entirety" or "fulness" (Gr. *pleroma*) of the Godhead is said to dwell (i, 19; ii, 9). He is "first-born of all creation" (i, 15; *i.e.,* in view of the consistent attitude of the New Testament, God's unique Son, prior to creation). Consequently, whatever reality or status may be accorded to the angelic powers ("thrones," "dominions," "principalities," "authorities," etc., i, 16 etc.), they are subordinate to Christ. To be incorporated in him is to be complete (ii, 9 ff.). Ascetic practices and a cult of angels are at best irrelevant (ii, 16 ff.). Thus, a supreme and cosmic position is more explicitly assigned to Christ here than in any epistle that is probably earlier (though *cf.* I Cor. viii, 6). Correspondingly, *ecclesia* is used of the universal church in Col. i, 18, 24 (as in Ephesians), although in iv, 15 (*cf.* Philem. 2) it is still used for the local congregation.

Instruction on Christian Conduct.—This vigorous doctrinal polemic is followed (ii, 20–iv, 6) by a noble treatment of the status of Christians and of the qualities of character and conduct following from the acceptance of Christ and incorporation in him by baptism. This includes (iii, 18 ff.) a Christian form of such household instructions as, in Jewish and pagan form, figure also in contemporary literature; and the most striking contrast which it presents when compared with non-Christian parallels is in the recognition of the reciprocity of the duties—husbands owing a duty to wives, parents to children, masters to slaves, as well as vice versa. And all is lifted to that level of relationship described as "in the Lord."

The letter closes (iv, 7–18), as it began (*see* i, 1 ff., which includes a magnificent prayer), with personal messages, injunctions and greetings.

Authorship.—There is a close relationship between Colossians and Ephesians (*q.v.*); and, despite certain opinions to the contrary, the balance of probability seems to favour the priority of Colossians, if either is derived from the other. Although the Paulinity of Ephesians is doubtful, that of Colossians is less vulnerable. Its genuineness, in whole or part, has nevertheless often been questioned by scholars, beginning at least as early as E. T. Mayerhof (1838).

The chief ground for doubt is the "advanced" or "high" Christology. But there is nothing here incompatible with assured Pauline thought, and the explicitness of the statements may be attributed to the situation addressed. As for vocabulary, the absence of certain terms familiar from other Pauline Epistles and the presence or particular use of certain others are not conclusive. Most of the Epistles are written to special situations, and their vocabulary is in part conditioned by this. And that there is no reference to "justification by faith" need only mean that this was not, at that moment, the particular issue. The style of writing, again, is an uncertain guide, especially where different amanuenses, with varying degrees of freedom, may be concerned.

In favour of genuineness is the fact that the Epistle to Philemon (*q.v.*), which is obviously genuine, coheres so closely with Colossians that it is difficult to accept the one and reject the other.

Date.—The date and circumstances of the imprisonment in question are debated. Until modern times it was generally assumed that the "captivity Epistles" were all written by Paul from Rome (*see* Acts xxviii, 16), that is, *c.* A.D. 62, but earlier imprisonments have been suggested by modern scholars. Acts xxiii, 35; xxiv, 27 indicates a prolonged imprisonment at Caesarea, and the presence of Aristarchus (Col. iv, 10) fits this period (Acts xxvii, 2). But, at Caesarea, expectation of release (Phil. i, 25; Philem. 22) could only have meant expectation of lynching (Acts xxiii,

12 ff.; xxv, 3), which renders the Caesarean hypothesis doubtful. Others postulate an imprisonment at Ephesus during the period covered by Acts xix (for although Acts here mentions no imprisonment, II Cor. xi, 23 ff. seems to demonstrate that Acts is not exhaustive). Advocates of this hypothesis appeal to affinities between the captivity Epistles and the Romans-Corinthians group; to the improbability of Paul's asking for hospitality at Colossae (Philem. 22) if he were far away in Rome; to the fact that in the "Marcionite prologues" (early introductions to the New Testament books, perhaps connected with the 2nd-century heretic Marcion) Colossians is described as written by the apostle from Ephesus; even, that tourists are still shown the "prison of Paul" among the ruins of Ephesus. But the latter is scarcely serious evidence, and the prologue is curiously worded (why is Paul described as *iam ligatus*, "*already* a prisoner?") and in any case the prologue to Philemon places that letter at Rome. Besides, Mark and Luke (Col. iv, 10, 14; Philem. 24) are not known to have been with Paul at Ephesus. Thus, the case against the Roman origin is not decisive; and although the allusions in Phil. i, 13 and iv, 22 to the *praetorium* and to the emperor's "household" have been shown to be possible in the provinces, they certainly fit Rome equally well if not better. But the "captivity Epistles" are, of course, not necessarily homogeneous in time and occasion, and the data are insufficient for certainty. Chronological arguments from style and contents are particularly precarious. Fortunately, date and place are in this case less vital than the doctrinal and ethical contents of the Epistle.

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See also C. R. Bowen, "The Original Form of Paul's Letter to the Colossians," *Journal of Biblical Literature,* 43:177–206 (1924); G. S. Duncan, *St. Paul's Ephesian Ministry* (1929); E. O. Percy, *Die Probleme der Kolosser und Epheserbriefe* (1946); G. Bornkamm, *Das Ende des Gesetzes. Paulusstudien* (1952); J. Coutts, "The Relationship of Ephesians and Colossians," *New Testament Studies,* 4:201–207 (1958); J. M. Robinson, "A Formal Analysis of Colossians I, 15–20," *Journal of Biblical Literature,* 76:270–287 (1957); G. S. Duncan, "Paul's Ministry in Asia," *New Testament Studies,* 3:211–218 (1957), "Chronological Table to Illustrate Paul's Ministry in Asia," *New Testament Studies,* 5:43–45 (1958). (C. F. D. M.)

COLOSSUS is a statue considerably larger than life-size. In Egypt and Mesopotamia, in particular, colossal statues were in favour in antiquity. The famous Egyptian sphinx, still to be seen near the pyramids at Gizeh, is about 240 ft. long, and the statue of Ramses II in the Ramesseum was originally perhaps 57 ft. high. Herodotus, visiting Egypt in the 5th century B.C., constantly refers to such gigantic statues as *colossoi.* Likewise, in India, China and Japan, colossal figures of deities were placed inside pagodas.

When the Greeks in the 7th century B.C. began to produce monumental sculpture, they too created colossal figures. The archaic Apollo of Delos, generally referred to as the Delos colossus, was four times life-size; fragments of archaic statues three times life-size have been unearthed at Samos; and the throne of Apollo at Amyclae, by the sculptor Bathycles, described at length by Pausanias, supported a primitive wooden statue about 45 ft. high. Though in the subsequent periods the scale diminished and life-size sculpture became the norm, admiration for the colossal persisted. Calamis (*c.* 460 B.C.) is said to have made a statue for Apollonia on the Black sea which was almost 50 ft. high. Phidias' chryselephantine statues of Athena Parthenos and the Zeus at Olympia were about six and seven times life-size, respectively. The Zeus made by Lysippus (*c.* 320 B.C.) for Tarentum stood over 59 ft. high, and of his seated Hercules, also at Tarentum, it was said that the thumb was as broad as a man.

BY COURTESY OF ENTE PROVINCIALE PER IL TURISMO, BOLOGNA

"FOUNTAIN OF NEPTUNE" BY GIOVANNI DA BOLOGNA: 1563–66. IN BOLOGNA, ITALY

The most famous colossus of all was the bronze statue of Helios in Rhodes, the work of Chares, a pupil of Lysippus. It was over 100 ft. high, took 12 years to complete and was considered one of the seven wonders of the world. After 56 years, it was overthrown by an earthquake (*c.* 224 B.C.), and it lay on the ground for centuries, until the pieces were sold and carried off in A.D. 653.

All over the Roman empire colossal statues of deities and emperors were erected to impress the might of Rome on the people. According to Pliny, Zenodorus, after having made a colossal statue of Hermes in Gaul, was summoned by Nero to Rome and there made a statue 106 ft. high, intended to represent that emperor but later dedicated to the sun. A Jupiter erected on the Capitoline hill is said to have been visible from Monte Albano.

The taste for colossal sculpture has never died out. It persisted through medieval times (a St. Christopher about 28 ft. high was placed at the entrance of Notre Dame), and continued through the Renaissance (*cf.* the statues by Michelangelo and Giovanni da Bologna) to the present time. The "Christ of the Andes," standing on the border of Argentina and Chile, is 26 ft. high; the "Bavaria" (Munich) by L. M. Schwanthaler is about 60 ft. high; the "France" ("Le Puy") by J. M. Bonnassieux is about 50 ft.; and the statue of "Liberty Enlightening the World" by F. A. Bartholdi, standing in New York harbour, attains, with torch and pedestal, a height of about 305 ft. Finally, the rock-cut portraits of Washington, Jefferson, Lincoln and Theodore Roosevelt by Gutzon Borglum, in the Black hills of South Dakota, measure 60 ft. from crown to chin. (G. M. A. R.)

COLOUR. Even casual observation indicates that an understanding of colour involves not only physics but physiology and

psychology as well. As a matter of common experience, a white tablecloth appears to be just as white under candlelight as it does under daylight, despite the fact that the light reflected by the tablecloth into the observer's eye is actually as yellow as the candle flame itself. The failure to perceive the cloth as yellow is the result of a tacit assumption by the brain concerning the constancy of the physical characteristics of things. Thus, an object at five feet does not appear to be twice as large as when it is ten feet away, although the linear dimensions of the image on the retina of the observer's eye are actually twice as large. Instead, the brain perceives the size of the object to be constant, after correcting the initial perception for the distance of the object. In much the same way, the colour of an object in daylight is intuitively regarded as one of its physical characteristics, and the brain corrects for the conditions of illumination whenever correction is necessary and possible.

The Physical Approach.—Colour has been used for decorative purposes since prehistoric times, but it was not until 1666 that a systematic investigation of its nature was undertaken. In that year, Sir Isaac Newton, then only 23, began a long series of experiments that provided the foundation for our modern knowledge. In the first experiments, Newton placed a glass prism in a beam of sunlight which entered a darkened room through a small hole in the shutter, thus producing the red, orange, yellow, green, blue, indigo and violet of the familiar solar spectrum. This dispersion of light by a prism to form a spectrum had been observed before, but Newton was the first to perform the additional experiment of recombining the spectrum colours by means of a lens or a second prism. The fact that white light was produced by the recombination led Newton to conclude that all the spectrum colours had been present in the original beam.

Newton was also the first to explain what he called "the permanent colours of natural bodies." In a typical experiment, he found that both cinnabar (vermilion red) and ultramarine blue appeared red when observed in the pure red light of the spectrum, the cinnabar being the more strongly luminous of the two. In spectrally pure blue light, on the other hand, both pigments appeared blue, but the ultramarine was then the more luminous. From many qualitative experiments of this sort, Newton concluded that bodies appear coloured under white light because they reflect some of its spectral components more strongly than others. These qualitative observations were confirmed later, after instruments called spectrophotometers had been developed for measuring the reflectance of a surface as it is illuminated in turn by all the visible components of white light.

Spectrophotometry.—A typical procedure in spectrophotometry is to disperse the white light from a suitable source into a spectrum and then to isolate a narrow spectral band by means of a slit placed in the plane where the spectrum comes to focus. The light passing through this slit is split into two beams, one of which falls on the sample under investigation and the other on a standard white surface that is known to reflect substantially all the light that falls upon it. The sample, being a poorer reflector of light than the white standard, will be correspondingly less luminous; and the luminance ratio is readily found by the application of any adequate photometric technique. This ratio is the spectral reflectance of the sample for light in the spectral region employed. For colorimetric purposes, the above procedure is repeated with the slit in a different position each time until the sample has been subjected to examination throughout the entire range of the visible spectrum. Ordinarily, it is quite sufficient if the spectral reflectance of the sample is determined at wave-length intervals of 10 mμ (1 mμ=0.0000001 cm.), in which case a total of 31 separate measurements suffices to cover the range from 400 mμ in the violet to 700 mμ in the red.

For obvious reasons, the results of such an analysis are usually represented graphically, as is done in fig. 1 for an artist's pigment (emerald green). This spectral reflectance curve shows that emerald green is a poor reflector of violet light (400 mμ to 450 mμ), an increasingly better reflector of blue light (450 mμ to 500 mμ), has a maximum of reflectance for green light (500 mμ to 570 mμ), and becomes a progressively poorer reflector of yellow light (570 mμ to 590 mμ), orange light (590 mμ to 610 mμ), red light (610 mμ to 700 mμ). As the curve indicates, when the sample is illuminated by ordinary white light, the reflected light is predominantly green.

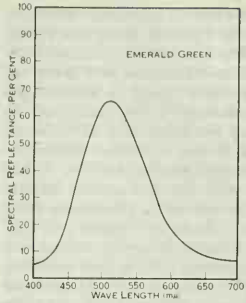


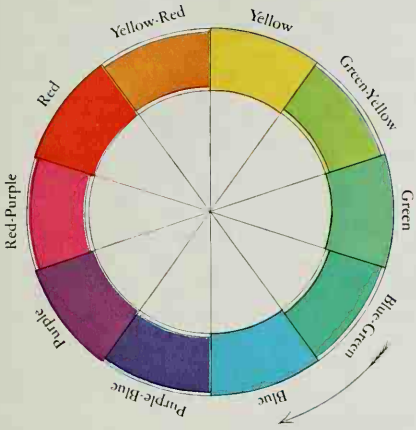
FIG. 1.—SPECTRAL REFLECTANCE CURVE OF AN ARTIST'S PIGMENT

The concepts of spectrophotometry, although dating from the time of Newton, were not embodied in physical instruments until the second half of the 19th century, when a number of types appeared in rather rapid succession. However, these instruments had little influence on the development of the techniques of colour measurement, partly because they were intended primarily for the spectrophotometry of light sources or transparent materials and partly because even a single analysis was a tedious and time-consuming procedure. In 1928, at Massachusetts Institute of Technology, A. C. Hardy constructed an instrument designed especially for the rapid routine analysis of opaque samples. The human eye was replaced by a phototube, and the instrument was made completely automatic, even to the drawing of the spectral reflectance curve of the sample on suitably prepared graph paper. Introduction of this instrument into a variety of industries led to the formal recognition of the spectrophotometer "as the basic instrument in the fundamental standardization of colour" (American Standards Assn., 1942).

Colorimetry.—Although spectrophotometry provides an adequate description of the colour of a surface when illuminated by spectrally pure (homogeneous) light of any wave length, it does not adequately indicate the colour under a heterogeneous mixture, such as daylight. Many instruments have been developed that do evaluate the colour of a surface under heterogeneous illumination, and, as a class, they are known as colorimeters. In a typical instrument, one half the field of view is occupied by the sample, illuminated in the desired manner. The other half is a comparison field whose colour can be altered by the observer until a colour match with the sample is established. In a colorimeter of the trichromatic type, the comparison field contains a mixture of red light, green light and blue light, the amounts of which can be varied independently. Inasmuch as only one setting for each of the three controls will produce a match with a given sample, the colour of the sample is indicated by the amounts of the three primaries employed in making the match. Such primaries are often called basic stimuli, and the colour of the sample is therefore said to be specified by its tristimulus values. (*See* below for distinction between additive and subtractive primaries.)

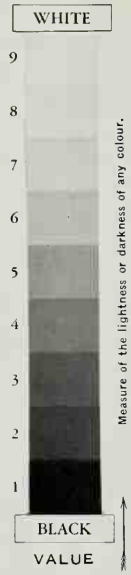
Colorimeters are not so useful as the simplicity of this procedure suggests because the two halves of the photometric field will ordinarily be different in spectral composition. For example, the primaries might be a spectrally pure red, green and blue; whereas, if the sample is the emerald green of fig. 1, it will, when illuminated by daylight (or its equivalent), reflect some light at all wave lengths. Although any person with normal colour vision experiences no difficulty in matching the two halves of the field under such circumstances, two substantially normal persons may require slightly different amounts of the three primaries to produce a match. These small individual differences are nevertheless large enough to cause measurements made with a colorimeter to be uncertain by an amount that is greater than the colour difference that can be easily observed in a direct side-by-side comparison of two samples. Attempts have been made to replace the eye by phototubes, or by other physical detectors, but even these devices have been unable to meet the exacting requirements when the comparison involves large differences in spectral composition.

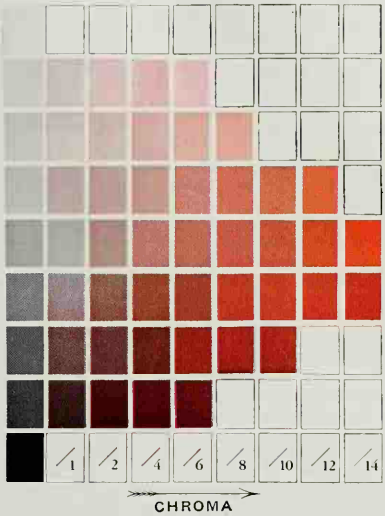
The Indirect Method of Colorimetry.—It is always possible to obtain the required accuracy with a colorimeter by using a large group of observers and averaging their results. Because this procedure does not lend itself to routine testing, an indirect method



HUE

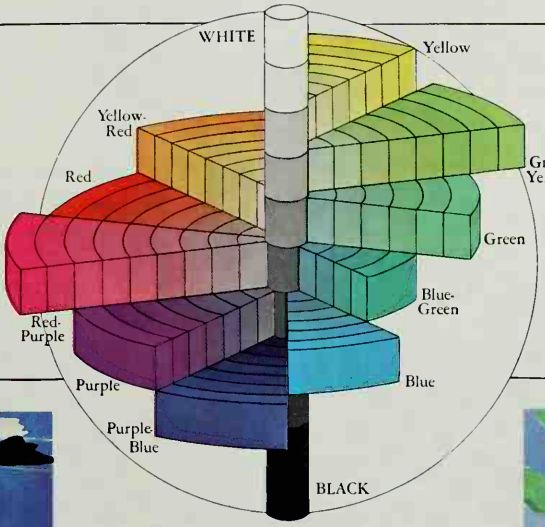
Quality that distinguishes one colour from another.





Measure of the strength or weakness of a colour.

At the right is a projection showing the Principal and Intermediate Hues arranged radially in ten equal divisions about the vertical scale of Value in the same order as the Hue circle above. For simplicity, Hues are shown only at the Value in which they reach their strongest Chroma. A complete Tree would show each Hue developed completely from black to white, as shown in the red Chroma chart above.



THE COLOUR TREE

Example 1

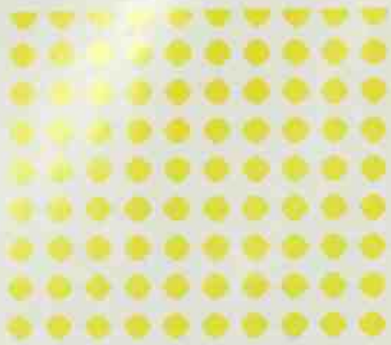
(1)
Purple-blue with grey and small areas of the complementary yellow. Note the yellowish hue of the grey, a result of simultaneous contrast.

Example 2

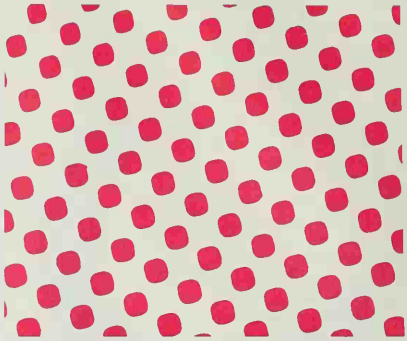
(2)
A free use of a number of complementary hues, purples and green-yellows predominating.

COLOUR MEASUREMENT—THE MUNSELL SYSTEM

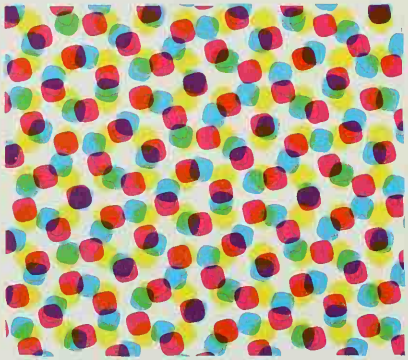
COLOUR



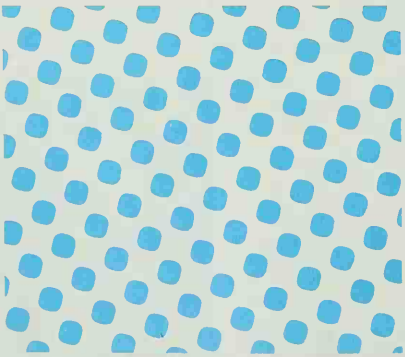
A yellow dot pattern printed on a white reflective surface



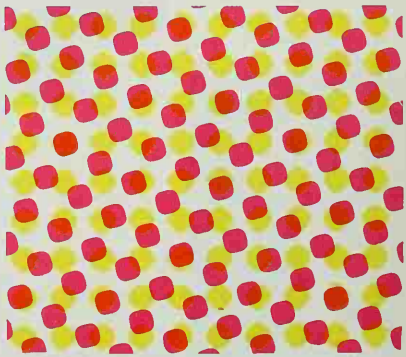
A magenta dot pattern printed on a white reflective surface



The cyan pattern rotated through 60° and printed over the combined magenta and yellow plate producing eight component colours from this three-colour process



A cyan dot pattern printed on a white reflective surface



The magenta pattern rotated through 30° and printed over the yellow pattern producing four colours

A THREE-COLOUR SUBTRACTIVE PROCESS IN COLOUR REPRODUCTION

ADAPTED FROM A. C. HARDY AND F. L. WURZBURG, JR., "INTERCHEMICAL REVIEW," VOL. 9, NO. 3

of colorimetry is ordinarily employed. The basis for this method was established about 1860 by James Clerk Maxwell, who evaluated the spectrum colours in terms of three arbitrarily selected primaries. Such measurements were subsequently repeated on several occasions, but the first systematic investigations, using large groups of normal observers, were made in England about 1928 by W. D. Wright and by J. Guild. Their combined results are indicated in abridged form in Table I after transformation to the same convenient set of primaries. In terms of these primaries, a unit amount of radiant energy having, for example, a wave length of 400 mμ is seen to be visually equivalent to a mixture comprising 14.3 units of the red primary, 0.4 units of the green primary and 67.9 units of the blue primary. Thus, the table indicates the tristimulus values of unit amounts of the various spectrum colours.

TABLE I.—*Tristimulus Values of the Spectrum Colours**

Wave length (mμ)	*X* (red)	*Y* (green)	*Z* (blue)
400	14.3	0.4	67.9
420	134.4	4.0	645.6
440	348.3	23.0	1747.1
460	290.8	60.0	1669.2
480	95.6	139.0	813.0
500	4.9	323.0	272.0
520	63.3	710.0	78.2
540	290.4	954.0	20.3
560	594.5	995.0	3.9
580	916.3	870.0	1.7
600	1062.2	631.0	0.8
620	854.4	381.0	0.2
640	447.9	175.0	...
660	164.9	61.0	...
680	46.8	17.0	...
700	11.4	4.1	...

*Adopted by International Commission on Illumination, 1931.

Data of this type form the basis for the indirect method of colorimetry because, given the tristimulus values for a unit amount of light of any wave length, the tristimulus values of any heterogeneous mixture of known spectral composition can be readily computed by a simple process of summation. Since the spectral composition of the heterogeneous light reflected by a given sample under a given illuminant is determined by its spectrophotometric characteristics, one can compute tristimulus values from spectrophotometric data without having to use a colorimeter. In effect, one hypothecates a colorimeter employing the standard set of primaries and then determines by computation what the tristimulus values would be in a given case if the observers of Wright and Guild were to use the hypothecated colorimeter under the same carefully controlled conditions. In 1931 the International Commission on Illumination or Commission Internationale de l'Éclairage (C.I.E.) defined the standard observer for colorimetry by officially adopting the data of Wright and Guild, and this hypothetical observer subsequently took part in countless colorimetric determinations throughout the civilized world.

At the same time, the C.I.E. recommended three standard illuminants for actual use with a colorimeter or for hypothecation when the indirect method is employed. Illuminant *A* was intended to be typical of the light from an ordinary gas-filled tungsten lamp, illuminant *B* to represent noon sunlight and illuminant *C* to represent average daylight. Of these three standard illuminants, illuminant *C* came into far greater use than did the others, especially in the United States. In 1942 the American Standards association recommended that, "In the absence of a special reason for adopting some other illuminant in reducing spectrophotometric data, the standard C.I.E. illuminant C, representative of average daylight, shall be used." In terms of this U.S. standard method of colour specification, the tristimulus values of the emerald green sample whose spectrophotometric curve is reproduced in fig. 1 are found by calculation to be $X=22.7$, $Y=39.1$ and $Z=31.0$.

Dominant Wave Length, Reflectance and Purity.—Although three tristimulus values provide a basic colour specification, it is common practice to translate them into a numerical language that is more interpretive. This translation is facilitated by the fact that the basic stimuli of the C.I.E. system were purposely so selected that, in the proper units, the value of *Y* indicates the reflectance of the sample in the ordinary photometric sense. That is, the emerald green sample of fig. 1 is only 39.1% as luminous as the standard white surface when both are illuminated equally by average daylight. The neutral colours (white, gray and black) are adequately specified by this single number, provided they are truly neutral, or achromatic.

The value of *Y* represents the reflectance of the chromatic colours as well, but it is then necessary to specify the quality of the reflected light as well as its quantity. The standard method of specifying the quality, or chromaticity, is based on the principle of the so-called monochromatic colorimeter, in which the comparison field is occupied, not by a mixture of three primaries, but by a mixture of white light and homogeneous light. Every colour (except purple) can be matched in the comparison field of this type of colorimeter by adding an appropriate amount of white light to an appropriate amount of homogeneous light of the proper wave length. The wave length of the homogeneous light is then known as the dominant wave length of the sample.

In practice, monochromatic colorimeters are almost never used because the indirect method is vastly more satisfactory. Tables and charts have been prepared which, for the assumed standard conditions, enable the dominant wave length of the sample to be readily determined from its tristimulus values. In the case of the above sample of emerald green, the dominant wave length is found by this method to be 511.9 mμ. It will be noted that the dominant wave length is not the wave length at which the spectrophotometric curve has its maximum; although, in the case of this particular sample, it is not very different.

Purples and other nonspectral colours are generally characterized by spectrophotometric curves having two maxima, one at the violet end of the spectrum and the other at the red end. When such samples are illuminated by daylight, they reflect a mixture of red light and violet light that cannot be matched by a mixture of white light and any single band of homogeneous light. Hence, in measuring nonspectral colours with a monochromatic colorimeter, green light is added to the sample side of the field until a match is produced with the white light in the comparison field.

TABLE II.—*Analysis of Artists' Pigments*

Pigment	Dominant wave length (millimicrons)	Reflectance (percent)	Purity (percent)
Alizarin crimson	628.0	6.6	57.2
English vermilion	608.1	22.3	59.9
Cadmium red	604.8	20.8	67.3
Venetian red	599.2	13.1	50.2
Burnt sienna	598.5	7.6	40.1
Burnt umber	589.5	5.1	34.2
Cadmium orange, medium	586.9	42.2	86.9
Raw sienna	584.2	20.0	61.3
Chrome yellow, medium	581.6	63.1	81.8
Zinc yellow	575.8	32.6	79.7
Zinc white	569.5	94.9	1.5
Chrome green, medium	552.4	16.0	34.7
Emerald green	511.9	39.1	22.8
Ivory black	494.5	2.2	1.7
Cobalt blue	474.6	16.8	65.5
Cobalt violet	560.3$_c$	9.3	48.5
Manganese violet	553.7$_c$	27.0	21.6

From "Technical Studies," Fogg Art Museum; Harvard University (Cambridge, Mass., 1939).

This addition of green light to the sample field is the equivalent of subtraction from the white light of the comparison field. The green light is therefore complementary (in the ordinary sense of complementary colours) to the mixture of red light and violet light that would need to be added to the comparison field if the match were to be produced by the ordinary procedure. Thus, the artist's pigment known as cobalt violet is found by these standard procedures to be a bluish-purple whose dominant wave length is 563.5$_c$, the subscript indicating that the complementary wave length is being specified.

Although two samples may be alike in both dominant wave length and reflectance, they may nevertheless be unlike in another respect. One sample may be nearly gray in appearance while the other may be strongly chromatic. This third attribute is called purity. Like dominant wave length, the numerical value of the purity is ordinarily ascertained from its tristimulus values by the aid of appropriate tables or charts. The standard practice is to represent purity on a scale that assigns zero purity to the achro-

matic colours (white, gray and black) and 100% purity to the strongest colours that are theoretically possible at each dominant wave length; *i.e.*, the spectrum colours themselves. On this standard scale, the emerald green sample of fig. 1 is found to have a purity of 22.8%.

As an aid to the interpretation of the significance of this standard method of colour specification, Table II is reprinted in abridged form from a study of artists' pigments published for the Fogg Art museum of Harvard university. The pigments have been arranged, for convenience, in the order of decreasing dominant wave length, with the nonspectral colours at the bottom. It will be seen, for example, that Venetian red is somewhat more orange than cadmium red, that it is the darker of the two, whereas the cadmium red is the stronger (purer). One wishes that the colours of the pigments used by the old masters might have been thus preserved forever in terms of objective physical measurements.

Graphical Representation.—For the same reason that the study of geography is facilitated by the use of maps, a graphical method of representing colour is desirable. The analogy is particularly pat because three parameters are required to describe either a colour or the location of a point in space. The customary procedure in colorimetry is to represent the quality of a colour on a two-dimensional diagram, its quantity being amply indicated by its Y tristimulus value. In the type of chromaticity diagram that has become standard through extensive use, the quality of a colour is specified by its trichromatic coefficients, which are defined in terms of its tristimulus values by the following equations:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

$$z = \frac{Z}{X+Y+Z}$$

It follows from this definition that $x+y+z=1$, for all values of X, Y and Z. Because of this relationship, chromaticity is adequately expressed by any pair of trichromatic coefficients; and the standard practice is to employ x and y.

The locus of the spectrum colours on the standard diagram is shown by the solid line in fig. 2. This locus is constructed by drawing a line through points representing the trichromatic coefficients of the spectrum colours at frequent intervals of wave length. As an example, the tristimulus values of a unit amount of light whose wave length is 400 mμ have been seen to be $X=14.3$, $Y=0.4$ and $Z=67.9$. Substitution of these values in the equations defining the trichromatic coefficients gives $x=0.1733$ and $y=0.0005$. The point labeled 400 in fig. 2 has these co-ordinates, and it represents the location of any amount of spectrum light of this wave length on this type of chromaticity diagram. An extension of this procedure enables the entire spectrum locus to be constructed.

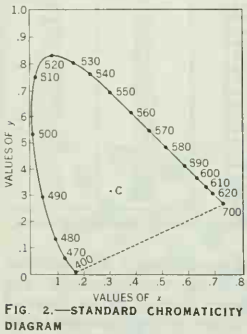


FIG. 2.—STANDARD CHROMATICITY DIAGRAM

If spectrum light whose wave length is 400 mμ be mixed with spectrum light whose wave length is 700 mμ, the resultant colour can be shown to lie along the dashed line of fig. 2 connecting the two points, the exact position in the line being dependent upon the proportions of each in the mixture. Since this is a general property of the chromaticity diagram, it follows that the point representing the additive mixture of any number of spectrum colours in any proportions, and hence all real colours, must always lie within the area bounded by the spectrum locus and the dashed line joining its ends. In particular, the mixture selected as the standard of average daylight (illuminant C) is found by the summation process referred to above to be represented by the point C near the centre of this area. The colour of a pure white reflecting surface under this illuminant is likewise represented by the point C.

The chromaticity diagram facilitates a better understanding of the concepts of dominant wave length and purity discussed in the preceding section. In fig. 3, the point G represents the trichromatic coefficients $x=0.2446$ and $y=0.4214$ of the emerald green sample whose tristimulus values were previously found to be $X=22.7$, $Y=39.1$ and $Z=31.0$. This point is seen to lie on a line connecting the white point C with a point on the spectrum locus at 511.9 mμ, and it will be recalled that this was the dominant wave length of the emerald green sample. The purity of this sample was previously found to be 22.8%, and this attribute is represented by the relative distance of the point G from the white point C.

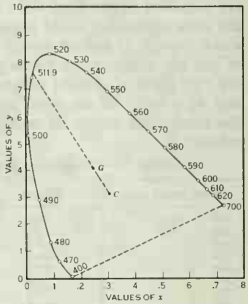


FIG. 3.—LOCATION OF EMERALD GREEN ON THE CHROMATICITY DIAGRAM

Since all neutral grays have the same trichromatic coefficients as a white surface and differ from it only in reflectance, they are all represented by the point C on this type of diagram.

The problem of graphically representing reflectance is akin to that of representing elevation on the ordinary map. One may imagine that surfaces of zero reflectance are represented by points in the plane of the chromaticity diagram; and that, in a three-dimensional diagram, reflectance would be represented by the height of a point above this plane. David L. MacAdam investigated the theoretical boundaries of the colour space thus defined by the C.I.E. chromaticity diagram. In practice, of course, these boundaries are set by the characteristics of the available dyes and pigments, and the boundaries are extended from time to time as new colorants are discovered. MacAdam, ignoring these essentially chemical limitations, calculated the theoretical limits that may some day be approached but never exceeded. Thus, each contour line in fig. 4 defines an area within which all colours having the indicated reflectance must inevitably be found, assuming no fluorescence. It is seen at once that any surface reflecting as much as 90% of the white light incident upon it must be either a yellowish-green or a near-white. It will also be seen that a strong blue must inevitably be a dark colour. To manufacturers of dyes and pigments, the shape of this colour solid is important because, when the available colours are plotted on this diagram, the regions of potentially profitable research on new colours are clearly indicated.

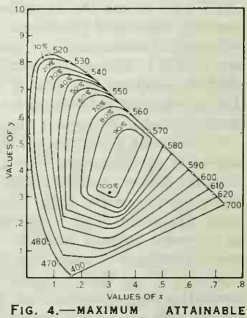


FIG. 4.—MAXIMUM ATTAINABLE REFLECTANCE FOR SPECIFIED CHROMATICITY

Material Colour Standards.—The concept of complete interchangeability of parts, which forms the basis of all mass-production industries, introduced a new era in which the public came to expect the colour of any product to be maintained constant within narrow limits. Prior to the development of adequate colorimetric techniques, the colour had perforce to be maintained by means of reference standards, often over long periods of time. This method presented no real difficulties in industries like the ceramic industry where the products are so permanent in their colour characteristics that samples from the production line can be set aside for use as reference standards. In many other industries, however, a sample of the product may be quite unsatisfactory for this purpose. In

any case, a growing collection of reference standards, accumulated at random, generally becomes unwieldy beyond a certain size because of its lack of organization.

It is not unnatural that there should have been many attempts to construct colour systems by organizing collections of material standards in accordance with some logical plan. Of the various systems of this sort, the most successful was that originated by A. H. Munsell, who prepared and issued the *Atlas of the Munsell Color System* in 1915. Munsell's three parameters, hue, value and chroma (figs. 5, 6 and 7), corresponded to the basic parameters, dominant wave length, reflectance and purity. The Munsell value scale divided the range between a perfect black and a perfect white into ten steps, spaced in accordance with the readings of a photometer that Munsell had constructed. This photometer contained a cat's-eye shutter, and, as a consequence, value in the original Munsell system was equal to the square root of the reflectance in the basic system. Thus, a surface of value 5 has a reflectance of 25%.

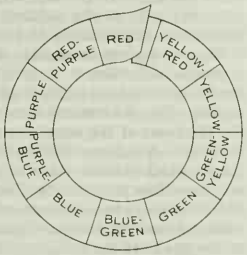


FIG. 5.—MUNSELL'S PARAMETER HUE

With the value scale established, Munsell selected samples of red, yellow, green, blue and purple at value 5 which appeared to be equidistant from a gray of the same value and from one another. These became the principal hues of the system. The five intermediate hues which completed the hue circuit are the complements of the principal hues. By definition, these principal hues and their intermediates were arbitrarily said to be of chroma 5. The several hundred colour chips of the *Atlas* are small rectangular slips of paper painted with water-colour paints of considerable permanence. All the chips in a horizontal row have the same value and all those in a vertical column have the same chroma. The entire system was constructed in accordance with rules of disk mixture (*see* below).

The colour tree of Munsell is a three-dimensional representation of this system in cylindrical co-ordinates with the scale of neutral values as the vertical axis. Hue is represented by points of the compass around the vertical axis; chroma by distances from this neutral axis. For each hue, the maximum chroma at any value level was limited by available pigments with suitable permanence. In 1939, J. Tyler, by using MacAdam's colour solid, computed the maximum chroma theoretically possible at each hue and value.

After Munsell's death, a new edition of the *Atlas*, the *Munsell Book of Color*, was issued in 1929. Superficially, the two editions are strikingly similar; but the philosophies underlying their construction were different. The nature of this difference will be clear from a consideration of the value scale of the original system. If Munsell had divided the range between black and white into equal steps of reflectance instead of into equal steps on a square-root scale, the chips would have appeared to be spaced too closely in the upper range and too far apart in the lower range. Psychologists have long recognized three attributes of a colour sensation: hue, brightness and saturation; and, by definition, the steps of a psychological scale appear to be equally spaced. The value scale of the *Atlas* approximates a psychological brightness scale, but the value scale of the *Munsell Book of Color* is a closer approximation. Each system has its advantages. Thus, the chips of the *Atlas* were assigned positions in the system in accordance with certain fixed rules; whereas the chips of the *Book of Color* were intended to be perceptually uniform in spacing, under standard viewing conditions.

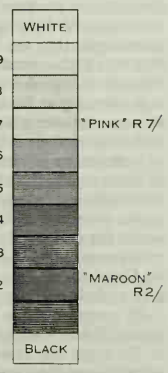


FIG. 6.—MUNSELL'S PARAMETER VALUE

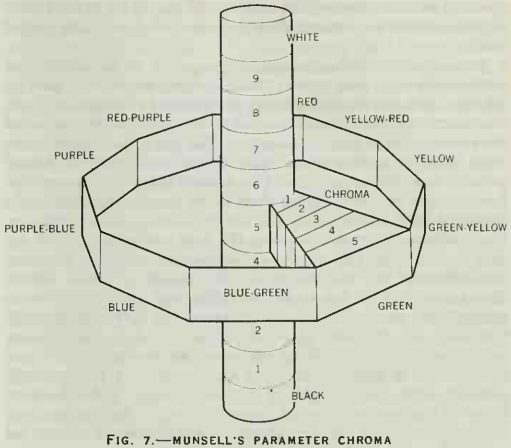


FIG. 7.—MUNSELL'S PARAMETER CHROMA

In 1935 J. J. Glenn and J. T. Killian analyzed all the chips of the *Munsell Book of Color*, determining the dominant wave length, reflectance and purity of each. In 1942 the American Standards association recommended the use of the *Munsell Book of Color* whenever applicable to the specification of the colour of surfaces. Approximate identifications of Munsell hue, value and chroma are secured by direct visual comparison with the chips themselves. For more accurate Munsell notations, it was recommended that the Munsell notation be determined by using the basic method and a special chromaticity diagram prepared by direction of the Colorimetry committee of the Optical Society of America. Interpolation on this diagram shows that the emerald green sample of fig. 1 has a hue designated by 5.0G, the symbol 5.0 indicating that the hue of the sample is the same as that of the primary green hue of the system. Its value is found to be 6.7; its chroma, 11.2. In the standard method of notation, the colour of this sample of emerald green would be written 5.0G 6.7/11.2.

The use of any system of material standards requires taking precautions that are often ignored. Frequently the spectral reflection characteristics of the sample are so unlike those of the chips used as reference standards that the match is meaningless unless made by a normal observer under a standard illuminant. Also, because of possible differences in surface characteristics, the geometrical mode of illumination and observation must be standardized; *e.g.*, the colour chips of the *Munsell Book of Color* have nearly matte surfaces, and their appearance is only slightly affected by the mode of illumination and the mode of observation. On the other hand, since the appearance of a glossy sample varies with the mode of illumination and observation, its comparison with the Munsell chips must be made under standard viewing conditions. Similar considerations apply to the mode of illumination and observation used in spectrophotometers and colorimeters, but standard conditions are then more likely to be maintained because they are fixed by the design of the instruments. Space does not permit discussion of other colour systems, as those of R. Ridgway, W. Ostwald and others. The significant fact is that chips of any system of material standards can be evaluated in terms of the basic system by standard procedures, thus making the basic system the common language into which all others can be translated. In this way, all systems can be interrelated; a colour specification in one system can be translated into any other.

The Colour of Light Sources.—It will be obvious that the colorimetric techniques described in earlier sections of this article can be adapted to the evaluation of the colour of a light source. Television is one field in which these techniques are particularly appropriate because the television screen is a primary source whose colour *per se* is of some importance. Ordinarily, however, a light

source is used to provide illumination, and the colour of the source is then of lesser importance than the colour of objects illuminated by it.

It was pointed out in the opening paragraph of this article that a tablecloth may look just as white by candlelight as it does by daylight, and this example of the psychological principle of colour constancy would seem to indicate that the spectral composition of the source is not of great importance. The fact is that the principle itself is not of general applicability, as can be deduced on logical grounds from the behaviour of two samples that match under daylight but fail to match under some other source. Evidently, the colour of both samples does not remain constant under changing illumination. If those who select the dyes and pigments that are used in producing the colours encountered in everyday life were not influenced by the desires of the consuming public, colour constancy might be the exception rather than the rule. For example, when dyeing a textile fabric green, the dyer will normally formulate the dye bath so as to produce a fabric that appears green under artificial light as well as under daylight. He could, however, by a different choice of dyes, produce a fabric which, although green by daylight, is a reddish brown under tungsten light. Thus, the principle of colour constancy derives much of its justification from the circumstance that inconstant colours are regarded by the public as freakish.

Of course, if two samples are identical in their surface characteristics and are also identical in their spectrophotometric characteristics, they are physically similar and will always be considered a perfect match by any observer under any illuminant. If the two samples are unlike in their spectrophotometric characteristics, they may nevertheless be a colour match under some illuminant. In this case, they will not ordinarily match under an illuminant of different spectral composition, even when the second illuminant appears to have the same colour as the first. It is therefore more important to know the spectral composition of the light emitted by a source, as determined by a spectroradiometer, than it is to know its colour, as determined (directly or indirectly) by a colorimeter.

Before the introduction of fluorescent lighting, tungsten lamps were the principal sources of artificial illumination. When the temperature of a tungsten filament is increased, its colour changes from red through orange to a pale yellow. From theoretical studies of the behaviour of ideal radiators, it is known that, if the temperature of a tungsten filament could be indefinitely increased, the colour of the filament would become white and finally blue.

Because the laws pertaining to the behaviour of ideal radiators are so well known, the colour of such a radiator at any temperature can be readily calculated by the indirect method of colorimetry. A tungsten lamp does not radiate so much energy as an ideal radiator at the same temperature, but its spectral quality is not very different. For this reason, it is common practice to specify the colour of a tungsten lamp in terms of its colour temperature, which is, by definition, the temperature of an ideal radiator of the same chromaticity. The concept of colour temperature can often be extended to sources whose colour is not a function of temperature. Thus, the colour temperature of blue sky is frequently in the neighbourhood of 20,000° on the Kelvin scale, the use of the concept being justified in this case because the spectral quality of sky light is a reasonably close approximation to that of an ideal radiator at this temperature.

The Colour of Transparent Materials.—Until now, we have been concerned with samples that were assumed to be opaque, but the techniques of colour measurement discussed above are applicable, with minor modifications, to the measurement of the colour of transparent materials, such as a sheet of coloured glass or coloured plastic. Thus, by means of a spectrophotometer, the spectral transmittance of a sample can be determined at convenient wave-length intervals throughout the visible spectrum, the spectral transmittance at any wave length being the ratio of the amount of light transmitted by the sample to the amount of light incident upon it. Colorimeters can likewise be used in a direct evaluation of the colour of the sample when it is placed in a beam of heterogeneous light, or the indirect method of colorimetry may be employed. Systems of material standards have also been developed, and the series of coloured glasses prepared for use with the Lovibond tintometer deserves special mention.

When the thickness of a coloured material is varied, its spectral transmittance curve changes shape in a manner that can be calculated by the application of Bouguer's law, after correction is made for the reflection losses at the two surfaces of the sample. Bouguer's law states that $t = t_0^x$, where, at any wave length, t is the spectral transmittance of a thickness x and t_0 is the spectral transmittance of a unit thickness. Thus, if a unit thickness of the sample transmits 10% of the incident light at some wave length, doubling the thickness will result in a transmittance of $(10\%)^2 = 1\%$. If at some other wave length, a unit thickness transmits 90% of the incident light, doubling the thickness will reduce the transmittance to $(90\%)^2 = 81\%$.

Because a given increase in the thickness of the sample causes a greater reduction in transmittance in spectral regions where the transmittance of a unit thickness is low than it does in spectral regions where the transmittance of a unit thickness is high, varying the thickness of the sample sometimes causes surprising changes in colour. A common illustration is provided by certain green eyeshades which contain a dye whose spectral transmittance may be not more than 30% for green light and even less elsewhere, except in the far red, where the transmittance may increase abruptly to a value approaching 100%. Because of the vastly greater sensitivity of the eye near the middle of the visible spectrum, the eyeshade appears green. The effect of increasing the thickness of the material is easily observed by folding it in such a manner that the light must pass through two or more layers. By thus increasing the length of the optical path through the material, the transmittance for green light is decreased more than the transmittance for red light; and, at some length of optical path, the dominant wave length shifts abruptly from green to red. This phenomenon, called dichromatism, was surrounded for many years by an aura of mystery before it was seen to be a direct consequence of Bouguer's law.

When a liquid, such as a dye solution, is contained in a glass cell having parallel sides, it is ordinarily of interest to know how the shape of the spectral transmittance curve will vary with the concentration of the solution. If only a single substance is present, Beer's law states that $t = t_0^c$, where t at any wave length is the spectral transmittance for a concentration c and t_0 is the spectral transmittance for unit concentration. This law holds also for a mixture of substances, provided no chemical reactions take place. Thus, although it is often stated that some substances do not obey Beer's law, such substances are invariably mixtures of two or more components in an equilibrium that depends upon the concentration. It will be seen that, when no such equilibrium is involved, varying the concentration produces the same change in colour as varying the length of the optical path.

The Optical Mechanism of Colour Production.—The brilliant colours produced by a prism or diffraction grating, by the interference of light or by polarization are the result of optical phenomena that are described elsewhere. Suffice it to say here that in all phenomena of this sort the devices employed are not themselves regarded as being coloured in the ordinary sense. This is presumably so because these devices merely separate white light into components which, although deviated in different directions, lose none of their original energy. Thus, the kaleidoscopic array of interference colours exhibited by a thin film of oil on the surface of water results from the fact that some components of the incident white light are reflected more copiously than others in the direction of the observer. When this oil film is observed from a different angle, the colours are seen to be different, and they may even be complementary. If it were possible for an observer to look at an oil film from all directions at once, the colour effects would disappear entirely.

By contrast, when the surface of an opaque object is viewed from different angles, the colour sensation is so nearly independent of the angle that there seems to be a reliable linkage between the stimulus and the sensation. In such circumstances, it is legitimate to regard the colour of the object as one of its inherent characteris-

tics. This is certainly true of matte surfaces, whose appearance is exactly the same from every viewing angle. Although it is not strictly true of glossy surfaces, which, because of their smoothness, exhibit a certain amount of mirrorlike reflection, the greater abundance of nearly matte surfaces makes it convenient to regard all opaque objects as being possessed of colour, even when the colour depends to some extent on the mode of illumination and the mode of observation.

Except for metallic substances, which exhibit surface colour, the colour of an opaque object is generally a body colour. The optical mechanism involved in the production of body colour is complex, but it can be simply illustrated by reference to the colour of the sky. On a clear day, the atmosphere consists of air molecules, dust particles and water droplets, most of which are small in size by comparison with the wave length of visible light. Sunlight can pass freely through the ordinary thickness of the atmospheric layer, but the submicroscopic particles of the atmosphere scatter part of the light, and this scattering is shown by both theory and experiment to vary as the inverse fourth power of the wave length. As a consequence, violet light whose wave length is 400 mμ is scattered about nine times more effectively than red light whose wave length is 700 mμ. The colour of the sky is caused by this selective scattering, the scattered light reaching the observer being predominantly blue. At sunrise or at sunset, on the other hand, the light from the sun loses its short wave-length components by selective scattering before reaching the observer, and it is therefore yellow or even red. There are many days on which the size of the droplets of water suspended in the atmosphere increases steadily as the day wears on. This increase in particle size is accompanied by a loss of blue colour in the sky and by a reduction in the visibility along a horizontal path, objects even a short distance away being hidden from the observer.

Similar effects can be observed in a film of paint applied to the surface of a sheet of glass when the paint is specially compounded of submicroscopic particles of a white pigment suspended in a clear vehicle. The light reflected by the paint film when it is placed in a beam of sunlight is predominantly blue because of the selective scattering, and the transmitted light is correspondingly deficient in blue and therefore yellowish. If the thickness of the paint film is increased, a greater proportion of the incident light is reflected by the film, and a smaller proportion is transmitted. The sun, when observed through a thick film of paint of this sort, appears as red as it does at sunset.

Evidently such a white pigment would not produce a satisfactory white paint because the particles are so small that light is easily diffracted around them. In the language of the paint industry, such a paint would be said to have little hiding power. The effect of using pigment particles of larger size is twofold; more light is scattered by each particle, and the scattering becomes less selective as to wave length. However, to obtain a maximum of hiding power, the particles should not be too large because the greater effectiveness of each particle is then more than offset by the reduction in the number of particles in a given mass of pigment. The optimum size is found to occur when the diameters of the pigment particles are, on the average, just slightly less than the wave length of visible light.

The hiding power of a white paint depends not only on the particle size of the pigment but also on the relationship between the refractive index of the pigment and that of the vehicle in which the pigment particles are suspended. When the two refractive indexes are identical, light passes through the pigment particles without change in velocity, and, from an optical standpoint, the effect is the same as though the pigment particles were not present, although the viscosity and other physical characteristics of the paint are altered by the presence of the particles. To secure hiding power, pigments are selected whose indexes of refraction are high by comparison with that of the vehicle. Some forms of titanium dioxide, for example, have an index of refraction as high as 2.76; whereas the index of refraction of most vehicles is in the neighbourhood of 1.5.

Most white pigments are crystalline substances precipitated under conditions that provide for the proper control of the particle size. It is not always realized that a large crystal of the material would be as transparent as a piece of clear glass. Indeed, it often assists the understanding of the behaviour of light in a paint film to speculate that a white pigment might be produced by grinding a sheet of glass into particles so fine as to produce a powder. If the glass were perfectly transparent in sheet form, a pile of this powder would be intensely white. It could not be otherwise because, if the pile is deep enough, no light is transmitted through it; and, if the glass is perfectly clear, no light is absorbed. Hence, all the light incident upon the pile must be reflected.

These considerations aid in understanding the behaviour of coloured pigments, which, from an optical standpoint, might be prepared by crushing coloured glass until the particles are of the size required for good optical and mechanical performance as a pigment. Thus, a red pigment might be prepared by crushing a sheet of red glass which transmits red light freely while absorbing all other radiations, the latter being effectively destroyed by conversion of the energy into heat. A red pigment produced in this way would behave like a white pigment when illuminated by pure red light, but it would behave like a black pigment when illuminated by light from any other part of the visible spectrum. The selective reflection characteristics of a paint film are thus seen to be caused by the selective absorption that takes place within the pigment particles.

Most commercial pigments are more intensely coloured than any available coloured glass, and the latter would be said to have little tinting strength. Indeed, some commercial pigments absorb so strongly in certain spectral regions that the refractive index becomes anomalously high in those regions; and the pigment particles at or near the surface of a paint film reflect the light that would be most strongly absorbed if it could penetrate the surface of the particles. This reflected light predominates when such a paint film is viewed at grazing incidence, and the film takes on a colour that is nearly complementary to the colour that is exhibited at normal angles of viewing. This effect is known as bronze, because of its resemblance to metallic reflection.

The combination of scattering and absorption that takes place in nonhomogeneous mediums has been treated mathematically by a number of investigators, but the mathematical theory cannot be appropriately treated here. It must suffice to say that most opaque substances owe their colour to a combination of scattering and absorption within the body of the material.

The Laws of Colour Mixture.—The surface of a roofing material that looks brown when seen from a distance may be found, on closer examination, to consist of crushed green slate, red brick dust and some sort of black bonding material. The green light reflected by the slate particles and the red light reflected by the brick particles are mixed together in the eye when the viewing distance is so great that the individual particles cannot be resolved. This mixture of green light and red light is yellow; but the total quantity of yellow light is small, partly because of the low reflectances of the particles, and partly because the interstices between the particles, being black, make little contribution to the total amount of light reflected. Thus, the resulting colour is a dark yellow, and the common name for all dark yellows is brown.

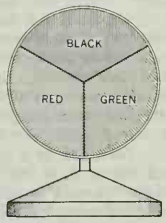


FIG. 8.—MAXWELL COLOUR DISK

Colours produced in the above manner are said to be additive mixtures because the components add their individual contributions of light to the resultant mixture. The essential characteristics of this type of mixture are even more apparent when the mixture is produced by means of a Maxwell disk like that shown in fig. 8. In this illustration, the components are a red, a green and a black in equal proportions; and the spinning disk is brown for the reasons outlined in the preceding paragraph.

In additive mixtures involving the addition of two or more beams of coloured light, as in theatrical lighting, the spectral

energy of the mixture at each wave length is the sum of the spectral energies of the components. It follows that each of the three tristimulus values of the mixture is likewise the sum of the corresponding tristimulus values of the components. When the mixture is made by means of an unresolved pattern or by spinning the colours on a Maxwell disk, the components are not independent of one another, since increasing the relative area allotted to one component reduces the area occupied by the others. In this case, the tristimulus values of each component are multiplied by its fractional area before performing the addition. As an example of the foregoing, the tristimulus values of a typical sample of the artist's pigment chrome yellow are $X=68.4$, $Y=63.0$ and $Z=9.6$. When one-third of a Maxwell disk is of this colour and the remaining two-thirds has the colour of cobalt blue, whose tristimulus values are $X=18.3$, $Y=16.8$ and $Z=67.2$, the tristimulus values of the additive mixture produced by spinning the disk are $X=34.8$, $Y=32.2$ and $Z=48.0$. The trichromatic coefficients of this mixture are $x=0.303$ and $y=0.280$; and, by reference to a large-scale chromaticity diagram, it is found that this mixture is a purple whose dominant wave length is 558_o and whose purity is 13.7%.

Those whose knowledge of colour is limited to empirical observations concerning the behaviour of dyes and pigments in the ordinary type of mixture would expect a combination of yellow and blue to produce green rather than purple. That is, if a yellow pigment and a blue pigment are intimately mixed in a transparent vehicle, such as linseed oil, a green paint is the usual result. The reason is simple when the optical mechanism involved in the production of body colour is kept in mind, because it is easily seen that the light incident upon the paint film must, on the average, pass through many particles of both pigments before emerging again as reflected light. A characteristic feature of strong yellow substances is their ability to absorb blue light and violet light, while transmitting all other visible radiations quite freely. Typical blue substances, on the other hand, absorb yellow light, orange light and red light, while transmitting blue light and violet light. As a consequence, the only spectral component that is not strongly absorbed by either pigment is green. If the paint film has the requisite scattering properties, this green light ultimately finds its way back to the surface through which it entered the paint film. Thus, the subtractive mixture of yellow and blue produces green because the other components of white light are so strongly absorbed within the body of the material.

The colour that results from a subtractive mixture is readily calculated in the case of two transparent substances, such as two coloured glasses, arranged in tandem so that the light must pass through both before reaching the observer. Neglecting the small amount of light reflected at the surfaces, the spectral transmittance of the pair at any wave length is the product of the spectral transmittances of the components at the corresponding wave length. The tristimulus values of the combination can be found by applying the standard procedure to the spectral transmittance data thus calculated. Unlike the case of additive mixtures, the tristimulus values of a subtractive mixture ordinarily cannot be calculated from the tristimulus values of its components. In other words, the visual colour of the components is not a reliable guide to the colour of their mixture. Instead, one must know the spectral absorption characteristics of the components—information that only a spectrophotometer can provide.

The laws of subtractive mixture are vastly more complex in the case of a paint film or a dyed textile fabric. Probably the most complex case of all is that of a plastic material that may contain particles of pigment as well as molecules of dye. Although the mathematical theory concerning the behaviour of light in the presence of absorption and scattering enables the change in colour of such a material with thickness to be calculated for both the reflected light and the transmitted light, it does not enable the colour of such a material to be readily calculated from the measured characteristics of its components. Nor can the optical absorption characteristics of even a single substance be readily calculated from its molecular or atomic structure.

In the field of photography, the entire colour gamut of a colour reproduction is customarily achieved by mixing three primaries in various proportions. The original three-colour process, invented by Maxwell in 1855, reproduced the colours of the subject by appropriate additive mixtures of red light, green light and blue light. Although Maxwell's choice of primaries seems to have been based on a slightly erroneous deduction from Thomas Young's theory of colour vision (*see* VISION OR SIGHT), the fact remains that the use of a deep red, a strong green and a deep blue provides the greatest gamut of possible colours in the reproduction.

The many ingenious methods of colour photography employing additive mixtures have been largely superseded by the more convenient subtractive methods. The starting point of all subtractive methods is a white projection screen or a sheet of white paper, either of which can be regarded as reflecting a mixture of red light, green light and blue light. In a projection system, three registered dye images, arranged in tandem, are inserted in the projector. In the case of colour prints, similarly registered images are superimposed on the surface of the white paper. In the latter case, the incident light passes through the three images, is reflected by the white paper and passes again through the three images before reaching the observer.

In additive processes, the colour gamut achievable with a set of primaries whose colours are known can be readily computed by application of the laws of additive mixture. This is true also of some of the subtractive processes employed in the graphic arts because the fact that the images are composed of dots makes these processes the equivalent of an eight-colour additive process. In general, however, the calculation of the colour gamut of subtractive processes is so laborious that it is simpler to determine it experimentally. Of course, certain characteristics of the most desirable set of subtractive primaries are obvious. If black is to appear in the reproduction, every component of the visible spectrum must be strongly absorbed by at least one of the primaries. Also, the fact that additive processes have the greatest gamut when the primaries are red, green and blue makes it reasonable to expect that the greatest gamut in subtractive processes will be achieved when the primaries are, respectively, red-absorbing, green-absorbing and blue-absorbing. Of course, the colour of an image that absorbs red light while transmitting all other radiations is blue-green, often called cyan. An image that absorbs only green light transmits both blue light and red light, and its colour is magenta. The blue-absorbing image transmits only green light and red light, and its colour is yellow.

The same principles apply in the mixing of pigments in a paint. If three pigments are to be capable of producing the greatest possible colour gamut, they must have the same optical absorption characteristics as the dyes of a three-colour subtractive process in photography. In 1933 Herbert E. Ives made a systematic study of the spectral absorption characteristics of all the readily available pigments, and he concluded that an artist's palette containing only three properly chosen colours is entirely adequate under most circumstances. The practical advantages of such a simplified palette result in part from the fact that the use of certain pigments of questionable permanence can be avoided and in part from the simplification of the laws governing the colours that mixtures of these pigments will produce.

No concepts in the field of colour have traditionally been more confused than those just discussed. This confusion can be traced to two prevalent misnomers: the subtractive primary cyan, that is properly a blue-green, is commonly called blue; and the subtractive primary magenta is commonly called red. In these terms, the subtractive primaries become red, yellow and blue; and those whose experience is confined for the most part to subtractive mixtures have good cause to wonder why the physicist insists on regarding red, green and blue as the primary colours. The confusion is at once resolved when it is realized that red, green and blue are selected as additive primaries because they provide the greatest colour gamut in mixtures. For the same reason, the subtractive primaries are, respectively, red-absorbing (cyan), green-absorbing (magenta) and blue-absorbing (yellow).

The Use of Colour.—Colour plays so important a role in every department of modern life, and its every application is surrounded

by so many special circumstances, that only a few general comments can be made concerning the features that are common to many of its applications. Ordinarily, the first problem in the use of colour is to decide what colour or colours to use. Science has been of little aid in this connection, not because its methods are necessarily inadequate, but rather because the tools of colorimetry had first to be developed. In a negative sense, science can supply the information that no harmonic combinations, comparable to chords in music, seem likely to be discovered. Light and sound are different forms of wave motion; the eye has only rudimentary powers of analysis by comparison with those of the ear; and, at best, the entire visible spectrum comprises less than one octave. Nor is there a physical or physiological basis for believing that some colours per se are always desirable and others undesirable. After all, the spectral array of colours exhibited by a rainbow is a glorious sight; and no one seems ever to have suggested that it would be improved by the omission of one or more of the components.

Of course, a civilization as old as ours has developed taste in colour, as it has in music. Through the centuries, many musical forms have been created, and each has come to be considered appropriate on some occasions and inappropriate on others. A similar sense of fitness has been acquired concerning the use of colour, but there is a significant difference between the two arts. One can be specific when discussing the musical form or the particular composition that would be appropriate for a given occasion because a standard method of musical notation was developed early; whereas the development of standard methods of colour notation was long delayed. The factors that determine the appropriateness of a colour scheme are numerous, and the influence of each is best determined by statistical analysis, now that colour can be measured. It seems almost certain that such analyses will show that there are no truly fundamental principles underlying good taste in colour applicable to all parts of the world and to all decades.

For the manufacturer of a coloured product, the selection of the colour is only the first step. He must then formulate the paint, make the appropriate mixture of dyes or do whatever is required to match the colour selected. For example, the original design for a soap wrapper may be a water-colour sketch prepared by an artist. The printer who prints the soap wrapper must duplicate the colour, but the number of commercially available pigments is so great that the artist's sketch can be matched visually by a variety of ink formulations. Hence, at the outset, the printer will normally investigate many different formulations from the standpoint of cost, permanence to light, resistance to alkali, etc. This second step in the use of colour is common to many industries.

In the mass-production industries, the third step is the establishment of the maximum colour tolerances that are to be allowed. The size of a just perceptible colour difference has been systematically investigated on a number of occasions, but holding the colour of the product within such fine limits is seldom justified from an economic standpoint. Nor is it safe to assume, in applying the results of these investigations, that the size of the tolerance should represent an equal number of just perceptible steps in every direction throughout the colour space. For example, the natural colour of butter varies from month to month with its carotene content, and it is standard practice in the dairy industry to add a harmless yellow dye to compensate for the carotene deficiency. If the proper dye is used, the allowable colour tolerance is large because the public is aware of the fact that the natural colour of butter can vary from nearly white to a strong yellow. In a three-dimensional colour space, the locus of these natural variations is a line; and the length of this line corresponds to many just perceptible steps of colour difference. The same number of just perceptible steps in another direction might not be tolerated at all. Indeed, butter would probably be quite unpalatable if it were green.

See LIGHT; PHOTOENGRAVING; PHOTOGRAPHY: *Colour Photography;* SPECTROSCOPY; *see* also references under "Colour" in the Index volume.

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COLOUR BLINDNESS, a term applied to the many forms and degrees of substandard colour perception occurring in man either as hereditary congenital anomalies or as the result of acquired disease. The principal manifestation of substandard colour perception is the inability to recognize differences in hue which are obvious to the normal eye. To the English chemist John Dalton, who wrote one of the first detailed accounts of the subjective aspects of colour blindness, "blood looked like bottlegreen and a laurel leaf was a good match for sealing wax."

Among the many existing forms of colour blindness in man a number of clearly definable types have been recognized and given names based, principally, upon matches between single spectral colours and mixtures of such colours. Normal colour vision of man is characterized by trichromatism—that is, by the fact that the subjective sensation elicited by any single spectral colour can be reproduced or matched, more or less accurately, by a mixture of three so-called primary colours, red, green and blue. The proportions of the three primaries required by the normal eye to match any given spectral colour are very constant and characteristic. Such trichromatism exists in about 92% of all males and in 99.5% of all females with undiseased visual organs, and it is considered the standard of colour vision. In the remaining 8% of males and 0.5% of females the colour perception is different from the norm, either in the sense that the mixing proportions of the normal trichromat are rejected or in the sense that fewer than three primary colours are necessary to reproduce the entire spectrum.

Persons who require three primaries but in proportions de-

cidedly different from the norm are called anomalous trichromats. Persons whose world of colour can be reproduced by mixtures of two or by only one primary colour are logically called dichromats and monochromats. The monochromats represent the most severe degree, the dichromats a moderate degree and the anomalous trichromats a slight degree of colour perception deficiency. Among the anomalous trichromats as well as among the dichromats there exist three types designated by the Greek prefixes proto-, deutero- and trito-, meaning first, second and third respectively. Proto- and deutero- refer to deficiencies of the red and green perception, trito- to a deficiency of the yellow-blue perception. Attached to the term anomaly these prefixes denote a form of anomalous trichromatism; attached to the term anopia, dichromatism. The difference between an anomaly and an anopia with the same prefix is, practically, only one of degree. The most common, congenital, hereditary colour deficiency is deuteranomaly requiring, in all colour matches, considerably more green than the normal. A person thus affected finds it difficult to distinguish between pale green and yellow. This difficulty is much more pronounced in the deuteranope, who actually matches spectral, that is saturated, green with spectral yellow. Protanomalous and protanopes are predominantly insensitive to red. The trichromatic and dichromatic colour deficiencies are as a rule not associated with any other ocular or visual defects. Even the colour perception defect, since it has been present since birth, causes very little difficulty in ordinary life, the affected person having learned to recognize common objects more by their relative brightness and shape than by their hue. But when he faces colour in a completely detached form or in a state of low saturation or when he has to make a colour judgment in "a split second" he is likely to make mistakes that in the case of signal or traffic lights may prove serious.

A different situation is present in the rare cases of congenital total colour blindness. If the visual sensations of the totally colour-blind person could be "seen" by a person with normal eyes, or be recorded objectively, they would look very much like blurred, out-of-focus, black-and-white photographs of whose imperfections the totally colour-blind person is only partly conscious since he has never seen any better. His colour perception deficiency is overshadowed by other ocular defects, such as poor visual acuity, lack of protective iris pigment (albinism), causing him to be almost constantly dazzled, and involuntary pendulum movements of the eyes (nystagmus).

The large number of pedigrees on colour blindness that have been reported show almost without exception recessive, sex-linked inheritance. The condition as it manifests itself in well-controlled tests is unalterable and incurable. The claim made by some authors that the performance of colour-blind persons in daily life can be improved by certain forms of visual training would be difficult to substantiate.

The abnormal colour sense of some anomalous trichromats can serve to detect military or other camouflage intended for and invisible to normal eyes. Among the anomalous trichromats there are persons whose sensitivity to red or green is greater than normal.

An originally normal colour sense may become impaired by diseases affecting the refractive media or the receptor apparatus of the eye, the optic nerve or its connections and terminations in the brain. These acquired pathologic forms of colour blindness tend to be less typical than the congenital ones but, in contradistinction to the latter, are amenable to treatment.

See also VISION. (P. C. K.)

COLOUR INDEX, in astronomy, the difference between the visual and the photographic magnitude of a star (*q.v.*). Since the ordinary photographic plate is proportionately more sensitive to blue light and less to red, this gives a measure of the colour of the star. The colour index ranges from about −0.5 magnitude for the bluest (hottest) stars to more than 2.0 magnitude for the reddest stars.

COLOURING MATTERS: *see* DYES AND DYEING.

COLOUR PHOTOGRAPHY: *see* PHOTOGRAPHY: *Colour Photography.*

COLOURS, MILITARY. The word colours indicates one or more of the flags or guidons carried by military units. It originally referred only to flags carried by dismounted units, particularly infantry, but was later applied also to the standards and guidons of cavalry, mechanized or other mounted units, to ensigns flown aboard ship and to flags in general. The term came into use in the late Elizabethan period, apparently as a reference to the many bright colours or hues in infantry flags. It spread also to civilian life to refer to the distinguishing colours of schools, colleges, clubs or political parties. The term gained wide currency in a figurative sense, in such expressions as "to come through with flying colours" or "to sail under false colours."

In the middle ages military flags were either religious or personal; the former were intended to afford protection and the latter to indicate the leader of a formation. Religious flags usually carried a picture or symbol of a particular saint. During the crusades the cross came into prominence as a symbol on religious flags.

The personal flag, whether the standard of a monarch or the pennon of a knight, carried devices ranging from the full coat of arms down to a simple badge. With the rise of nationalism and the gradual disappearance of feudalism, personal flags were used less and less. In the 16th century, impersonal flags appeared, often consisting of stripes, waves, diamonds and other geometrical shapes. These flags sometimes followed the hues of the captain's coat of arms but were usually chosen arbitrarily. With the formation of companies and bands into regiments, colours were systematized, but each nation developed its own system.

Great Britain.—The Thirty Years' War and the English Civil War saw the use of many diverse types of colours. Some infantry companies were distinguished by such symbols as stars or balls; mottoes, quotations and allegorical figures or scenes were freely used for their propaganda value. Just as each infantry company had its own colour, so each troop of cavalry had its own standard, or cornet as it was then known. Dragoons, being mounted infantry, followed an in-between course and carried guidons, usually related to the regiment, whereas the other cavalry cornets were often single and independent in their usage.

By the end of the 17th century the British army began to reduce the number of colours per unit. In the infantry, three colours per regiment were deemed sufficient to indicate the rallying point; when units of pikemen were discontinued, so, generally speaking, was the third colour. In 1747 the two remaining colours were to be, first, the national flag, and second, the regimental flag, thus eliminating the previous pattern which frequently had included the commanding officer's coat of arms or portions of it. The cavalry also reduced the number of its standards and guidons, but these were usually allowed at one per squadron and, as their numbers increased in time of war, up to five or six per regiment. Squadron standards and guidons were abolished in 1858 and the types with the colour of the regimental facings disappeared. Henceforth dragoon guards had one crimson standard and dragoons, one guidon.

The life guards have four standards, the first being the sovereign's with the royal arms, and the other three being squadron standards with the union badge of the rose, thistle and shamrock. After the accession of Queen Elizabeth II, both types carried the royal letters "E II R" and battle honours. The royal horse guards also have four standards.

Cavalry regiments, although mechanized, still carry standards or guidons. All are crimson, the standards being square and the guidons swallow-tailed. They bear the regimental device in the centre, battle honours for World Wars I and II on one side and the remaining honours on the other side. In the four corners are cartouches, the first and fourth having the white horse of Hanover, the second and third having the regimental title on a ground of the colour of the regimental facings. Where new standards have been issued to combined regiments the badges of both regiments are frequently placed in the centre. When the royal tank regiments were granted standards in 1958 the white horse was replaced by a helmet.

As hussars and lancers carried out dispersed duties, guidons were discontinued in William IV's reign, but in 1959 guidons, somewhat

after the dragoon pattern, were issued to certain hussar and lancer regiments.

The foot guards retain much of their ancient usage of colours, or ensigns, and each of the five regiments has its own characteristics. As in the past, each company has its own badge; a different company badge appears when a new battalion colour is granted, so that each badge is used in rotation. Here the union flag is in second place, the crimson, or sovereign's, colour taking the first.

With the exception of the rifle regiments, which have none, infantry of the line also carry two colours, the first, or queen's, colour being basically the union flag with the regimental title in the centre and the World Wars I and II battle honours on the arms of the cross of St. George. The second, or regimental, colour is usually the hue of the regimental facing; *i.e.*, if blue cuffs, then a blue flag. If facings are white, red or black, a white flag is used with a red St. George's cross over it. The regimental device and title are in the centre and the honours are grouped around them. At the top of the staff is a gilt crown with a lion statant, modeled in the round. Gold cords and tassels are attached; the fringe is of gold, mixed with other colours.

United States.—In the United States the term colour, when used alone, denotes the national flag, but the term colours covers both the national flag and organizational or individual flags.

During the Revolutionary War and for some years thereafter the colours carried by the newly created American forces followed no set system. The establishment of a regular army allowed both national and regimental colours to be carried by artillery and infantry regiments from 1796, but until 1895 the cavalry had only the national colour, though individual companies carried guidons. The national colour first used by U.S. army forces consisted of a blue field on which was depicted an eagle in flight with a shield of the United States on its breast. Below this device was a scroll with the regimental name and number and above was a constellation of stars. The regimental flag at this time consisted of a white or yellow or green field with a scroll in its centre containing the unit designation. When the Stars and Stripes was made the national colour for the artillery (1834), infantry (1841) and cavalry (1895; authorized, 1887), each branch adopted a new regimental flag. Artillery had a yellow (after 1886, scarlet) field with crossed cannon; infantry kept the old national colour as a regimental flag; cavalry adopted a yellow flag with the coat of arms of the United States in the centre. After 1904 the regimental flag for all branches consisted of the coat of arms of the U.S. centred on a field whose colour was that of the branch. Below the coat of arms was a scroll with the unit designation; sometimes a symbolic device, representing the branch, was placed between the arms and the scroll. Later the coat of arms of the United States was replaced with an eagle upon whose breast was the organizational coat of arms. In the eagle's beak was a scroll with the organizational motto and above its head the organizational crest. Beneath the eagle was a scroll with the unit designation. For units without official coats of arms the eagle's breast was feathered and the unit badge replaced the organizational crest.

Whereas dismounted units once had large colours and mounted units smaller standards, all regiments and separate battalions later had a flag 3 ft. by 4 ft., trimmed on three edges with a fringe 2½ in. wide. Armoured units have the yellow field and fringe of the old cavalry standards. Artillery colours have scarlet grounds with yellow fringes. The infantry has dark-blue grounds on its colours, with yellow fringes. The corps of engineers has scarlet and white; the signal corps, orange and white; the military police corps, green and yellow; the ordnance corps, crimson and yellow; the quartermaster corps, buff and light blue; the transportation corps, brick red and golden yellow; the army medical service, maroon and white; the chemical corps, cobalt blue and golden yellow; the adjutant general's corps, dark blue and scarlet; and the finance corps, silver gray and golden yellow. Units not assigned to a branch carry colours with teal blue fields. The colour of the fringe is usually repeated in the central device, which may have an additional piping colour. Among the exceptions to this rule are infantry and armoured colours, whose devices are in white and green, respectively. Campaign and war-service streamers (or silver bands) are worn as extra distinctions, as are other awards, including those from other countries.

On June 12, 1956, the president of the United States officially approved the adoption of an army flag. The new flag consisted of a white field (of silk or rayon) upon which part of the seal of the department of the army (the same as that formerly used by the war department and the old war office) was embroidered in ultramarine blue. The seal included the motto, "This We'll Defend." Beneath the seal was a broad scarlet scroll bearing the inscription in white letters, "United States Army." Below the scroll, in blue arabic numerals, was the date "1775," indicating the year the army was created. The flag's white field was edged with a 2½ in. gold fringe; from the spearhead hung 145 battle streamers.

Australia.—The colours of the Australian army generally follow the trend of the British forces. Guidons are carried by light-horse regiments, and colours by infantry battalions. The guidons are of crimson silk damask, bearing in the centre the title and the regimental colour patch, all within a wreath of wattle leaves and under an imperial crown. In some cases mottoes are carried below and honours appear at the sides.

Infantry units have the union flag as the first colour, and the regimental colour has distinctions somewhat after those of the cavalry but on the appropriate field. The regimental patches are those first worn on the sleeves of service dress in World War I, usually in two colours.

Light-horse units, even though converted to units of the royal Australian armoured corps, continue to carry guidons, as in the case of 2/14 Queensland, which has the emu and motto of the badge in the centre of the guidon.

Canada.—Colours mostly follow the practice of Great Britain. Cavalry units carry but one flag. The governor general's horse guards and Princess Louise's dragoon guards are the only ones to carry standards. All other cavalry (except hussars, who have none) carry guidons. These standards and guidons have a crimson or dark red ground with the regimental device in the centre under a crown. Two branches of maple leaves in autumnal tints joined with a bow at the base surround the central device. In the four corners are the regimental initials or other devices, while battle honours on scrolls fill the sides or are placed centrally below.

The newly created Canadian guards were given in 1957 special queen's and regimental colours, the patterns being based on British foot guards' practice.

Infantry battalions carry two colours, the union flag being the first, or queen's, colour, and the regimental colour being the second. The queen's colour contains the number of the battalion in large Roman numerals inside a band containing the regiment's title and having a crown above. The regimental colour has almost the same central device but with the royal cipher in the centre and the battalion number in the corner nearest the head of the staff. Maple leaves surround the centre, and outside these, on a laurel wreath, appear the battle honours. If there are but a few honours, they are placed singly on the field; but if there are many, they are placed on a laurel wreath. Regimental badges are frequently carried in the corners.

Gold tassels and fringe (mixed with other colours) and the royal crest (the lion on the crown) on the staff are common features for all the above-mentioned flags. The Royal Newfoundland regiment had new colours in 1953, the regimental one having the caribou's head in the centre and other details following the Canadian line regiments' practice.

New Zealand.—The regiments of mounted rifles have crimson guidons, and the regiments of infantry have colours (the basic hue of the regimental colour to be that of the provincial district according to an official suggestion). In the centre are placed the regimental badge and title, both being surrounded by sprays of fern leaves and all under an imperial crown. Guidons have the regimental number in the second and third corners, and the infantry colours have the regimental number in the dexter canton (upper right).

South Africa.—Military units have had a checkered life and thus many different designs of colours have appeared in the past.

However, in 1931 regulations were laid down that standards of mounted regiments were to be of crimson and colours of infantry to be of the facing colour. The other general features followed those of the British army. The standards and colours bore the title of the regiment in a circle around a regimental badge, the whole being within a wreath of protea flowers and leaves, all placed under a crown. Colours following this pattern were presented to the Transvaal Scottish, the special service brigade and others.

Another variety of military flag is that carried by the Boer commandos. The fabric is the basic colour of the province—orange for Orange Free State, red for Cape Colony, blue for Natal, etc.; the device in the centre with the title is in a wreath of protea. The motto in Afrikaans is placed below and honours are on angular ribbons at the sides. A distinctive springbok head tops the staff.

Belgium.—There is a single national flag per unit. Before 1830, when the Belgian nation separated from the Netherlands, the military colours followed those of the governing nation, but the Belgian revolution brought into prominence the *couleurs brabançonnes*, the black from the arms of Brabant, the yellow from the arms of Flanders and the red from the arms of Hainaut. These colours were now revived for the national and the regimental colours. Originally the three parts were horizontal, but an order of Jan. 23, 1831, stated that they were to be made perpendicular and parallel to the staff.

Battle honours in letters of gold vary according to the unit. Infantry, cavalry and artillery units have flags, as do such units as cyclists. At the head of the staff is a fully molded rampant lion standing on a pedestal, the whole being placed on a wreath of laurel and oak leaves. Gold cords and tassels are also attached to the top of the staff.

Denmark.—From the most ancient times the Dannebrog, the white cross on red, has flown in Denmark. The regimental colours are square with the ends of the white cross slightly splayed. Up to 1957 the royal cipher was generally placed in the corner nearest the spearhead, with the regimental number in the corner below. Cavalry flags were similar but smaller. From 1957 regimental colours have shown the crowned royal cipher in the centre of the cross and a regimental badge in the previous position of the cipher. Down below, instead of a number, is the title of the regiment.

A typical example is that of the Slesvigske Fodregiment. The badge of the shield and sword is in the upper canton; the regimental title in three parts below and the cipher in gold are the distinctions on the flag itself. The gilt spearhead is pierced with the royal cipher, and from the base of the finial hangs a long streamer with battle honours in gold letters. Long cords and tassels are attached at the same place.

France.—When the Revolution broke out in 1789 the colours of the city of Paris (red and blue) were used in a cockade and later combined with the white from the royal flag to make the new tricolour. The pattern arrangement of these three colours varied until 1803, when three vertical stripes were authorized, as still carried. The infantry flag is 90 mm. square, and the cavalry standard is 64 mm. square, only one flag being carried by each unit. On one side of the colour are the words "République Française" and the title of the regiment or unit in letters of gold. In the four corners on both sides are golden laurel wreaths, inside which is placed the number of the unit. On the other side are the inscription "Honneur et Patrie" and the most important battle honours. The colours are fringed with gold on three sides.

The solid spearhead springs from a flat circular boss, the latter bearing the initials "RF." At the base of this gilt finial is attached a scarf or cravat. This is blue, white and red in longitudinal stripes with a gold fringe at the extremities, where the regimental number appears in a wreath just above the fringe. If a *Croix de guerre* or other decoration is awarded it is attached to the cravat. For further honours *fourragères* ("cords") are awarded and these rest on the cravat.

Artillery and air-force units use the same method of distinction.

Germany.—In older times the German army had many varieties of colours indicating royal or national origins. After World War I, the flags appeared only on special occasions. Under the Nazi regime the regimental flags showed an iron cross with a swastika in each corner. On the centre of the cross was a black eagle standing on a swastika, within a wreath of oak leaves. The field of the flag was white for infantry, yellow for cavalry, red for artillery, etc. In the German Federal Republic established after World War II there was but a single flag, the *Dienstflagge* of black, red and yellow horizontal sections bearing in the centre a yellow shield with the black eagle.

Italy.—The green, white and red of the Italian flags are attributed to Napoleon, who gave the newly created Cisalpine republic the French flag but with green instead of blue. These three colours were later used by unified Italy, regimes being distinguished by different arms or central devices. After World War II the new republic had but a single flag for each military unit. The pure silk flag is 99 cm. square, divided into three equal vertical sections of green, white and red. On the gilt spearhead is engraved the name of the original founder, the date of raising of successive formations and services, deeds of arms and any other award. The staff is covered with green velvet and ornamented with brass nails. The cravat is of bright blue silk fringed with silver at the ends. The cords and tassels are also of silver. Any decoration of military valour or honour which may be awarded is also fixed to the spearhead.

Netherlands.—Each military unit of the Netherlands carries but a single flag. It is not based on the national flag but is inspired by the house of Orange and has an orange field.

The colours and standards are of a basic pattern following an army order of 1925. The silk ground is 87 cm. square for infantry and 50 cm. square for cavalry. The orange flag has a gold fringe on the edges. On one side is embroidered the crowned initial of the sovereign; on the other the royal arms within a mantle. These arms are surrounded by a wreath of oak leaves on the left and laurel on the right. The borders of the flags are ornamented with orange blossom branches.

The top of the staff has an oak wreath, above which is a lion holding aloft a sword and resting on an oblong pedestal. On the short sides of the pedestal are the crowned initials of the sovereign; and on the long sides "Koningin en Vaderland." In 1948 regiments were authorized to carry the royal initial "J" instead of "W," and in 1951 three infantry regiments received new colours with the crowned "J" in the centre, their titles below and their battle honours in the corners. In 1952 silk cravats were authorized to indicate any change of name. These cravats are of orange fringed with gold and have orange blossoms on the edges.

Spain.—Up to 1843 regiments had their own flags, but it was then ordered that all flags should be based on the national flag. This flag is of silk and consists of a broad horizontal stripe of yellow in the centre and a narrower stripe of red above and below. On the stripes is the coat of arms of Spain and around this is embroidered in black letters the title of the unit. Cavalry and motorized units have smaller flags fringed with gold but otherwise follow the style of the infantry.

Sweden.—During the Thirty Years' War troops from many nations supported Gustavus Adolphus and brought their own types of colours to fight in his army. The use of the king's initials and the three golden crowns of Sweden was widespread on military colours at the time.

The three crowns still appear, but many regimental colours take the arms or symbols from the districts to which they belong. Thus the royal Svea and Göta *livgarde* carry a white flag with the royal arms of Sweden in the centre, the royal crown in the four corners, battle honours around the arms and the title in gold letters near the staff. Cravats of blue and yellow, fringed with gold, are tied to the top of the staff. Other infantry regiments have coloured grounds with various devices. The Upplands regiment has a red ground with a large orb and cross in the centre. On a narrow yellow strip at the top are written the battle honours in red letters. Below the spearhead is tied the blue and yellow cravat. The Hallands regiment follows the same basic principles but has a large rampant lion instead of the orb and cross.

The cavalry flags are smaller and in all cases are standards, the one exception being the Norrlands dragoon regiment which has a guidon. The life regiments and the Skånska dragoon regi-

ment have white fields with royal devices. The Smålands, Skånska and the crown prince's hussars have respectively yellow, yellow and blue fields, with various devices of a lion, an eagle's head and a cross. The Norrländs dragoons' guidon is yellow with an elk as a device.

The artillery and some other corps have their own flags, the former having crossed cannon barrels. Their districts are often indicated by the appropriate coats of arms.

Switzerland.—Although most cantons had their own flags going back to their conflicts of the middle ages, it was not until 1848 that a flag was authorized to be used in the federal army. This was based on the national flag, the well-known white cross on a red field. For the infantry the edges of the colours are left plain. In 1890 abbreviated titles were permitted to be borne on the white cross. The simple spearhead has a cravat and the staff is banded in red and white.

The artillery and cavalry have smaller flags, square standards also of the national pattern with red and white fringes and the cravat.

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COLT, SAMUEL (1814–1862), U.S. inventor of the Colt revolver, was born July 19, 1814, at Hartford, Conn. He ran away to sea at 16, sailing from Boston, Mass., Aug. 2, 1830, for India. During this voyage he whittled a wooden model of a revolver and upon his return to the U.S. had several metal models made between 1831 and 1835. Having perfected his invention—a single-barreled pistol or rifle having a many-chambered rotating breech which was turned, locked and unlocked by cocking—he took out English and European patents in 1835 and a U.S. patent in 1836. On March 5, 1836, the Patent Arms Manufacturing Co., of Paterson, N.J., was formed to manufacture and sell the new weapons, but lack of general acceptance caused the company to fail in 1842.

Colt then turned to the invention of electrically discharged submarine mines. He also conducted a telegraph business, which utilized the first cable ever laid under water. At the outbreak of the Mexican War, 1846–48, Colt received a government order for 1,000 revolving pistols. These were made at the factory of Eli Whitney at Whitneyville, Conn. Colt established his own plant at Hartford in the latter part of 1847, and thereafter the business grew rapidly. He moved twice until, in 1855, he set up the largest private armory in the world on the site of the present Colt plant in Hartford.

Colt developed beyond any maker before him the manufacture of interchangeable parts and the production line. He also had advanced ideas concerning working conditions and employee welfare. His invention netted him one of the oustanding fortunes of the period. He died at Hartford, Jan. 10, 1862. (C. T. H.; X.)

JOHN MARKHAM

COLTSFOOT (TUSSILAGO FARFARA)

COLTSFOOT, a perennial herb, *Tussilago farfara* (composite family), so called from the shape of its leaves. It has creeping rootstocks from which arise, in early spring, scaly and woolly stems, each bearing a head of yellow flowers. The leaves appear later and are rounded-cordate, shallow-lobed, long-stalked and at first woolly above and below, eventually only below. Coltsfoot is native to Eurasia and north Africa and was introduced into eastern North America. It is usually found in clay soils in fields and waste places and may become a troublesome weed. The plant is a reputed remedy for asthma and cough.

The name sweet coltsfoot is applied to the 15 species of the genus *Petasites* (composite family) of Eurasia and North America. *Galax aphylla* (also called beetleweed) and *Shortia galacifolia* (diapensia family) of southeastern United States are also called coltsfoot. *See* also GALAX; SHORTIA. (J. W. TT.)

COLUMBA (COLUM or COLUMCILLE), **SAINT** (*c.* 521–597), Irish missionary and abbot who founded the monastery of Iona, was born in County Donegal. His father, Feidlimid, a member of a reigning family in Ireland, was closely allied to that of Dalriada (Argyll). To these connections as much as to his piety and ability Columba owed his immense influence. He studied under the distinguished Finnian of Moville (at the head of Strangford lough) and Finnian of Clonard, and *c.* 551 was ordained priest. During his residence in Ireland he founded a number of churches and the famous monasteries Daire Calgaich (Derry), on the banks of Lough Foyle, and Dair-magh (Durrow) in County Offaly.

About 563 Columba with 12 disciples established himself on the island of I or Iona, where he erected a church and a monastery and applied himself to the task of converting the Picts. By his preaching, his holy life and miracles he converted important parts of northern Scotland and established monasteries there, the monastery of Iona being regarded as the mother house and its abbots as the chief ecclesiastical rulers even of the bishops. Columba gave formal benediction and inauguration to Aidan, the successor of Conall, as king of the Scots of Dalriada. He accompanied that prince to Ireland in 575 and took a leading part in a council held at Druim Cetta (modern Druim Ceata), which determined the position of the ruler of Dalriada with regard to the king of Ireland. The last years of Columba's life appear to have been spent mainly at Iona, where he was already revered as a saint. He died in the night of June 8–9, 597. His feast day is June 9.

Irish poems are ascribed to Columba, but they are manifestly of a later age. Three Latin hymns (edited by G. M. Dreves and C. Blume in *Analecta hymnica medii aevi*, vol. 51 [1908]) may be attributed to him with some degree of certainty.

See also IONA.

The principal source for the life of St. Columba is the *Life* written by St. Adamnan, ninth abbot of Iona, and edited by J. T. Fowler (1894). *See* J. F. Kenney, *The Sources for the Early History of Ireland*, vol. i (1929).

COLUMBAN (COLUMBANUS), **SAINT** (543–615), Irish missionary, abbot and writer, who initiated a revival of monastic and lay spirituality on the continent, was born in Leinster and educated in the monastery of Bangor, County Down. About 590 he left Ireland with 12 other monks and established himself in the Vosges at Annegray (Haute-Saône). He then built the abbey of Luxeuil (*q.v.*) nearby, for the congregation of which he drew up his rule. He was indicted before a synod of French bishops (603) for keeping Easter according to the Celtic usage, and a powerful conspiracy was organized against him at the court of Burgundy on the grounds of his bold rebukes to King Theuderich II. Being forcibly removed from his monastery in 610, he withdrew with St. Gall and other monks to Switzerland, where he preached to the Alamanni. On being compelled to leave, he went to Italy and founded the monastery of Bobbio, where he died on Nov. 21, 615. His writings, which include poems, letters and sermons, prove him a man of learning, acquainted with Latin and Greek classics. His feast day is Nov. 23.

St. Columban's works were edited by G. S. M. Walker, with an introduction and English translation (1957); they also may be found in J. P. Migne, *Patrologia Latina*, vol. 80, col. 201–326 (1850).

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COLUMBANI, PLACIDO, Italian architectural designer,

who worked chiefly in England in the latter part of the 18th century. He belonged to the school of the Adams and Pergolesi, and like them frequently designed the enrichments of furniture. He was a prolific producer of chimney pieces, molded friezes and painted plaques for cabinets. English furniture designers of the end of the 18th century, and especially the Adams, Hepplewhite and Sheraton, owed much to his graceful, flowing and classical conceptions, although they are often inferior to those of Pergolesi.

COLUMBARIUM, a sepulchral building containing many small niches for cinerary urns, originally referred to a pigeon house or dovecot (it is still so used, particularly to refer to large, round, towerlike structures common in France, but "columbary" is the more prevalent term). The word acquired its later, commoner meaning by association of imagery.

Columbaria were common during the early Roman empire when cremation was normal pagan practice. They were usually erected and supervised by funeral societies to which most of the lower and middle classes in Rome belonged. Originating as variants of traditional Etruscan and republican Roman house tombs, they were ordinarily rectangular brick structures built around an open court, the walls of which contained niches for the urns. Some columbaria were very elaborate; their numerous inscriptions, stucco paintings and mosaics provide information about the otherwise almost totally forgotten life of the lower classes in antiquity. Perhaps the best examples of columbaria are those in the great heathen necropolis discovered in 1915 beneath the church of S. Sebastiano in Rome.

When in Hadrian's time (A.D. 117–138) inhumation replaced cremation in pagan practice, columbaria became obsolete. They did not reappear until the large-scale 20th-century revival of cremation, particularly in Germany and Scandinavia.

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COLUMBIA, a city in central Missouri, U.S., midway between St. Louis and Kansas City, about 10 mi. N. of the Missouri river, is an important educational and cultural community; seat of Boone county. Settled in 1821 and incorporated in 1826, education early became Columbia's chief concern. It was selected in 1839 as site of the state university after Columbia and Boone county subscribed $117,900. Christian college was organized in 1851 and Columbia Baptist Female college, predecessor of Stephens college, began in 1856. Growth of the city was handicapped by lack of water transportation or main line rail service. However, the highway system that developed in the 1920s placed Columbia at a major crossroads. Under council-manager government, established in 1949, Columbia rapidly expanded its municipally owned utilities, obtained airline service and sponsored public housing and urban-renewal projects. The city's manufactures include dairy products, furniture, women's clothing, brick and tile. The state cancer hospital and the university's teaching and research hospital make Columbia a medical centre. Main and regional insurance offices and headquarters for professional, government and educational associations are also located there. Abundant cultural and recreational opportunities are afforded by its educational institutions. For comparative population figures *see* table in MISSOURI: *Population.* (J. C. C.)

COLUMBIA, a borough of Lancaster county in southeastern Pennsylvania, U.S., along the Susquehanna river, 75 mi. W. of Philadelphia. Laid out as a town in 1788 by Samuel Wright, it missed congressional selection in 1789 as the permanent U.S. capital by a 28–21 vote. Important in the state works system, 1834–57, as the terminal of the railway from Philadelphia, Columbia reshipped goods by canal to the Juniata river. Slaves knew it as a station on the underground railroad. Shad fishing, sawmills, rolling mills and railroading provided 19th-century employment. In the second half of the 20th century its manufactures included textile, metal and glass products. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (V. BK.)

COLUMBIA, the capital and largest city of South Carolina, U.S., and the seat of Richland county, situated in the centre of the state on the east bank of the Congaree river just below the confluence of the Broad and Saluda rivers. Population increased from 62,396 in 1940 to 97,433 in 1960, according to the federal census. Columbia's rapid growth may be largely attributed to its location; its highway, rail and airline facilities; its increasing importance as a location of federal and state governmental agencies; its continued development as an educational centre; the growth of industry; and the nearby location of Ft. Jackson, a permanent infantry training post.

Columbia's history dates from 1786 when the legislature ordered a town laid out on the site to replace Charleston as the state capital. Since the first meeting of the legislature in 1790 Columbia has been the chief focal point of South Carolina's political history. Conventions sitting there drew new constitutions in 1790, 1865 and 1895, nullified the federal tariff in 1832, and in 1860 (before adjourning to Charleston) made the decision to secede. The city was occupied by Federal troops and almost totally destroyed by fire in Feb. 1865. It suffered during the reconstruction period after the war and, as the state capital, witnessed at close range the political developments of later times.

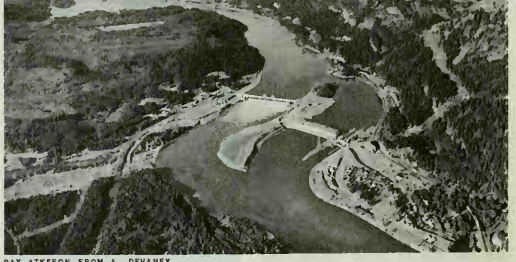
Local government was by commissioners chosen by the legislature until incorporation as a village under elected officials in 1805; incorporation as a city came in 1854. The aldermanic form of government was changed to the commission type in 1910 and to council-manager in 1950.

Educational and cultural facilities include six institutions of higher learning, an active little theatre and numerous music and art organizations. The University of South Carolina was chartered in 1801 and opened in 1805 as South Carolina college. Other institutions are Columbia college for women (Methodist, 1854), Columbia Bible college (private, 1923), Lutheran Theological Southern seminary (moved to Columbia in 1911) and two colleges for Negroes: Benedict college (Baptist, 1870) and Allen university (Methodist, 1880).

Columbia is a city of broad avenues, beautiful homes and gardens and many imposing public buildings, notably a statehouse of native granite in Roman Corinthian style. A number of private homes and institutional buildings were designed by the distinguished architect Robert Mills. (C. E. CN.)

COLUMBIA RIVER, the largest river flowing into the Pacific ocean from North America, is one of the world's greatest sources of hydroelectric power. Its annual discharge of 180,000,000 ac.ft. (1 ac.ft. = 43,560 cu.ft.) is exceeded on the North American continent only by the Mississippi, Mackenzie and St. Lawrence. With its tributaries, the Columbia represents one-third of the potential hydro power of the United States.

The river drains 258,000 sq.mi., 85% in northwestern United States. Major tributaries are the Kootenay, Snake (*qq.v.*), Pend Oreille, Spokane, Okanogan, Yakima and Willamette. At The Dalles, farthest downstream point for which there is a long-term



RAY ATKESON FROM A. DEVANEY

COLUMBIA RIVER, ABOUT 35 MI. E. OF PORTLAND, ORE. BONNEVILLE DAM, IN THE FOREGROUND, CONNECTS BRADFORD ISLAND WITH THE STATES OF WASHINGTON AND OREGON

record, average discharge is 195,500 cu.ft. per second (maximum, recorded June 6, 1894, was 1,240,000; minimum, 35,000 on Jan. 12, 1937). High flows occur in late spring and early summer with melting of snow on the mountainous watershed. Low flows occur in autumn and winter, causing power shortages.

The Columbia flows 1,214 mi. from its source in Columbia lake (elevation 2,700 ft.), in British Columbia near the crest of the Rockies, to the Pacific ocean at Astoria, Ore. For the first 190 mi. its course is northwesterly; then it flows southerly 270 mi. to the Canadian-U.S. border (elevation 1,290 ft.) where it enters northeastern Washington. It traverses east central Washington in a sweeping curve known as the Big Bend, its prehistoric course having been disarranged first by lava flows and later by ice sheets. Shortly below the mouth of the Snake, its largest tributary, the Columbia turns west and continues 300 mi. to the ocean as the boundary between Oregon and Washington, cutting through the Cascade and Coast ranges. From Portland, Ore., it flows northerly about 50 mi., then westerly another 50 mi. to the Pacific. Tides flow 140 mi. upriver. For most of its length, the river flows in deep valleys and canyons.

The Columbia provides the first deepwater harbour north of San Francisco. Channel improvement, inaugurated in 1877, has helped Portland (*q.v.*) become a major Pacific coast port. Aided by locks, ocean vessels may continue upstream to The Dalles. Channel depths of 35 ft. to Portland and 27 to The Dalles are maintained by the federal government.

Plans for a series of multiple-purpose dams on the Columbia river and the major tributaries of the river were advanced both by federal and by nonfederal agencies after the 1930s. The dams on the Columbia river either in operation or under construction in the second half of the 20th century are shown in the accompanying table in upstream order. Other dams for the purpose of converting the whole river into a series of pools from tidewater to the Canadian border were under consideration.

The Grand Coulee and Bonneville dams were put into operation prior to World War II, and several dams were built after the war. The four lower dams include large locks to permit the passage of river vessels, and several of the dams provide emergency floodwater storage. Grand Coulee, the largest and most complex of the dams, augments the low winter flows (when the power demand is greatest) for the entire system from its 9,402,000 ac.ft. of available storage (of which approximately 5,100,000 ac.ft. is active storage), and also pumps water to the Columbia Basin Irrigation project. Passage facilities for migrating fish are installed or planned at all but the upper two dams.

All the power plants are connected by high-voltage, federal transmission lines, backbone of the superpower grid in which all power utilities of the Pacific northwest participate. The federal government operates as a wholesaler of power, the only ultimate consumers it serves being federal agencies and heavy power-using industries (mainly aluminum plants). On June 1, 1958, this superpower grid connected 8,565,000 kw. of installed capacity. The Federal Power commission expected the regional power demand to be double this amount by 1975.

Many controversies have marked development of the Columbia, especially concerning the division of responsibility between public and private agencies; the effect on fish; proposals for a Columbia Valley authority; the assignment of some joint costs to navigation and flood control, for which no direct repayment is made to the federal treasury; the proper rate of interest to be charged on the federal power investment; and arrangements for sharing power revenues and costs with Canada for any upstream storage reservoirs built in British Columbia. In 1961 the Columbia River treaty was signed by the United States and Canada providing for co-operative development of the river with storage projects upstream in British Columbia and power generation projects downstream in Washington and the sharing of flood control costs and benefits and of increased power production resulting from the program.

Dam	Height (ft.)*	Installed capacity (kw.)	Sponsorship
Bonneville	197	518,400	Federal
The Dalles	260	1,119,000	Federal
John Day	219	2,700,000	Federal
McNary	183	740,000	Federal
Priest Rapids	180	600,000	Nonfederal
Wanapum	170	831,250	Nonfederal
Rock Island	100	165,000	Nonfederal
Rocky Reach	135	775,000	Nonfederal
Chief Joseph	205	448,000	Federal
Grand Coulee	550	1,974,000	Federal

*Dam crest from bedrock.

The Boston trader Capt. Robert Gray discovered the Columbia in 1792, naming it for his ship. The Lewis and Clark expedition (*q.v.*) wintered at its mouth in 1805–06, and David Thompson explored the upper basin for the North West company in 1807–11. Early posts were established at Astoria (1811) and Vancouver (1825).

See also references under "Columbia River" in the Index volume.

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COLUMBIA UNIVERSITY, one of the oldest of the major universities in the United States, has its main campus in a section of New York city known as Morningside Heights.

In 1754 a group of civic-minded citizens, desiring to establish a college in the province of New York, obtained a royal charter that created "a Body Corporate to erect and maintain a College to be known as King's College for the Instruction and Education of Youth in the Learned Languages and Liberal Arts and Sciences." The charter was free from narrow sectarianism, providing that the governors should not "exclude any person of any religious denomination whatever from equal liberty and advantage of education or from any of the degrees, liberties, privileges, benefits or immunities of the said college on account of his particular tenets in matters of religion." The first president of King's college, Samuel Johnson (1696–1772), carried out this purpose, which has been a basic principle of the institution.

The first classes were held in the vestry room of Trinity church. Enrollment was limited to men. In 1756 the college moved to its first permanent home erected on land granted by Trinity church. This site, now known as Park place, two blocks west of the city hall, continued to serve the educational needs of the growing city until 1776 when the Revolution forced the college to close, its building being used to house troops.

In 1784 King's college was reopened and renamed Columbia college. The college moved in 1857 to a site at 49th street and Madison avenue. It was during this period that Columbia acquired the land on which much of Rockefeller centre stands. Continued growth in its educational organization led to a third move to the present site in 1897.

Columbia university embraces four separate corporate units within its educational framework, joined through the direction of the educational interests of the university council. This body, an academic senate, is composed of the president, the major administrative officers and deans and elected representatives from the faculty of each school.

Affiliated units are the College of Pharmacy (1829) located on W. 68th street, part of the university since 1904; Teachers college, founded in 1889 as the New York College for the Training of Teachers and a part of the university since 1898; and Barnard college, the undergraduate liberal arts school for women, founded in 1889 and a part of the university since 1900. Reciprocal relations also have existed since 1891 between the university and Union Theological seminary. The divisions that form a part of the university corporate unit and their dates of establishment within the university are Columbia college, the liberal arts college for men (1754); the college of physicians and surgeons (1767), at 168th street where, with the Presbyterian hospital and allied institutions, it forms the nucleus of a great medical centre; the school of law (1858); the school of engineering, organized as the school of mines in 1864; the school of architecture (1881); the graduate faculties of political science (1880), philosophy (1890)

BY COURTESY OF COLUMBIA UNIVERSITY

LOW MEMORIAL LIBRARY (1897), NOW CENTRE OF ADMINISTRATION AT COLUMBIA UNIVERSITY, MORNINGSIDE HEIGHTS, NEW YORK CITY

and pure science (1892), for advanced studies in those fields; the school of journalism (1912); the graduate school of business (1916); the school of dental and oral surgery (1916); the school of public health (1921); the school of library service (1926); the New York School of Social Work (1940); the school of international affairs (1946); the school of general studies (1947), the successor to university extension (1920); and the program in the arts, the interim division for the schools of dramatic arts and painting and sculpture (1948). Except for Columbia college and Barnard, all these schools are coeducational.

Barnard college, which occupies four acres of land adjacent to Columbia university, has a president, faculty and trustees of its own, and is responsible for its financial endowment. Members on the university staff also give instruction. The music, classics, mathematics, physics and religion departments are joint departments with Columbia, and some undergraduate classes are held with Columbia college. The college offers a four-year liberal arts curriculum to women. Upon graduation, a Barnard student receives the degree of bachelor of arts conferred by Columbia. In the 1960s enrollment was about 1,400 students, about one-third of them residents, from nearly every state of the U.S. and from as many as 30 other countries. In 1952 Millicent Carey McIntosh became president of Barnard.

A series of institutes offer specialized study and research. The American Press institute provides a series of seminars annually for every level of personnel in the newspaper industry. There are area institutes giving specific training in Russian, east Asian, near and middle eastern, east central European and Israeli and Jewish studies. The American assembly, established in 1950 at Harriman, N.Y., serves as a forum for discussion of broad policies of national and international importance.

The university enjoys reciprocal agreements with such institutions as the American Museum of Natural History, the New York Botanical garden, the New York Zoological society, the Metropolitan Museum of Art and the Museum of Modern Art. Besides its Lamont Geophysical laboratory at Alpine, N.Y., and its cyclotron at Nevis estate, Irvington, N.Y., the university has associated organizations and facilities at the Marine Biological laboratory, Woods Hole, Mass.; the Long Island Biological laboratory, Cold Spring Harbor, N.Y.; the Brookhaven National laboratory, Upton, N.Y.; and the Yale-Columbia Astronomical observatory in Adelaide, Western Australia.

The numerous university publications include works embodying the results of original research published by Columbia University Press; "Studies" published in the form of a series by each of several departments; various periodicals, such as the *Romanic Review*, the *Germanic Review*, the *Political Science Quarterly*, etc., edited by members of the faculty; the *Columbia Forum*, a quarterly journal; and several papers or periodicals published by the students, among which are the *Columbia Spectator* (a daily paper), the *Columbia Law Review* and the *Columbia Jester*.

The campus at Morningside Heights includes, besides the several departmental buildings and laboratories, two library buildings. Butler library is the centre of an extensive system with divisions in a number of other university buildings; Low Memorial library is primarily used for administrative offices, but has three special libraries. Other buildings are University hall (with gymnasium), Earl hall (for interfaith activities), St. Paul's chapel, the president's house, the Faculty club, the Citizenship centre, residence halls for men and for women and four centres of foreign interests: Maison Française, Casa Italiana, Casa Hispanica and Deutsches Haus. The total number of university buildings on the Morningside campus is about 70.

Of the 14 presidents of Columbia, those serving in the 20th century have been Seth Low (1890–1901), Nicholas Murray Butler (1902–45), Dwight D. Eisenhower (1948–53) and Grayson Kirk (1953–). Frank D. Fackenthal was acting president (1945–48) between presidents Butler and Eisenhower.

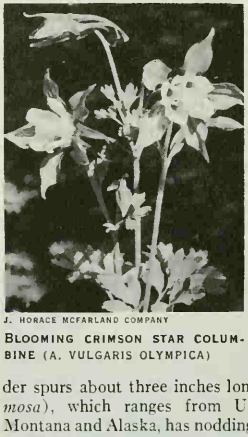
See also references under "Columbia University" in the Index volume.

See the several volumes of *The Bicentennial History of Columbia University* (1954). (Rd. H.)

COLUMBIDAE, the family of birds that includes the pigeons and doves. *See* PIGEON.

COLUMBINE, any plant of the genus *Aquilegia* of the crowfoot family (Ranunculaceae, *q.v.*). They bear slender, delicate, long-stalked, deeply divided leaves with blunt segments and loose panicles of handsome, drooping, blue, red, white or yellow flowers, which are characterized by having all the five petals spurred. Columbines grow in woods and thickets, and often in alpine meadows. Some horticultural varieties are well known in cultivation. There are about 70 species of columbine, natives of north temperate regions, together with numerous varietal forms and crosses developed by cultivation.

The 20 or more species found in North America, chiefly in the Rocky mountain region, rank among the most beautiful wild flowers of the continent, several of which, including the following, are widely cultivated. The eastern columbine (*A. canadensis*), called also honeysuckle and rock bells, found in dry woods from Nova Scotia to Saskatchewan and southward to Florida and Texas, with nodding scarlet and yellow flowers, an inch or more across, is a favourite spring wild flower. The Rocky mountain columbine (*A. coerulea*), with handsome, erect, blue and white flowers, two inches or more across, and spurs two inches long, is the state flower of Colorado. The golden columbine (*A. chrysantha*), found from western Texas to Arizona, grows three feet to four feet high, with clear yellow flowers, sometimes three inches across, and very slender spurs about three inches long. The Sitka columbine (*A. formosa*), which ranges from Utah and northern California to Montana and Alaska, has nodding red and yellow flowers, about two inches across, with short, thick spurs. The common columbine of California is a form of this latter species, with pendulous scarlet flowers and short spurs.



J. HORACE MCFARLAND COMPANY

BLOOMING CRIMSON STAR COLUMBINE (A. VULGARIS OLYMPICA)

The cultivation of more than 35 species in England and about 15 in the U.S. has greatly stimulated the production of many horticultural forms, mostly derived from hybridization and selection. The showy Eurasian *A. vulgaris* has been especially prolific in the production of new varieties. White, lilac, mauve, double-flowered and purple forms are cultivated and these have been crossed with several American species, notably *A. coerulea*. Columbines are of easy culture in most ordinary garden soils, except the rare alpine species, which demand a rock garden. All the showy hybrids can be grown in partial shade or full sun. (N. Tr.)

COLUMBITE (TANTALITE), a mineral series consisting of columbate (niobate) and tantalate of iron and manganese, which provide important ores of tantalum (*q.v.*) and columbium (*see* NIOBIUM). It was in this mineral that Charles Hatchett discovered, in 1801, the element columbium (niobium) which he named after the country (Columbia, or America) whence came the specimen in the British museum collection which he examined.

The general formula is (Fe, Mn) $(Cb, Ta)_2O_6$, in which both the iron and columbium are replaced by varying amounts of manganese and tantalum respectively. Columbite ($FeCb_2O_6$) crystallizes in the orthorhombic system and the black, opaque crystals are often very brilliant with a submetallic lustre. Hardness is 6; specific gravity, 5.3. With an increasing amount of tantalum the specific gravity increases up to 7.3, and members at this end of the series have been given the name of tantalite ($FeTa_2O_6$). These minerals occur as crystals and compact masses in granite and pegmatite and in placer deposits. (CL. F.)

COLUMBIUM: *see* NIOBIUM.

COLUMBUS, CHRISTOPHER (Sp. CRISTÓBAL COLÓN) (1451–1506), discoverer of the new world, was the son of Domenico Colombo, a weaver living first at Genoa and later at Savona, and of Suzanna Fontanarossa. The exact date of his birth is not known. The evidence concerning the early life of Columbus is sparse and admits of many interpretations. One view is that Christopher at first followed his father's business and resided at Genoa and Savona, but Columbus must be believed when he says that he began to navigate at 14. In any event, he was a corsair in the service of René d'Anjou in 1472–73; he was in the Greek island of Chios in 1473–74; and he fought in a battle off Cape St. Vincent, under his namesake and probable relative Guillaume de Casenove-Coullon, on Aug. 13, 1476, when his ship took fire and he swam to the Portuguese coast with the help of an oar. The fact that in this battle he fought on the Portuguese side, against Genoa, shows him to have been no Genoese patriot. There is no explicit statement by him declaring himself a Genoese. He never went back to Genoa. He never wrote in any form of Italian, not even to his brothers, or to Genoese persons and institutions, but always in Spanish. He wrote in Spanish, even his own private notes certainly three years before he came to Spain, and the mistakes in his Latin are definitely Hispanisms. Columbus signed himself successively Colombo, Colomo, Colom and Colón. The latter was the form he himself came to prefer and wished to be used. He never took the traditional form "Columbus," not even when writing Latin. His brothers also, in Spain and the Indies, called themselves Colón and hispanicized their Christian names (Bartholomeo becoming Bartolomé and Giacomo, Diego). One explanation of all these facts, as well as certain features of his character, is that Columbus came from a Spanish-Jewish family settled in Genoa.

Columbus' Plan.—It is a fact that Columbus discovered America by prophecy rather than by astronomy. "In the carrying out of this enterprise of the Indies," he wrote to King Ferdinand and Queen Isabella in 1502, "neither reason nor mathematics nor maps were any use to me: fully accomplished were the words of Isaiah" —referring to a more or less apposite passage in Isaiah xi, 10–12 —and, in fact, any writing became prophetic in his eyes when it could be interpreted as a forecast of his discovery. Nor is it any wonder that he felt sure of having been divinely selected for a mission, an assurance to which he often gives vent in his writings and which is the source of both his pride and his humility, because his was a life rich in dramatic scenes. His very arrival in Portugal, miraculously saved from the wreck of his ship, his landing so close to the rock of Sagres where Prince Henry the Navigator had established his academy of seamanship, do seem to justify his sense of having been chosen.

Portugal was then the westernmost end of the known world and Lisbon the natural meeting place of mariners bent on discovery. From there the Portuguese had discovered Madeira, turned the forbidding Cape Bojador and reached the Tropic of Cancer, and it was in Lisbon that these and future exploits were talked about, prepared, financed and manned. The city was already a busy centre for the arts and sciences, particularly cosmography and astronomy. It was probably there that Christopher came across his younger brother Bartolomeo, who had also left home for the sea and was working as a cartographer.

The idea of reaching the east by sailing westward seems first to have been mooted by the Florentine cosmographer Paolo Toscanelli. A concession that may be interpreted as contemplating such a quest was granted by the king of Portugal to one Fernão Telles on Nov. 20, 1475. Soon after landing in Portugal, Columbus sailed to Iceland, and during this voyage seems already to have been thinking of his voyage to "Cathay" through the west. In 1478 he married Filipa Moniz Perestrello; by this marriage, Columbus had a son, Diego, born in 1479 or 1480. He then settled for a time on the island of Porto Santo, Madeira Islands, of which his brother-in-law had inherited the captaincy. From this base he acquired a considerable sailing experience of the South Atlantic and a number of hints (big canes, pine tree trunks, pieces of wrought wood) as to probable lands beyond the western horizon.

Back in Lisbon, Columbus read assiduously in Cardinal Pierre d'Ailly's *Image of the World* and Marco Polo's account of the east. But though he studied Ptolemy and certainly knew Toscanelli's opinion, the system of ideas he elaborated owed most to "the prophet" Esdras. (*See* ESDRAS, FIRST BOOK OF.) These ideas were: (1) the earth is round; (2) the distance by land between the edge of the west (Spain) and the edge of the east ("India," *i.e.*, Asia) is very long; (3) the distance by sea between Spain and "India" is therefore very short; (4) the length of a degree is $56\frac{2}{3}$ mi. These "miles" were not Arabic (1,975.5 m.) which would have made the figure remarkably accurate, but Italian (1,477.5 m.) which made his equator about one-quarter too small. Columbus calculated that the land distance between Spain and "India" was 282°; he was therefore left with only 78° for the sea distance, which he further reduced by his method of reckoning the degree. The outcome of all these errors was that "India" would be about 3,900 mi. from the Canaries; *i.e.*, more or less where America happens to be. This tallied tolerably well with Esdras who asserts that the earth is six parts dry land and one part sea.

Quest for a Patron.—This system set Columbus' imagination afire with the untold avenues for discovery that the western way opened up. It is unlikely that he was ever clear as to the exact nature of such avenues: new lands? new ways to sail to the old lands? Although vague about his plan, however, Columbus was clear about what he wanted in exchange: honour and wealth, definitely in that order. The proposal was finally put to the king of Portugal, who rejected it (1484). Columbus then went to Spain. He applied first for help to the powerful duque de Medina-Sidonia, who was not interested, then to the conde (late duque) de Medinaceli, who housed and sheltered Columbus from 1484 to 1486; but though he conceived the idea of letting him have some caravels, he decided in the end that the enterprise was too big for even as big a subject as he was, and sent the would-be discoverer to King Ferdinand and Queen Isabella. The queen handed the matter over to Alonso de Quintanilla, her chief accountant, and eventually Columbus met Ferdinand and Isabella in Córdoba in the spring of 1486.

The monarchs then decided to set up a special commission of "learned men and mariners" to study Columbus' proposals. This commission, under the chairmanship of the queen's confessor, Hernando de Talavera, then bishop of Ávila, made him wait four years. This was not, as is often asserted, because the commission was either incompetent or backward in its views, for it was not, but because Columbus was vague and secretive as well as incoherent. For four years he went from city to city, following the court. In Salamanca he became acquainted with Diego de Deza, a professor at the university there, who in 1486 became the tutor of Don Juan, the heir to the throne. Thanks no doubt to Deza, who throughout his life was to be his main stand-by, Columbus received several sums of money from the royal treasury in 1487, and on May 12, 1489, he was granted the privilege of being lodged and fed at public expense on his travels to court. During this period he became entangled with Beatriz Enríquez, who was to be the mother of his son Fernando (b. Aug. 15, 1488).

In 1490 the Talavera commission reported unfavourably; and though the king and queen did not abandon him, Columbus may

have felt that his Spanish quest was at an end. He went to La Rábida, near Huelva, where he met two men who were to restore his faith: the friar-astronomer, Antonio de Marchena, and a pilot and shipowner from Palos, Martín Alonso Pinzón. Pinzón told him that a year earlier, in Rome, he had been informed by a papal cosmographer "of those lands which were still undiscovered." Columbus asked him to become his partner, and Pinzón accepted. The evidence available suggests that the two Rábida friars, Juan Pérez and Marchena, succeeded in having Columbus recalled to the court—not to discuss his plan this time but to name the price he set on it. The price was exorbitant. He was to be knighted, appointed grand admiral and viceroy (these titles to remain in his family forever), and he was to receive 10% of the transactions within his admiralty. The king and queen were stunned by his audacity. He held his ground so firmly that no compromise was possible, and he was dismissed. He left Santa Fé (the city camp built to besiege Granada) early in Jan. 1492, possibly for France and England, but friends at court persuaded the king and queen to recall him, and all was done as he wished.

First Voyage.—Thanks to his own and to Pinzón's drive, obstacles and inertia were conquered, and soon Columbus beheld at quay, ready to sail, his three vessels, the decked ship "Marigalante" (officially renamed "Santa Maria"), and two caravels, "Pinta" and "Niña." The first was about 117 ft. long, the other two about 50; the first two had castles fore and aft, the "Niña," only aft. They were armed with 4-in. *bombardas* for heavy granite balls and *espingardas* for smaller lead projectiles. As Columbus was uncertain whether he was to come across new savages or old civilizations, he loaded his ships with cheap merchandise to relieve aborigines of their gold, but also took on board one Luis de Torres —"who had been a Jew and knew Hebrew and Chaldean and a little Arabic"—in case he met the "grand khan." More than 1,000,000 maravedis had been supplied by the crown, though the story that the queen pawned her jewels to provide the money is quite untrue. The sum of 500,000 maravedis was supplied by Columbus himself (advanced by Pinzón). The "Santa Maria" sailed under Columbus; the "Pinta" under Martín Alonso Pinzón with his brother Francisco Martín Pinzón as his pilot; and the "Niña" under Vicente Yáñez Pinzón, another brother, later to prove one of the finest sailors of the era. (*See* also PINZÓN.)

On Aug. 3, 1492, half an hour before sunrise, the small fleet sailed out of Palos. On Aug. 12 it reached the Canary Islands, where it stayed until Sept. 6, when at last it sailed resolutely westward. Once the three ships finally lost sight of land (Sept. 9) the greatness of Columbus began to reveal itself, for it was at this moment that he conquered by faith and will power the resistance of the unbelieving and faint-hearted. He showed a typical mixture of strategic resolution and tactical caution, for he quickly handed out an "instruction" to his crews that after 700 leagues they were not to navigate at night because land would certainly be near. On Sept. 13 he observed the earth's magnetic variation, a memorable discovery, but one which he might have wished to have made on a less hazardous occasion. A whole month passed in alternation of good and bad weather, good and bad mood. "There will be no wind to come back," the unbelievers sighed; and a strong contrary wind came to the rescue of their leader. On Sept. 25, Columbus himself was infected by doubt and sought the help of Pinzón, who that very evening "saw" land. Columbus altered course to southwest in search of it but it vanished. Disbelief led to a conspiracy that might have degenerated into a disastrous mutiny but for the spirited intervention of Pinzón. On Oct. 6 Pinzón suggested altering course again to the southwest; but Columbus was too proud to listen. The next day the "Niña" again "saw" land, but it was another illusion. Flights of birds all southwestward, however, made Columbus swallow his pride and follow Pinzón's advice (Oct. 7). "All the night they heard birds passing," and carved sticks and reeds, picked up, gave them comfort and hope. Two hours after midnight (Oct. 12) a sailor named Rodrigo de Triana or Juan Rodríguez Bermejo saw land from the prow of the "Pinta."

The New World Discovered.—At dawn, a land of virginal beauty and fresh colour revealed itself to the delighted Spaniards. With his two captains and the fleet officials, Columbus went ashore carrying the royal banner. He planted it on the shore and took possession of the land in the name of Ferdinand and Isabella. This land—of which he had, of course, no idea—was Guanahani, one of the Bahama islands, which the Spaniards renamed San Salvador. But everything he saw persuaded Columbus that he was among "the islands which are set down in the maps at the end of the Orient." So, although he saw signs of gold on the noses of the natives, he left in a hurry to see "whether I can come across the Island of Cipango" (*i.e.*, Japan).

For a fortnight he wandered among lovely islands to which he gave Spanish names, hoping "the Lord would show him where gold is 'born'," yet already alive to the possibilities of what would now be called economic development. He even thought of slavery. In his mind seemed to combine and struggle the two different strains that, curiously enough, appear also in his name: Christ-bearer; Colonizer. He raised crosses everywhere, but he kept an eye on the material value of things even to the extent of seeing men as goods for sale. His honeymoon with the islanders may have ended on the day when he took away by force seven of them from Guanahani. They began there and then to think of the Spaniards as only a shade less tyrannical than the *caniba* or "cannibals," who from islands further south came to take them away and eat them. Columbus was convinced that these *caniba* were the subjects of the great can or khan. This "fact" persuaded him that a big island so often mentioned by the islanders as Cuba was Cipango itself. This became the more certain in his mind when he found that in Cuba, when he asked where gold "was born," he was told: "In Cubanacan" (*nacan* meaning the centre of the island). He sent Luis de Torres to interview the khan, but Torres found neither the khan nor the source of gold. He did, however, discover a greater source of wealth—tobacco. The fleet sailed on. On Nov. 21 Pinzón and his "Pinta" vanished before a strong east wind. Columbus was worried. Had Pinzón gone to discover the source of gold and to talk to the great khan before him? Or worse still, did he sail to Spain to steal from Columbus the glory of the discovery? In search of his vanished second-in-command he arrived in Haiti.

Columbus was so struck by the beauty of this island that he renamed it Española (Hispaniola), "the Spanish island" (he usually thought in terms of Spain as a whole, not of Castile or Aragon). He praised the natives for their intelligence, industry and handsomeness and thought that "they are good to be ordered and made to work, sow and do all that is necessary and to adopt our ways." At this point the "Santa Maria" ran aground in a strong wind and became a total loss. It happened exactly at midnight on Christmas day, 1492. The "Pinta" was not available, and Columbus lost no time persuading himself that God meant him to leave behind an establishment with all the men and stores he could not carry back in the "Niña." He named his establishment Villa de la Navidad, and chose 38 men to remain there under Diego de Arana, a relative of Beatriz Enríquez. Columbus left them food and stores for a year, including ammunition—so that the natives should obey "with love and fear"—and sailed for Spain (Jan. 4, 1493).

Return to Spain.—On Jan. 6 the "Pinta" turned up. Columbus sailed back 40 mi. to seek a safe anchorage and he and Pinzón went through a stormy scene on board the "Niña." Pinzón's explanations were rejected, and his deeds disavowed. Columbus threatened to have him hanged from the castle door, which, Pinzón declared, "is what I deserve for having raised you to the honour in which you stand." The quarrel was patched up, although the two men remained estranged, and they sailed on. Columbus was worried about the men he had left behind—a decision of which Pinzón strongly disapproved—and by astrological considerations, let alone his own struggle between haste to return and report and curiosity to explore. At last, on Jan. 16, 1493, he sailed for Europe.

Columbus deliberately chose a more northerly course, roughly on the parallel of Cape St. Vincent, for his return voyage. The first weeks were happy and carefree, but in mid-February the ships met storms that threatened to drown the explorers. During the night of Feb. 14 both captains seem to have resigned themselves to let the wind do as it pleased; they signaled throughout the night but by dawn they had lost sight of each other. The storm raged on. Tormented by the thought that his discovery might remain un-

known, Columbus wrote out its story and entrusted it to a cask which he threw overboard. For four days he went without sleep, but on Monday, Feb. 18, he at last cast anchor at Santa Maria, the southernmost island of the Azores. He was so pleased that he let out in his journal that he had kept secret the distances covered daily in order to put sailors off the track of "his" Indies. On Feb. 24, 1493, he sailed for Spain. Worse storms assailed him, but at dawn on March 4, he recognized the rock of Sintra. He decided to enter the Tagus river. The Portuguese king received him on March 9 with full honours (though some of his courtiers, it appears, would gladly have killed him then and there) and suggested he go to Castile by land; but Columbus preferred his less unsafe element and on March 15 the "Niña" entered an enthusiastic Palos.

Pinzón arrived at Palos soon after on the same day, having sought refuge in Bayona, near Vigo, from which he wrote to the king and queen a letter loyal to Columbus. He died, exhausted, on March 20. Columbus also wrote to the king and queen who, upon receipt of his letter, wrote to him from Barcelona (March 30) asking him to come to court at once. They feared lest the king of Portugal should steal a march on them, and they wished to send a second expedition as soon as possible; they also obtained two papal bulls granting them the Indies discovered and to be discovered and apportioning the undiscovered parts of the west between the two Iberian powers by a line from pole to pole 100 leagues west of the Azores. The man who had started this keen rivalry between two powerful kingdoms marched in triumph from Seville to Barcelona, where at the end of April he was received by the king and queen in a scene of solemnity and splendour. The monarchs rose to greet him and offered him a stool. This was but the beginning of a flow of privileges and honours that staggered the court, including the right to display a castle and a lion (royal symbols) on his arms. Wealth and honour were his. He nevertheless insisted on being paid the prize of 10,000 maravedis promised to the first man of the crew to see land. The humble sailor who actually had first sighted land went over to Morocco in disappointment and became a renegade. This episode sheds some light on a side of Columbus' character that was to bring him much unhappiness.

Second Voyage.—Trouble began soon enough with the man the king and queen had put in charge of "Indian" affairs, Juan de Fonseca, afterward bishop of Burgos, but far more gifted as a soldier than as either an administrator or an ecclesiastic. Royal letters urged both Columbus and Fonseca to make haste; but the plan for the second expedition was ambitious: 17 vessels manned in all by between 1,000 and 1,500 persons. The material obstacles must therefore have been formidable enough, but much of the trouble came from personal differences between Columbus, Fonseca and two other officials, Juan de Soria and Francisco Pinelo. Soria was reluctant to treat an upstart like Columbus as a magnificent lord and had to be reprimanded for it by his royal masters; while Columbus himself was impatient of all supervision.

This second fleet was organized on the basis of a memorandum Columbus had prepared more as "Colonizer" than as "Christbearer." Populating and developing came to the fore, while Christianizing took what was left. But his ideas were sensible and he even suggested that gold-seeking was to be forbidden at certain periods of the year so that settlers could turn their attention to the land. The king and queen, however, added their own ideas: Christianization and welfare of the Indians; assertion of royal sovereignty over the new territories and the men who were sailing; greater stress on land cultivation than on gold. Several priests were sent, a doctor, a surgeon, peasants, hidalgos and Columbus' own brother Giacomo, who became known as Don Diego. The fleet sailed from Cadiz on Sept. 25, 1493.

After the usual stay in the Canary Islands to restock food and water and live animals for the new world, Columbus began his second crossing on Oct. 13. He chose a southwesterly course aiming at the mainland; this enabled him to benefit by the trade winds, and on Nov. 3 the expedition sighted land. They had the choice of Dominica and Marigalante (Marie Galante), and they anchored at the second. The next day they discovered Guadalupe (Guadeloupe) and later, Puerto Rico, all islands, though Columbus was looking for the mainland. He was also worrying about the men he had left in Haiti. When he at last arrived there, he found that the Spaniards had been wiped out by the local chiefs. On hearing of the disaster, he remained cool, indeed cold, and he ordered a search for any gold the massacred men might have buried. Guacamari, the local "king," was unmasked by the doctor as a dissembler but the irresolute admiral allowed him to escape. Columbus sailed away in search of a better base on the island and kept moving for a month, at the end of which he chose a site and founded the first European city in the new world, Isabela.

Quarrels and Exploration.—From Isabela, Columbus sent to Spain his first messenger, Antonio de Torres, of the royal household, with a number of explanations, excuses and proposals, all of which were eventually approved except his scheme for a regular exchange of Spanish cattle for cannibal slaves. The news of the disaster at La Navidad, however, shook faith in him at court. Was the discovery worth the trouble and expense? His credit in the new world was also falling. The chief accountant of the fleet, Bernal de Pisa, wrote a report on Columbus for Juan de Soria, which he hid in a wooden buoy. The admiral ferreted it out, imprisoned the accountant and dealt no less severely with other "conspirators." Then he left for Cibao (March 12, 1494), a region of the island where gold was believed "to be born," leaving Isabela in charge of his inexperienced brother Diego. In Cibao he founded Santo Tomás, a settlement with a fortress, where he left 50 men under the command of a Catalan captain, Mosèn Pedro Margarite.

On his return to Isabela (March 29) Columbus found the food putrified by the heat, the men hungry and angry. He tried to make them work to erect a mill (for he had wheat), and punished those who refused. Bernardo Buil, a Catalan friar who had come in charge of spiritual affairs, objected to his harsh ways (Columbus had several men hanged) and a conflict arose between the two powers. The friar struck the viceroy with interdicts and the viceroy countered by stopping the friar's rations. He sent a strong force to relieve Margarite and to explore the island.

Although the situation in Isabela and Santo Tomás was by no means good, Columbus sailed away again (April 24, 1494) taking with him 3 caravels of the 5 that remained after Torres' departure for Spain with 12; and he again left Isabela in the care of his brother, though now assisted by a council of men all of whom were better qualified than their chairman. Columbus was anxious to explore Cuba, which he sighted on April 29, but, induced by a converted Indian, christened Diego Colón, he veered southward and discovered Jamaica (May 13). All Jamaica's charms, however, could not lure him away from his westward urge, and within five days he sailed back toward Cuba determined to find out whether or not it was the mainland. His determination came suddenly to an end on June 13, when he was about 150 mi. west of the island. He returned to Isabela just because he made up his mind that Cuba was the mainland, which he forced everyone in his squadron to swear on oath under pain of having their tongues torn out should they recant. He sailed eastward, lingered at the Isle of Pines and sailed round the southern coast of Jamaica. He then fell ill and remained as dead for days. The fleet returned to Isabela (Sept. 29).

Columbus' brother Bartolomé had now arrived and was put in command with the title of *adelantado*, which, when known at court, was rightly considered an encroachment on royal authority. This step increased the discontent prevailing at Isabela. Margarite and Buil had left for Spain with many complaints against Columbus and his brothers. Torres returned with royal letters for the admiral congratulating him on his success and enjoining all and sundry to obey him. But, alleging that the natives were restive, he and Bartolomé left Isabela (March 24, 1495) to "pacify" them—in fact to take prisoners which might be justified as slaves. The natives were of course defeated. Columbus sent his trusted messenger Torres back to Spain with a report, together with his brother Diego and 500 prisoners. His human cargo arrived in Spain when Buil and Margarite had spread their unfavourable views on him. When Juan de Aguado, sent to Haiti by the king and queen to report on the situation, landed (Oct. 1495), he found the natives on the point of rebellion because Columbus had imposed a gold tax.

A duel of jurisdictions began between Aguado and Columbus which lasted five months and deeply humiliated the proud viceroy. He decided to leave, appointed Bartolomé as governor and Diego, who had returned from Europe, as his substitute, and sailed for Spain (March 10, 1496) on one of two caravels (the other had Aguado on board) which had been built in the island. Columbus lingered among his islands for weeks and finally began his crossing on April 20. On June 11, the first two American ships to arrive in Europe cast anchor at Cadiz.

Third Voyage.—Columbus chose to arrive in Franciscan habit as a protection against any further humiliations. He left at once for Seville and Burgos. His adversaries had the ear of the king and queen, but in July he received a royal letter of welcome. He prepared an efficient colonialist, but not very Christian, memorandum for the future organization of the Indies. He still possessed his fire and magnetism, however. He won over his adversaries, had all his privileges confirmed and some of the more material ones substantially increased, and was authorized to populate Haiti-Española with convicts. He declined a royal offer of an estate, in Española, 50 leagues east-west and 25 north-south with the title of duke or marquess, no doubt feeling that the estate to which he was entitled was no less than the whole new world.

Financial difficulties delayed the third expedition, which did not sail from Sanlúcar until May 30, 1498. It was composed of six ships conveying 200 men, excluding the sailors. On June 19 Columbus arrived in Gomera, where he rescued some Spanish ships from a French corsair, and then decided to send three of his ships directly to his brother and sail southwest with the other three. With one ship and two caravels he left Gomera on June 21, 1498, and called at the Cape Verde Islands. While anchored in one of them, Santiago, he was told of islands to the south. Southward he sailed in haste, until July 13. He then turned west. Had he kept his course, he would have discovered the Amazon within four days. By July 28 his course was parallel to the mainland he sought and he was only saved from a long frustration by a land crowned with three summits, which was sighted as he had ordered to alter course northward toward Dominica. He named the new land Trinidad. He sailed round the island, to the Gulf of Paria, saw the mainland, deemed it an island and left in a hurry, drawn by the call of his "mainland," *i.e.*, Cuba. But he had time to observe that the gulf received huge and powerful currents of fresh water on which observation he built up his fantastic theory that he was at the mouth of one of the four rivers of paradise, situated at the top of the earth, the earth being not round but pear-shaped.

When Columbus arrived in Española he found that Francisco Roldán, whom he had appointed mayor of Isabela, had rebelled against his brothers in Xaraguá with about 70 followers. Bartolomé's attitude to the rebellion had been vigorous; Christopher's was temporizing. He wrote a subservient letter to Roldán; concluded an agreement with him; allowed the rebels to break it; and finally concluded a second agreement which amounted to complete surrender to Roldán, for his past was condoned and he was appointed alcalde mayor. This done, Columbus sent a messenger to Spain reporting the incident and explaining why the agreement was void since, among other reasons, he had signed it as viceroy but on board a caravel where he was not viceroy but admiral. He felt depressed, and his troubles increased with the sudden arrival (Sept. 5, 1499) of a small fleet he was not expecting. One of his youngest and most enterprising lieutenants, Alonso de Ojeda, while in Seville had heard of Columbus' discovery of pearls in Paria. He thereupon obtained from Fonseca permission to go "discovering," sailed about with varied fortunes and, when short of supplies, calmly turned up at Española. Columbus had every right to consider him as a poacher. He sent Roldán with two caravels. Ojeda listened to Roldán but went his own way to Xaraguá (Feb. 1500). Roldán followed him there. Ojeda left again, but Xaraguá's settlers, in a state of near-rebellion, had to be terrorized into obedience by a capital execution ordered by Columbus himself. The rule of Columbus then came to a sudden end.

Columbus Removed From Command.—Reluctantly and slowly the king and queen had come to the conclusion that Columbus was a good admiral but a bad governor. He himself had written to them (Oct. 1498) asking for a learned man to administer justice in the new world. They chose an old member of their household with an excellent reputation, Francisco de Bobadilla, whom they gave powers strictly limited to an enquiry into the rebellion and the punishment of the rebels (March 21, 1499). A fresh batch of bad news made them go one step further, and on May 21, 1499, Bobadilla was appointed governor and chief magistrate of Española by letters patent in which no mention was made of Columbus. Bobadilla was empowered to embark for Spain any person of any rank. A special letter addressed to Columbus and his brothers enjoined them to obey and deliver to Bobadilla all royal property, castles, arms and stores. But the rest of the year went by and Bobadilla did not sail. There are strong reasons for thinking that the final decision to let him go was due to information obtained by the sovereigns of Columbus' obscure dealings, bordering on treason, with Genoese agents.

Bobadilla arrived at Santo Domingo on Aug. 23, 1500. Before the wind allowed him to land he was informed by a messenger sent out by Diego that several Spaniards had been hanged that week and five more were waiting for the gallows. He was also told that Christopher Columbus was in Concepción and Bartolomé in Xaraguá, each with a confessor to despatch guilty prisoners by the same method. On Aug. 24, Bobadilla, after mass, had his first dispatch read aloud—that appointing him enquirer into the rebellion—and asked for all prisoners to be handed over. Diego refused. Next day, after mass, he had his second dispatch read—that appointing him governor. Obstructed again, he had all his guns unmasked and revealed the royal letter enjoining him to pay all arrears of salaries, if need be, on Columbus' account. On Diego's persistent refusal, Bobadilla forced his way into the citadel and took possession of the prisoners. On Sept. 15, Bobadilla met Columbus, who refused to acknowledge his appointment on the ground that the king and queen could not deprive him of his position. Bobadilla had both him and Diego arrested and put in fetters. Bartolomé, who in Xaraguá "had 16 Spaniards in a ditch or well waiting to be hanged," was summoned to Santo Domingo and fettered. When he was brought to embark for Spain, Columbus feared that he was being conveyed to the gallows. Though he was treated with respect throughout the voyage he refused to be unfettered. Sad and with his irons still on, he landed in Cadiz toward the end of Nov. 1500. The king and queen, who were at Granada, were shocked at the news, ordered him to be set free and sent him 2,000 ducats to enable him and his brother to come to court. When Columbus saw his royal patrons, he stood dumb with emotion, fell on his knees and burst into tears.

Attitude of the Spanish Sovereigns.—The king and queen were sympathetic and generous, but by no means disposed to alter their view as to the political capacity of the admiral. They probably disapproved of the harsh ways of Bobadilla but not, in general, of his handling of a delicate and possibly dangerous situation. Though legally bound by their agreement with Columbus they had to consider that the land already discovered far exceeded their expectations and that he was no man to be entrusted with a government. Generous with him they could afford to be, but not at the cost of the public good. On the other hand, Columbus, now frustrated in his dreams of greatness in the new world, cast about for another grand work to achieve and found it in his biblical, prophetic mind: he would liberate Jerusalem. To that effect, he did not consult cosmographers, merchants or ambassadors. He read the prophets, and having collected all the texts he could showing that Jerusalem would be liberated by Spain, he presented his *Book of Prophecies* to the king and queen.

Meanwhile a crowd of discoverers was sailing his seas, landing in his islands and stealing his future discoveries; French and English sailors were astir: everybody seemed to be entering the business, to a point that made Columbus write bitterly: "They all made fun of my plan then; now even tailors wish to discover." That was all very well, but how was he going to liberate Jerusalem if he were not allowed to find more gold in that new world where gold was born? The king and queen were willing provided he did not return to Española; and he suggested a search for a passage through the new-discovered lands to the other seas.

Last Voyage.—Nicolás de Ovando, appointed governor to succeed Bobadilla, sailed for Española from Sanlúcar (Feb. 13, 1502) in command of 32 ships, 2,500 men and 12 Franciscan friars. He carried orders to restore to Columbus his property confiscated by Bobadilla. By Oct. 1501, Columbus felt confident enough to go to Seville to prepare his fourth expedition. He bought four ships of about 50–60 tons, which he thought the best size for discovery, and he selected 146 men. He left his eldest son Diego (then 21) to represent him at court, and took with him his younger boy, Fernando (then 13). He asked to be allowed to call at Española and was expressly forbidden to do so, at any rate on the way out. He sailed from Cadiz on May 9, 1502.

On May 25 Columbus began his crossing from the Canary Islands and on June 15, 1502, he discovered an island he called Matinino, one of the Lesser Antilles. A few days later he sailed straight for Santo Domingo. Ovando refused him admittance, and he left for Puerto Hermoso, 16 leagues to the west, where he sheltered from a storm. He produced pretexts for his disobedience to royal orders, but the reason was his usual stiff-necked reluctance to bow before authority; it was but natural that he should regard as his those lands he had brought to light. The ship conveying Bobadilla, Torres, Roldán, the cacique Guarionex in irons, and considerable gold was lost in the storm he weathered in Puerto Hermoso. He sailed for Jamaica on July 14, 1502, overcame a mutiny of his men, sailed along the coast of Honduras and was at Cape Gracias a Dios on Sept. 14. His men were mutinous again, but he sailed on, wandering in lands of his imagination. He wrote to the king and queen that "from there to the river Ganges there are ten days," and he referred again to the earthly paradise. Formidable storms all but smashed his ships. On Epiphany Sunday, 1503, he was pushed by the wind into a kind of estuary he named Belén (Bethlehem). As there seemed to be gold about, he resolved to leave his brother Bartolomé there with 80 men; but the natives thought otherwise and he had to give up the plan and sail away, "in the name of the Holy Trinity, on Easter night, with the ships rotten, worm eaten, all in holes. Two only remained in the same state, boat-less, empty of supplies, to cross 7,000 miles of sea with a son, a brother and so many men."

On May 13, 1503, he was "in Mango province, which is next to that of Cathay, and from there I sailed towards Española." His geography remained that mixture of scientific truth and wild fantasy which his whole life incarnates. After more storms, mutinies, imprecations to God, and narrow escapes, he found himself derelict in a small cove in Jamaica (June 23, 1503) whence he wrote to the king and queen a truly magnificent letter, telling them of his perils, wanderings, dreams and voices he heard from on high, in a style worthy of the Old Testament.

Return to Spain and Death.—For a whole year, Columbus struggled against all his usual troubles: indiscipline, native restlessness, ill health, lack of shelter and food, doubt and disillusionment. He had sent a messenger, Diego Méndez, to ask Ovando for help. Two caravels arrived late in the spring, and at last he was able to sail for Española (June 28, 1504) and for Spain (Sept. 12). Storms pursued him again in his last crossing, but he landed safely in Sanlúcar on Nov. 7, 1504. He could hardly move and had to be conveyed to Seville; traveling north was out of the question. On Nov. 26, 1504, Queen Isabella died. Columbus hoped that she had provided in her will for him to be "restored in the possession of the Indies." His hopes were disappointed, and he wrote to his son to seek the help of King Ferdinand's men. He wrote memoir upon memoir on the Indies and their gold. Sick in body, but worse still in mind with humiliation, frustration and impatience, he was not able to move northward until May 1505, when he was received by Ferdinand in Segovia, and asked to be restored "the capital of my honour . . . the government and possession of the Indies." The king was sympathetic and willing to please Columbus and, on his suggestion, put Deza in charge of his affairs. But as a responsible monarch he could not reappoint the passionate admiral as governor of the Indies. Columbus' health went from bad to worse. He dictated his will on May 19, 1506, and died at Valladolid the following day.

After the funeral ceremonies at Valladolid, Columbus' remains were transferred to the Carthusian monastery of Santa Maria de las Cuevas, Seville, where the bones of his son Diego were also laid. Exhumed in 1542, the bodies of both were taken to Hispaniola and interred in the cathedral of San Domingo. The remains of Christopher Columbus later rested in a tomb in the cathedral of Santo Domingo. In the 1940s, however, construction of the Columbus Memorial lighthouse, a huge monument designed as the last resting place of the great admiral, was started on a high cliff at the mouth of the Ozama river in the Dominican Republic.

In general appearance, Columbus was tall and dignified, red-haired and of a very white complexion, which reddened at the slightest excitement. His mind was lofty and imaginative, and so taut that his actions, thoughts and writings do at times suggest a man just this side of the edge of insanity.

See also references under "Columbus, Christopher" in the Index volume.

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COLUMBUS (COLÓN), **DIEGO** (*c.* 1480–1526), eldest son of Christopher Columbus (*q.v.*), was born on the island of Porto Santo. When his father undertook the great voyage of discovery in 1492, Diego was made page of Prince Juan, heir to the thrones of Ferdinand and Isabella. His marriage to Doña María Álvarez de Toledo, after the death of his father, helped him obtain confirmation as admiral of the Indies and governor of Hispaniola. He took up his governorship in 1509 but continued the family suit against the crown for restoration of all the discoverer's privileges. This was settled in 1536 after his death. During his governorship of Hispaniola a controversy over the status of the Indians broke out and he left for Spain in 1515 to defend himself, leaving his wife in charge. He returned to the island in 1520 but had to go to Spain for further negotiations in 1523. He died in Spain in Puebla de Montalbán on Feb. 24, 1526.

See Samuel Eliot Morison, *Admiral of the Ocean Sea, A Life of Christopher Columbus* (1942). (U. S. L.)

COLUMBUS, a city of Georgia, U.S., and seat of Muscogee county, is situated 95 mi. S.S.W. of Atlanta at the head of navigation on the Chattahoochee river. Population according to the 1960 census was 116,779. In early times the site of the city was the focal point of several Indian trading posts. Founded in 1828, Columbus was on the main route of westward migration and was also the centre of a potentially rich agricultural area which later produced cotton, livestock and peanuts. It grew rapidly into a commercial and industrial community, becoming a leading textile centre by 1840. Its mills were the first to operate by hydroelectric energy, generated at the nearby fall line. During the American Civil War Columbus was an important source of Confederate ordinance, producing artillery, swords, guns, uniforms and two gun boats. It was captured by Gen. James H. Wilson on April 16, 1865, and its factories suffered a small measure of destruction.

The standard metropolitan statistical area of Columbus had a population (1960) of 217,985. (For comparative population figures *see* table in GEORGIA: *Population.*) This area continues to be one of the leading industrial centres of the south, the textile industry alone operating nearly 400,000 spindles. Other leading manufactures are brick, tile, concrete pipe, fertilizer, ice-making and refrigerating machinery, agricultural implements, cane mills, engines, boilers, shafting and pulleys, lumber products, food processing, meat packing, textile machinery, bank and office furniture, automobile batteries and many complementary smaller industries.

Columbus is the trading centre of the 22 surrounding counties comprising the Chattahoochee valley. Widely known for its public school system, Columbus was the first city in Georgia to establish municipal graded schools, and among the earliest in the south to provide industrial training as part of its public school system.

Near Columbus is Ft. Benning, one of the largest army posts in the U.S., with a military reservation of about 189,000 ac.

Columbus established a commission-manager form of government in 1922. The city has 17 public parks, 2 public libraries, a public museum of arts and crafts and a symphony orchestra. Columbus junior college, established in 1958, is operated by the University System of Georgia. (Js. C. B.)

COLUMBUS, a city of Indiana, U.S., seat of Bartholomew county, is 42 mi. S.E. of Indianapolis. It was laid out in 1821 and called Tiptonia in honour of John Tipton who had donated 30 ac., but a month later it was renamed Columbus. It was incorporated as a town in 1839. Ohio, Kentucky, Pennsylvania and New York made substantial contributions to the early population.

Columbus is a diversified industrial community surrounded by productive land. Industries include the manufacture of diesel engines, castings, variable-speed transmissions, radio and electronics components, metal furniture, leather, men's clothing, die sinking and tool making. A Purdue University extension centre is located there.

For comparative population figures *see* table in INDIANA: *Population.* (E. W. H. L.)

COLUMBUS, a city of northeastern Mississippi, U.S., seat of Lowndes county, is located 9 mi. from the Alabama border, 169 mi. S.E. of Memphis and 122 mi. W. of Birmingham. It was founded in 1821 on a high bluff overlooking the Tombigbee river. The steamboat "Cottonplant" first landed in Columbus in 1822, as at that time the city was a port of entry. Many beautiful ante-bellum homes dot the Columbus landscape and a pilgrimage for tourists is held every spring.

Agriculture long dominated the Columbus area, but diversified industry balances the economy and stimulates growth. Manufactures include men's clothing, automatic electric equipment, drainboards, bricks, compressed cotton, ornamental stone, automobile plates, furniture, lumber and creosoted ties.

Established in 1884, Mississippi State College for Women became the first state-supported college in the United States exclusively for women. Franklin academy, founded in 1821, is the oldest free public school in Mississippi.

For comparative population figures *see* table in MISSISSIPPI: *Population.* (E. H. Hs.)

COLUMBUS, the capital and third largest city of Ohio, U.S., the seat of Franklin county, is situated centrally in the state on the relatively flat Ohio till plain. It is a planned political centre created by an act of the legislature in 1812 to be located on the east bank of the Scioto river. Its political functions remain important but it has gained respect as a commercial, industrial and educational centre as well.

Population of Columbus was 471,316 according to the federal census in 1960, reflecting an increase of 25.4% from 1950, and 682,962 for the standard metropolitan statistical area (Franklin county), an increase of 35.7% from 1950. Columbus annexed extensively after 1950: its area in 1960 was 89.0 sq.mi. compared to 39.4 sq.mi. in 1950, an increase of 125.9%. The trend of suburbanization is emphasized by the sharp percentage of increases in population in the communities of Upper Arlington, Whitehall, Worthington, Hilliards and smaller communities and townships lying on the urban fringe.

The federal government organized surveys of the "Ohio country" in 1785, and in 1787 enacted the Ordinance for the Northwest Territory. Later, land grants were offered in Ohio to satisfy the varied claims of participants in the American Revolution. Included was a grant to Virginia of extensive lands west of the Scioto river. Early Virginian surveys into the area resulted in the village of Franklinton in 1797 on the west bank of the river.

The Ohio general assembly, in seeking a permanent site for the state capital, accepted the offer of land speculators for acreage on the east bank of the river in the refugee tract (a land grant established by the U.S. congress for the benefit of Canadian sympathizers of the American Revolution). A capitol, penitentiary and several other government buildings were constructed upon 20 ac. of donated land. A city plan was developed by Joel Wright, state director of planning, and the first sale of lots occurred on June 18, 1812. By 1824, Columbus had replaced Franklinton as the county seat.

Growth was slow with fewer than 700 persons in the city in 1815. By 1840, following the extension of the National Road and the opening of a feeder branch of the Ohio and Erie canal into the city, the population exceeded 6,000. With the exception of the decade 1850–60, substantial population increases were recorded reflecting the city's emergence as a rail and commercial centre. By 1900 the population reached 125,560.

After 1950 increases in population and area surpassed the growth rates of the previous five decades. This resulted partially from the unprecedented industrial development occurring after 1940. The location of a large aircraft plant in the city in 1941 was an initial stimulus but additional plants, often large branches of national organizations, were also attracted to the city. In the second half of the 20th century there were approximately 800 manufacturing plants employing 76,800 workers in the city. Even so, this was only 28% of the total work force, the lowest ratio of manufacturing employees to total work force in any major Ohio city. In part, this emphasizes the diversified activities present. Among the leading industrial plants in Columbus are branches of national organizations manufacturing airplanes, automobile parts, and electrical equipment and appliances, as well as local organizations engaged in the manufacture of machinery, glass, coated fabrics, shoes, fire-fighting equipment and food products. The city's favourable geographical position is enhanced by the presence of five major railroads, an extensive highway network and the airport, Port Columbus, which is 7 mi. E. of the downtown district. Columbus serves a 12-county retail trade area, accounting for two-thirds of all retail business in the area.

Approximately 12% of the work force is employed by some governmental agency. The federal government operates the world's largest military depot in Columbus, as well as Lockbourne air force base, Ft. Hayes and other facilities. Many of the state's welfare institutions and numerous state offices, the penitentiary, fairgrounds and the capitol are present. An attractive civic centre, one block west of the commercial core, includes city hall, a veterans' memorial hall (an exhibition hall and auditorium seating 4,000), Central high school, various state and federal offices and the 555.5 ft.-high Lincoln-LeVeque tower, the city's only skyscraper.

The city supports the Columbus Gallery of Fine Arts and the Columbus Symphony orchestra. Ohio State university (1870) occupies an attractive campus 4 mi. north of the downtown section. The university is a land grant institution with more than 90 departments of instruction, including medical, law and graduate schools. Other major educational institutions include Capital university (1850) including the Evangelical Lutheran Theological seminary, Otterbein college in Westerville (Evangelical United Brethren, 1847) as well as Franklin university, a branch of the Columbus Y.M.C.A., and College of St. Mary of the Springs (1868) and Josephinium Pontifical college. Battelle Memorial institute, private industrial research organization, began operations in 1929; its research in metallurgy and mineral industries is world renowned. Present also are the Orton Ceramic foundation, Nalin laboratories, local branches of national research organizations and research-oriented university functions, such as the research foundation of Ohio State university.

Columbus has more than 1,000 ac. in parks, including city parks, playgrounds, a metropolitan park system along sections of the rivers and public parks associated with reservoir areas. The water supply is obtained from three dams: Griggs, built in 1905; O'Shaughnessy, built in 1925 on the Scioto river; and Hoover, completed in 1955, on the Big Walnut creek. (H. L. Hu.)

COLUMELLA, LUCIUS JUNIUS MODERATUS (1st century A.D.), Roman soldier and farmer, who wrote extensively on agriculture and kindred subjects in the hope of arousing a love for farming and a simple life. A Spaniard by birth, from Gades in southwestern Spain, he became in early life a tribune of the Legio VI Ferrata which was stationed in Syria, but neither an army career nor the law attracted him and he took up farming, successfully, in Italy.

The *De re rustica* in 12 books which is his second and fuller treatment of farming and country life has survived; also a treatise *De arboribus* which was part of the earlier work. The subjects of the first nine books of the *De re rustica* are general precepts, land and crops, vines, land dimensions, trees and livestock including birds, fishes and bees. The 10th book, on gardening, was written in hexameters as a supplement to the *Georgics* of Virgil. It is carefully written but Columella had no poetic gift. This was intended to close the work but, to fulfill a promise to a friend, Columella added the 11th book, on the duties of a bailiff, on what work must be done in each month of the year and on the culture of gardens and garden herbs. The 12th book concerns the choice and duties of a bailiff's wife.

Columella was an experienced farmer; he had an attractive enthusiasm for his calling and great pride in it. His style is neat, lucid and sober and he avoids technicalities as far as is compatible with giving necessary information.

In addition to his extant works Columella wrote the lost *Aduersus astrologos*. He intended to write a work on rituals followed in farming, but whether he did so is not known.

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(G. B. A. F.)

COLUMN, in architecture, a general term for any vertical structural support; particularly, the monumental pillars in a portico or colonnade. The base (*q.v.*) and capital (*q.v.*) are usually considered parts of the column; a column and entablature (*q.v.*), considered as an architectural unit, form an order.

The monumental column evolved from primitive prototypes constructed of short-lived materials, the character of which persisted as a stylistic tradition when large buildings came to be built of permanent materials. In Mesopotamia primitive columns were made of bundled reeds and mud; by 3000 B.C. they were covered with small glazed tiles, which provided waterproofing and a decorative system. Similarly, the columns of ancient Egyptian architecture probably evolved from primitive types, as indicated by the prevalent decorative system of reeds, stems, buds and blooms, all translated into stone. The largest Egyptian examples (69 ft. high) were erected (*c.* 1300 B.C.) in the great temple at Karnak, where the columns were laid up in large sections (drums) and were decorated with intaglio and colour. Polychromatic and sculptural characteristics also evolved in stone columns in Persian and in Indian architecture; the lacquered wooden columns of China and Japan also displayed these characteristics.

In Europe the first columns were crude wooden posts. Inverted tree trunks were doubtless the primitive origin of the downtapering columns at Knossos and Mycenae (*c.* 1300 B.C.). The Greeks, however, reversed the taper, gradually substituted stone for wood, and finally produced the Doric order, which attained classical perfection in the Athenian Parthenon (begun 447 B.C.). The Doric column consisted of capital and shaft, which was usually constructed of drums, although monoliths or brick and stucco sometimes were used. The shaft was usually fluted and the profile refined by subtle curvature (*see* Entasis). Ionic and Corinthian columns, developed later, were characterized by slender proportions, sculptured capitals, and the addition of a base.

Roman columns were adapted from Greek precedent, influenced by wooden Etruscan prototypes. They appeared freestanding in colonnades, as in Greece, although more characteristically the Roman column was engaged to a square pier supporting an arch, as on the Colosseum (finished A.D. 82).

Secondhand Roman columns were frequently used in Early Christian churches, from the 4th century onward; and basic Roman forms, with modifications, were perpetuated in Byzantine, Romanesque and Gothic architecture. External usage in Romanesque and Gothic was restricted largely to the church portal, where clustered columns were often enriched with statues; *e.g.,* at Chartres and Amiens cathedrals. The Renaissance marked the revival of pure Roman forms, especially the engaged column with pier and arch, best characterized in the 16th-century Farnese palace, Rome, although there were numerous variations. The free-standing column in portico and colonnade reappeared in the 17th century (two early instances being the twin churches in the Piazza del Popolo, Rome, and the east façade of the Louvre, Paris) and became common in the 18th and 19th centuries, when the memorial column, as a civic monument, was also revived from Roman antiquity.

The Industrial revolution produced cheap imitations of historical styles in cast-iron columns, which were used extensively by the 1850s. From this development emerged the system of metal-frame construction, notably in Chicago of the 1880s, leading to further developments in steel (*e.g.,* the H-column). The structural system employing reinforced-concrete columns had also evolved by the end of the 19th century. Despite some attempts to modernize historical columns, the most significant developments after 1900 were conditioned by new materials and new structural concepts. *See* Order; *see* also references under "Column" in the Index volume.
(E. A. C.)

COLUMNIST, the author or editor of a regular, signed contribution to a newspaper, usually under a permanent title and devoted to comment on some aspect of the contemporary scene. The column may be humorous or serious, on one subject or on life in general, frivolous in tone or heavily freighted with good advice on manners, morals or other subjects of interest. Essentially a column is a reflection of the writer's individual tastes and point of view, whether it is concerned with women's hats, foreign policy or the stock market.

The word columnist is recent and U.S., apparently dating from about 1920, but columns came earlier. The late 19th century saw the development in the U.S. of humorous miscellanies frequently featuring contributions from readers. Among the pioneers in this form were Eugene Field (*q.v.*) and Bert Leston Taylor. In the early 20th century the role of the columnist who presided over these collections of diverse elements became more defined, and the modern column emerged. In the 1920s columns proliferated in many fields, including politics, economics, books, movies, society, medicine, homemaking, sports and contemporary life and ideas. National syndication of columns increased rapidly; in the latter half of the 20th century there were over 400 in the U.S. A great number of these were devoted to commentary on public affairs. At the same time, newspapers ranging from eight-page weeklies to metropolitan dailies recognized the value of the "personal touch" provided by their own columnists.

Writing a column requires, in addition to knowledge of the subject matter, ability to project a personality, ability to find an audience and to establish rapport with it. The columnist's subject matter is frequently ephemeral in interest and may appeal to a limited geographic area as well. His work is therefore highly transitory for the most part, but at its best it fulfills an important educational function—and it is often a favourite feature with readers of the newspaper in which it appears.

COLURE, in astronomy, either of the two principal meridians of the celestial sphere (*q.v.*), one of which passes through the poles and the two solstices, the other through the poles and the two equinoxes; hence designated as solstitial colure and equinoctial colure, respectively.

COLUTHUS (Colluthus) of Lycopolis in the Egyptian Thebaid (fl. *c.* A.D. 500), Greek epic poet, is represented by one extant poem, *The Rape of Helen,* which was discovered by Cardinal Bessarion (*c.* 1395–1472) in Calabria. This poem of 394 hexameters is in imitation of Homer and Nonnus and tells the story of Paris and Helen from the wedding of Peleus and Thetis down to the elopement and arrival at Troy. According to the Suda lexicon he was also the author of *Calydoniaca* (probably an account of the Calydonian boar hunt); *Persica* (an account of the Persian wars); and *Encomia* (laudatory poems in epic verse). These are all lost.

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(J. M. Hy.)

COLVIN, SIR SIDNEY (1845–1927), English literary critic and connoisseur of art, whose scholarship particularly illuminated his work on Keats, was born in London on June 18, 1845. He was educated at Cambridge. In 1873 he became Slade professor of fine art at Cambridge, and was director of the Fitzwilliam museum from 1876 to 1884, when he became keeper of prints and drawings at the British museum. In 1873 he formed a lasting friendship with Robert Louis Stevenson, and in 1895 published *Vailima Letters*, Stevenson's letters to him from Samoa. He also edited Stevenson's works, and two further volumes of his letters. Colvin's *Keats* (1887) marked an advance in the study of the poet. He recognized the quality and importance of Keats's letters, and prepared a selection of them in 1891. He published many works on fine art, and his *Memories and Notes of Persons and Places* appeared in 1921. He died in London on May 11, 1927.

See E. V. Lucas, *The Colvins and Their Friends* (1928).
(P. M. Y.)

COLWYN BAY (Bae Colwyn), a municipal borough (1934), in the Denbigh parliamentary division of Denbighshire, Wales, on the Irish sea, 41 mi. W.N.W. of Chester by road. Pop. (1961) 23,090. The town grew rapidly after 1918, until it became virtually continuous with Old Colwyn and Rhos-on-Sea, with which it is linked by a promenade 3 mi. long around the sandy bay. It is a seaside resort and a centre for excursions in north Wales and has an industrial diamond factory. Rydal school for boys was founded in 1885. To the southeast (2½ mi.) is Llanelian-yn-Rhôs, famous for its "cursing well" (Ffynnon Elian). The name Colwyn is that of the lords of Ardudwy, in west Merionethshire.

COLY, a small group of African birds about 12 in. long, with crested heads, finchlike bills, rounded wings and long tails. Six species are all included in the genus *Colius*, which constitutes the peculiar order Coliiformes and family Coliidae of the Ethiopian region. Although they are most closely related to hummingbirds and trogons (*qq.v.*), they appear very different from them. The sexes are similar in appearance, being generally of a dun or slate colour, but sometimes marked with white or chestnut. Colies are often called mousebirds, probably from their habit of creeping along the boughs of trees with the whole tarsus of the foot applied to the branch. The toes are very long, and the first one is reversible; *i.e.*, it can be directed forward or backward. Colies are gregarious and notably acrobatic. They often hang head downward and are reputed to sleep in that position. The voice includes harsh calls, mewing cries and whistling notes. They feed principally on vegetable matter, but occasionally take insects. The nest, placed above the ground, is a shallow cup of twigs and bark lined with soft materials. Both parents incubate the two to seven usually pure white eggs. (E. R. Be.)

ARTHUR W. AMBLER FROM NATIONAL AUDUBON SOCIETY

RED-FACED COLY (COLIUS INDICUS)

COLZA OIL, a nondrying or semidrying oil, also called rape oil or rapeseed oil. It is obtained from the seeds of a turniplike plant that is cultivated in France, Belgium, the Netherlands and Germany.

See Oils, Fats and Waxes.

COMA is a complete loss of consciousness from which the subject cannot be aroused by various stimuli. It is a symptom of various disease states. It is often associated with convulsive attacks and may be transient or prolonged.

Coma requires prompt medical treatment. First aid is bodily quiet and comfort with warmth and cleanliness. Free access of air is vital as the relaxation of the jaw and tongue may interfere with proper breathing. *See* also articles under various diseases such as Diabetes. (F. L. A.; X.)

COMA BERENICES ("Berenice's Hair"), in astronomy, a small constellation between Leo and Boötes, first mentioned in the 3rd century B.C. It is said to represent the hair of an Egyptian queen, placed by her as an offering in a temple of Venus. The distinguishing feature of this constellation is the Coma cluster, a galactic cluster of stars, which is faintly visible to the naked eye and which marks the position of the north pole of the Milky Way. (R. H. Br.)

COMANA, an ancient city of Cappadocia, the site of which lies at Shahr, a village in the Anti-Taurus mountains on the upper course of the Seyhan (Sarus) river, about 20 mi. downstream from the little town of Sariz in the Adana (Seyhan) *il* of Turkey. Frequently called Chryse, or Aure (*i.e.*, the golden), to distinguish it from Comana in Pontus, it was celebrated as the place where the rites of Ma-Enyo, a variety of the great west Asian nature goddess, were celebrated with orgiastic rites of an Anatolian character.

The service was carried on in a sumptuous temple with great magnificence by many thousands of *hierodouloi* (temple servants). To defray expenses, large estates were set apart, which yielded a more than royal revenue. The city, a mere appanage of the temple, was governed immediately by the chief priest, who was generally a member of the reigning Cappadocian family and took rank next to the king. The number of persons engaged in the service of the temple, even in Strabo's time (63 B.C.–*c.* A.D. 21), was upward of 6,000, and among these, to judge by the names common on local tombstones, were many Persians. Under the emperor Caracalla, Comana became a Roman colony, and it received honours from later emperors down to the official recognition of Christianity. The place derived importance in antiquity from its position at the eastern end of the main pass of the western Anti-Taurus range, through which passed the road from Caesarea Mazaca (Kayseri) to Melitene (Malatya), converted by Septimius Severus into the chief military road to the eastern frontier of the empire. The extant remains at Shahr include a theatre on the left bank of the river, a fine Roman doorway and many inscriptions; but the exact site of the great temple has not been satisfactorily identified.

See P. H. H. Massy, "Exploration in Asiatic Turkey, 1896–1903," *Geogr. J.* (Sept. 1905); E. Chantre, *Recherches archéologiques dans l'Asie occidentale. Mission en Cappadocie* (1898).
(D. G. H.; Wm. C. B.)

COMANA, an ancient city of Pontus, traces of which are visible near the village of Gumenek on the Yesil Irmak, 7 mi. N.E. of Tokat in the Tokat *il* of Turkey. The mother goddess Ma-Enyo was worshiped in the city with rites like those employed at Comana in Cappadocia, whence the city was said to have been colonized. There were 6,000 slaves attached to the temple. The high priest in Roman times was a rich and autonomous landlord.
(Wm. C. B.)

COMANCHE, a warlike Indian tribe of the southern Great Plains of the United States, closely related to the Wind River Shoshone of Wyoming and the Northern Shoshone of the Great Basin (*see* Shoshone). In speech, they belong to the Uto-Aztecan (*q.v.*) linguistic stock.

Evidence indicates that the immediate ancestors of the Comanche occupied the Yellowstone river country in the 17th century. As the Blackfoot, Crow, Arapaho, Cheyenne and Dakota tribes pushed westward, the Comanche moved south along the edge of the plains into western Texas. They are first reported in New Mexico, in 1705. They early became possessors of numerous horses and were one of the first tribes to develop the pattern of equestrian nomadism that became so characteristic of the Plains Indians in the 18th and 19th centuries.

The Comanche drove the Apache from the southern plains, and in 1790 and 1840 they entered into formal alliances with the Kiowa and Cheyenne (*qq.v.*), respectively. Raids for booty and captives carried the Comanche as far south as Durango in north central

Mexico. Comanche resistance blocked the westward expansion of the Texas frontier for nearly half a century.

The social organization of the Comanche lacked lineages, clans, military societies and tribal government. The 13 or so bilateral bands were nontotemic and politically autonomous. The Comanche did not possess the sun dance (*q.v.*) or any other integrating tribal ceremonial prior to 1874. They also lacked the communal buffalo hunt so characteristic of other Plains Indians.

Although a reservation of nearly 3,000,000 ac. in the present state of Oklahoma was assigned to the Comanche, Kiowa and Kiowa-Apache in the Medicine Lodge treaty of 1867, the Comanche wars with the United States did not end until June 1875. The Kiowa-Comanche reservation was broken up into individual allotments in July 1901. In 1945, 2,700 Comanche were living on their individual holdings in the vicinity of Lawton, Okla. *See* also PLAINS INDIANS.

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COMAYAGUA, department in central Honduras. Pop. (1961) 96,420; area 2,006 sq.mi. Although consisting mostly of highlands, the department has several fertile valleys and produces coffee, tobacco, rice, yucca, beans, corn and cattle; it is also significant in swine, poultry, vegetable and fruit production.

Comayagua city, the departmental capital (pop. 8,456) founded in 1540 on the right bank of the Humuya river, lies in a fertile valley 32 mi. long and 16 mi. wide. It served as the Spanish colonial capital of the province of Honduras under the name of Valladolid la Nueva. The town was burned by revolutionaries in 1827, when it had a population of 18,000. It also served as the capital of the republic until 1880, when it was replaced by Tegucigalpa. Comayagua has a handsome cathedral built in 1715, other public buildings dating from colonial times, and several small industries.

The city is 65 mi. from Tegucigalpa by way of the modern Inter-Ocean highway, which extends northwestward to beautiful Lake Yojoa along the eastern shore and on to Potrerillos, where it connects with the railway to the north coast at Puerto Cortés. (C. F. J.)

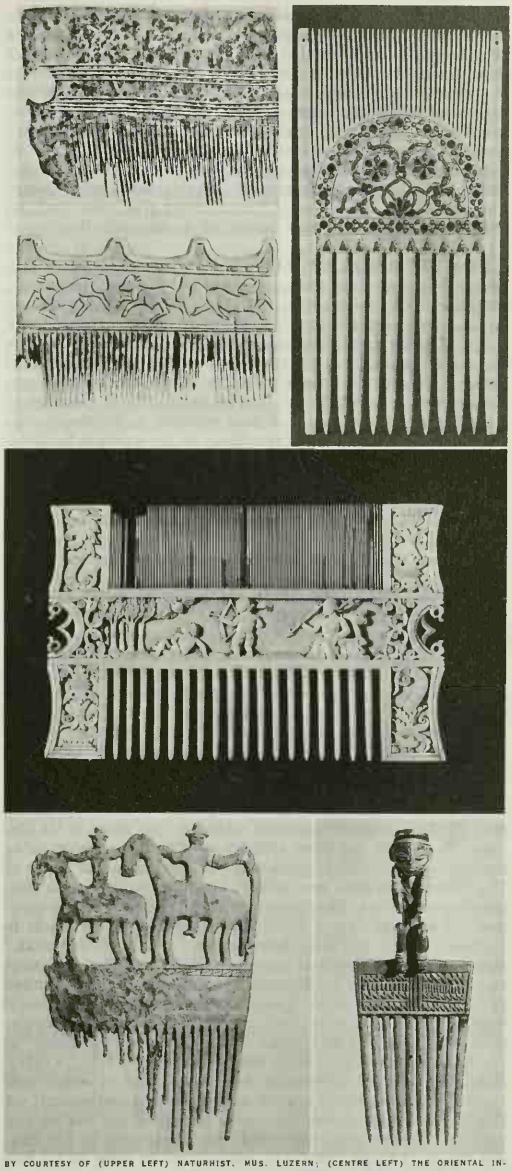
COMAYAGUELA: *see* TEGUCIGALPA.

COMB is a toothed toilet implement used for cleaning and arranging the hair, and also for holding it in place after it has been arranged; the word is also applied, from resemblance in form or in use, to various appliances employed for dressing wool and other fibrous substances, to the indented fleshy crest of a cock and to the ridged series of cells of wax filled with honey in a beehive.

Hair combs are of great antiquity, and specimens made of wood, bone and horn have been found in Swiss lake dwellings. Among the Greeks and Romans they were made of boxwood, and in Egypt also of ivory. For modern combs the same materials are used, as well as tortoise shell, metal, India rubber, celluloid and other synthetic plastic materials.

There are two chief methods of modern manufacture. A plate of the selected material is taken of the size and thickness required for the comb, and on one side of it, occasionally on both sides, a series of fine slits are cut with a circular saw. This method involves the loss of the material cut out between the teeth.

The second method, known as twinning or parting, avoids this loss and is also more rapid. The plate of material is rather wider than before, and is formed into two combs simultaneously, by the aid of a twinning machine. Two pairs of chisels, the cutting edges of which are as long as the teeth are required to be and are set at an angle converging toward the sides of the plate, are brought down alternately in such a way that the wedges removed from one comb form the teeth of the other, and that when the cutting is complete the plate presents the appearance of two combs with their teeth exactly dovetailing into each other. In India-rubber combs the teeth are molded to shape and the whole hardened by vulcanization.



BY COURTESY OF (UPPER LEFT) NATURHIST. MUS. LUZERN, (CENTRE LEFT) THE ORIENTAL INSTITUTE; (UPPER RIGHT) THE TRUSTEES OF THE VICTORIA AND ALBERT MUSEUM; (CENTRE) MUSEO NAZIONALE; (BOTTOM LEFT) ROCHESTER MUSEUM OF ARTS AND SCIENCES; (BOTTOM RIGHT) MUSÉE ROYAL DE L'AFRIQUE CENTRALE, TERVUREN, BELGIUM

(UPPER LEFT) PREHISTORIC SWISS LAKE DWELLER COMB; (CENTRE LEFT) WOODEN EGYPTIAN COMB, 1300 B.C.; (UPPER RIGHT) CAROLINGIAN COMB OF IVORY INLAID WITH GOLD AND GLASS, 10TH CENTURY; (CENTRE) IVORY COMB CARVED WITH VENUS AND AMORETTI, ITALIAN, 16TH CENTURY; (BOTTOM LEFT) IROQUOIS INDIAN COMB, 18TH CENTURY; (BOTTOM RIGHT) TSHOKWE COMB, CENTRAL AFRICA, 19TH CENTURY

COMBAT FATIGUE (also called flying, operational, pilot, convoy and battle fatigue, or combat exhaustion), a term commonly used in World War II to designate states of (1) hypersensitivity to stimuli such as noises, movements and light accompanied by

overactive responses that include "startle reactions" with involuntary defensive jerking or jumping; (2) easy irritability progressing even to acts of violence; (3) sleep disturbances including battle dreams, nightmares and inability to fall asleep. Although persons in combat differed widely in their susceptibility to combat fatigue because of hereditary factors and previous training, most cases resulted from exposure to physical hardship, fatigue and emotional conflicts. The emotional conflicts usually were related to loss of comrades, leaders and group support, together with other precipitating events in the battle setting. Most patients were treated with best results near the front lines by being given rest, food and sedation, provided they were permitted to stay with their units.
(H. W. Bn.)

COMBE, ANDREW (1797–1847), Scottish physician, an advocate of phrenology and a pioneer of popular health education, was born in Edinburgh on Oct. 27, 1797. While studying in Paris he came under the influence of J. C. Spurzheim, the founder with F. J. Gall of the pseudo science of phrenology, and in 1820 Andrew and his brother George (1788–1858) founded the Phrenological society. He acquired an extensive practice in Edinburgh but was handicapped by ill-health. In 1836 he was appointed physician to King Leopold of Belgium, but soon returned to Edinburgh. In 1838 he became physician-extraordinary to the queen in Scotland. Combe wrote *The Principles of Physiology Applied to the Preservation of Health* (2nd ed., 1834), *The Physiology of Digestion* (1836) and *A Treatise on the Physical and Moral Management of Infancy* (1840). He died at Gorgie, near Edinburgh, on Aug. 9, 1847.

See George Combe, *Life and Correspondence of Andrew Combe* (1850). (W. J. Bp.)

COMBE, WILLIAM (1741–1823), English writer, the creator of "Dr. Syntax," was born in Bristol in 1741. Many details of his life are obscure, though Combe, a brilliant talker, is the hero of scores of anecdotes. He was educated at Eton; then, having been left a legacy by a rich London merchant, William Alexander (who may have been his father), he traveled widely and lived "in a princely style"—whence his nickname of "Count Combe." He fell heavily into debt, and after a varied career as private soldier, waiter, teacher and cook, returned to London about 1771 and took to writing for a living. He died at Lambeth on June 19, 1823.

An able journalist and voluminous writer, Combe has at least 84 works to his credit, besides numerous periodical articles, sermons, etc. Nothing, however, appeared under his own name in his lifetime. In 1789 he was given £200 annually for his pamphleteering support of William Pitt; and about 1797 he became an editor of *The Times*. The most successful of his earlier works were a vituperative verse satire, *The Diaboliad* (1776), and a prose "continuation" of Le Sage (*q.v.*), called *The Devil Upon Two Sticks in England* (1790). His fame, however, rests upon his "Dr. Syntax," written originally (1809–11) for Ackermann's *Poetical Magazine* to accompany plates by Thomas Rowlandson (*q.v.*). Reprinted in 1812 as *The Tour of Dr. Syntax in Search of the Picturesque*, it went into nine editions by 1819 and was one of the most popular books of the early 19th century. It was followed by *Tours* "in Search of Consolation" (1820) and "in Search of a Wife" (1821). In all, the three *Tours* comprise over 25,000 lines of octosyllabic couplets, undistinguished in style, sententious and sentimental; yet they have a certain charm, score some fair satiric hits and are still readable. Combe also co-operated with Rowlandson in *The English Dance of Death* (1815–16), which contains some of his best verse, and *The Dance of Life* (1816).

See *Gentleman's Magazine*, obituary (Aug. 1823) and a list of works (May 1852); *Times Literary Supplement* (July 19, 1941).
(R. P. C. M.)

COMBES, (JUSTIN LOUIS) ÉMILE (1835–1921), French statesman responsible for the separation of church and state, was born at Roquecourbe, Tarn, on Sept. 6, 1835. Destined for the priesthood, he studied at the seminary at Castres and at the École des Carmes in Paris. A doctor of divinity, he published his thesis *La Psychologie de Saint-Thomas d'Aquin* (1860) and taught philosophy at the Collège de l'Assomption at Nîmes. Being refused ordination, Combes studied medicine and became a doctor in 1867. He practised at Pons (Charente-Inférieure) where he became mayor in 1875. A member of the Grand Orient de France, he sat with the predominantly masonic Radical party when he was elected senator in 1885. He was appointed minister of education and of cults under Léon Bourgeois (1895–96). He actively supported Waldeck-Rousseau's ministry and upon its retirement was himself charged on June 7, 1902, with the formation of a government which became one of the longest in the third republic. He took the portfolios of the interior and of cults and devoted himself to the rigorous application of the Associations law of 1901 (*see* Waldeck-Rousseau, Pierre Marie René).

At the age of 67, Combes preserved something of his clerical training in a dogmatic combativeness to which he had added all the prejudices of the republican anticlerical. He took a simple view of his duties: he was delegated by the republican majority to extirpate the clerical menace and was determined to finish, once and for all, with "the enemies of the republic." A great number of Roman Catholic schools were shut, and Combes proposed to authorize only five religious orders; for the others, authorizations were refused en bloc. Then even the authorized orders were assailed, but the few remaining teaching orders among them were allowed ten years' further life (law of July 1904 suppressing schools directed by a religious congregation). The Vatican's protest against President Loubet's visit to Rome in March 1904 was published by *L'Humanité* in May, despite the cabinet's efforts to keep it secret, and the ensuing crisis enabled Combes to table legislation in October for the separation of church and state. This became law in Dec. 1905; but Combes had already resigned office on Jan. 18, after the split of the supporting coalition over the allegation that the personal staff of the war minister, Gen. Louis André, regularly received reports (the so-called *fiches de délation*) from the masonic Grand Orient de France on all officers suspected of reactionary opinions or of clericalism.

Combes sat as minister without portfolio in Briand's cabinet of 1915–16 and died at Pons on May 25, 1921. His works include *Une campagne laïque* (1904); *Une deuxième campagne laïque* (1905); and *Mon ministère 1902–05* (1956).

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COMBINATION IN INDUSTRY: *see* Monopoly; Cartel.

COMBINATION LAW, the name given to the British acts of 1799 and 1800 which made trade unionism illegal. The law, as finally amended, sentenced to three months in jail or to two months' hard labour any workingman who combined with another to gain an increase in wages or a decrease in hours, or who solicited anyone else to leave work or objected to working with any other workman. The sentence was to be imposed by two magistrates, and appeal was forbidden unless "two sufficient sureties in the penalty of £20" were given, which was most unlikely since anyone contributing to the expenses of a person convicted under the act would be fined £10, and the recipient another £5. The removal of a conviction by a writ of certiorari was forbidden, and defendants could be forced to bear witness against each other. Other clauses forbade employers' combinations, but these were never in any recorded case put into operation. The laws were repealed in 1824 as a result of the patient intrigue of the radical tailor, Francis Place (*q.v.*), acting through Joseph Hume, M.P. The repeal was followed by a rash of strikes and in 1825 an unsuccessful attempt was made to reimpose the acts. *See* also Labour [Trade] Union: *Great Britain;* Labour Law. (R. W. P.; X.)

COMBINATORIAL ANALYSIS, a branch of mathematics which deals with problems of arrangements or designs. As examples may be cited: (1) the problem of arranging a bridge tournament so that each player will have every other player as partner the same number of times and as opponent the same number of times; and (2) the problem of arranging $n^2 + n + 1$ points into $n^2 + n + 1$ sets of $n + 1$ points so that these sets will be the lines of a projective plane; *i.e.*, so that any pair of distinct points will lie on exactly one line. There may be a time element in the prob-

lem; for example, it may be required to schedule the use of tankers to transport specified quantities of oil so as to minimize the time consumed in delivery and reduce the number required.

In a problem of arrangement or design there are generally two natural questions: (1) Can it be done at all? (2) If so, in how many ways? In some problems the existence of at least one solution is trivial and the interest lies almost entirely in the number of ways in which the problem can be solved. These are problems of enumeration. Occasionally it may happen that the best way of finding that an arrangement is possible is to derive a formula giving the number of solutions. And, of course, procedures for constructing arrangements and designs are relevant to both questions.

It is difficult to subdivide combinatorial analysis into clear-cut sections; however, there are four major subdivisions which include most of the subject. These are: (1) permutations and combinations; (2) theorems on choice; (3) theory and construction of designs; (4) minimal and maximal choices.

Permutations and Combinations.—In how many ways can two letters be selected from x, y, z? This naturally depends on whether it is permissible to choose the same letter twice and whether the order of the two letters chosen matters. If order is counted and repetition is allowed there are 9 choices:

$$xx,\ xy,\ xz,\ yx,\ yy,\ yz,\ zx,\ zy,\ zz$$

If order is counted but repetition disallowed there are only 6 choices:

$$xy,\ xz,\ yx,\ yz,\ zx,\ zy$$

If repetition is allowed but order not counted there are 6 choices:

$$xx,\ yy,\ zz,\ xy,\ xz,\ yz$$

If order is not counted and repetitions are not permitted there are only 3 choices:

$$xy,\ xz,\ yz$$

A selection in which order counts is called a permutation; a selection in which order does not count is called a combination.

The number of permutations of n objects $x_1, \ldots, x_n$ taken r at a time with repetitions permitted is n^r, since in a choice $a_1\, a_2 \ldots a_r$ there are n possibilities for a_1, and for each choice of a_1 there are n choices for a_2, and so on for each of $a_3, \ldots, a_r$. If repetitions are not permitted then there are still n choices for a_1, but for a_2 there are only $n-1$ choices since the object chosen as a_1 may not be chosen again. Having chosen $a_1\, a_2$, there are now $n-2$ choices for a_3. More generally, having chosen $a_1\, a_2 \ldots a_{i-1}$ there are $n-i+1$ choices for a_i. Hence for a permutation of n things taken r at a time, $a_1\, a_2 \ldots a_r$, there are $n(n-1)(n-2)\ldots(n-r+1)$ choices. This number is frequently written ${}_nP_r$. It is convenient to use the factorial notation $n!$ for the product $1\cdot2\cdot3\ldots(n-1)n$ for a positive integer n. Thus, $6! = 1\cdot2\cdot3\cdot4\cdot5\cdot6 = 720$. By definition, $0! = 1$. Now

$$n! = 1\cdot2\cdot3\ldots(n-1)n = n(n-1)!,$$

thus $(n-1)! = n!/n$ for any positive integer n. In this notation it will be seen that ${}_nP_r = n!/(n-r)!$.

A particular set of r distinct objects $b_1, b_2, \ldots, b_r$ chosen from n distinct objects $x_1, x_2, \ldots, x_n$ will give $r!$ permutations $a_1\, a_2 \ldots a_r$, since a_1 may be any one of the r objects $b_1, \ldots, b_r$, a_2 may be any one of the $r-1$ remaining and so on. Hence each combination of n objects taken r at a time without repetition gives exactly $r!$ permutations of the n objects taken r at a time without repetition. Also, each of the ${}_nP_r$ permutations arises exactly once from a combination. Letting ${}_nC_r$ denote the number of combinations of n things taken r at a time without repetition, it has been shown that ${}_nP_r = r!\,{}_nC_r$, whence ${}_nC_r = n!/(n-r)!\,r!$. The numbers ${}_nC_r$ are the binomial coefficients arising in the formula

$$(x+y)^n = \sum_{r=0}^{n} {}_nC_r x^{n-r} y^r,$$

since in a product of n factors $(x+y)(x+y)\ldots(x+y)$ the coefficient of $x^{n-r}y^r$ is the number of ways of choosing y from r of the factors and x from the rest.

What can be said about the number of combinations of n things taken r at a time with repetitions permitted? To find this number, a trick is employed. Suppose it is desired to find the number of combinations of 5 letters a, b, c, d, e taken three at a time, with repetitions permitted. Of the $8 = 5+3$ numbers 0, 1, 2, 3, 4, 5, 6, 7, take a combination of three of the 7 numbers 1, 2, 3, 4, 5, 6, 7. One such combination is 3, 4, 7. Now list 0 through 7, replacing the chosen numbers 3, 4, 7 by x's. This gives 0 1 2 x x 5 6 x. Now replace the remaining numbers by the letters a, b, c, d, e in order. This gives a b c x x d e x. From this pattern, a combination is obtained by taking each letter as many times as it is followed by an x, in this case the combination c c e. Conversely, a combination of three of the letters, repetitions permitted, determines in this manner a unique combination of three of 1, . . . , 7 without repetitions. Thus a a d gives the pattern a x x b c d x e corresponding to the combination 1, 2, 6. The above argument may be generalized to the case of combinations of n things taken r at a time with repetitions permitted, the number of these being ${}_{n+r-1}C_r$. In the example under discussion, the number of combinations of 5 letters taken three at a time with repetitions permitted is ${}_7C_3 = 7!/4!3! = 7\cdot6\cdot5/1\cdot2\cdot3 = 35$. Since the value of $n!$ increases so rapidly with n, complete lists of combinations or permutations cannot in practice be written down except for small values of n or r.

Discordant Permutations.—A permutation of n objects taken n at a time will be called more briefly a permutation. Of the $n!$ permutations of n objects it may be desired to find the number satisfying certain restrictions. Some problems have a natural formulation in terms of restricted permutations. Suppose it is desired to find the number of ways n married men may choose their n wives as dancing partners so that no man dances with his own wife. If the husbands are numbered arbitrarily as $1, 2, \ldots, n$ and if the ith husband dances with the wife of husband a_i, then $a_1\, a_2 \ldots a_n$ is a permutation of $1, 2, \ldots, n$ in which the restriction $a_i \neq i$ is imposed. Clearly, the number of these "discordant" permutations is the answer to the problem. The calculation of this number may be made by the celebrated Principle of Inclusion and Exclusion. Consider N objects and n properties $1, 2, \ldots, n$. Let N_i be the number of objects with property i, N_{ij} the number with properties i and j, and more generally $N_{i_1 i_2 \ldots i_s}$ the number with all properties $i_1, i_2, \ldots, i_s$. If $N(0)$ is the number with none of the properties $1, 2, \ldots n$, the Principle of Inclusion and Exclusion asserts that

$$N(0) = N - \sum_i N_i + \sum_{i<j} N_{ij} - \sum_{i<j<k} N_{ijk} + \cdots +$$

$$(-1)^s \sum_{i_1<i_2<\cdots<i_s} N_{i_1 i_2 \cdots i_s} + \cdots + (-1)^n N_{123\cdots n}$$

An object with none of the properties is counted above once in N and not at all in the remaining terms. An object with exactly one property u is counted $+1$ times in N and -1 times in $-\sum_i N_i$ and thus, in all, is counted a total of 0 times on the right. Similarly, an object with exactly r of the properties is counted $+1$ times in N, $-r$ times in $-\sum_i N_i$, $r(r-1)/2$ times in $+\sum_{i<j} N_{ij}$ and $(-1)^s {}_rC_s$ times in $(-1)^s \sum_{i_1<\cdots<i_s} N_{i_1 i_2 \ldots i_s}$. Hence this object is counted in all $1 - r + {}_rC_2 - {}_rC_3 \ldots + (-1)^s {}_rC_s \ldots + (-1)^r {}_rC_r = (1-1)^r = 0$ times, since the coefficients ${}_rC_s$ are the binomial coefficients. To find the number of discordant permutations, let $N = n!$ be the total number of all permutations of $1, \ldots, n$ and let the ith property of a permutation $a_1 \ldots a_n$ be the property that $a_i = i$. Here $N(0)$ is the number of discordant permutations. It is clear that $N_{i_1 i_2 \ldots i_s} = (n-s)!$, and thus the number of discordant permutations turns out to be

$$N(0) = n! - n\cdot(n-1)! + [n(n-1)/2](n-2)!\cdot\cdots\cdots$$
$$\cdots + (-1)^s[n(n-1)\cdots(n-s+1)/s!](n-s)!\cdot\cdots$$
$$= n!\left[1 - 1 + \frac{1}{2!} - \frac{1}{3!}\cdot\cdots\cdot + \frac{(-1)^n}{n!}\right]$$

This is the integer nearest to $n!/e$, where $e = 2.71828\ldots$ is the well-known base of natural logarithms.

The "problème des ménages" is a more complicated problem of the same kind. Given a circular table with $2n$ seats, it is required to find the number of ways of seating n couples with gentlemen and ladies alternating so that no husband sits on either side of his wife. Clearly, the ladies may be seated in $2(n!)$ ways. Now number the wives $1, 2, \ldots, n$ in a clockwise fashion and also assign the number i to the empty seat to the right of the ith wife. Then the ith husband may not sit in either of the seats numbered i or $i+1$. Hence if the number of the husband sitting in the jth seat is a_j, then $a_1\, a_2 \ldots a_n$ is a permutation discordant with both $1\ 2\ 3 \ldots n$ and $2\ 3\ 4 \ldots n1$. The number of such permutations, the "ménage number," is $U_n = \sum_{k=0}^{n} \frac{(-1)^k 2n}{2n-k}\binom{2n-k}{k}$ $(n-k)!$. The solution of the ménage problem and many others of a similar kind may be found in the book by John Riordan listed in the bibliography.

Partitions.—A subject at first sight independent of permutations but in fact almost identical with it is that of partitions. This topic is a phase of the general subject of distributions, being the theory of combinations of summands having a given sum. For compactness in display, it is convenient to formulate the typical problem as follows: In how many ways can the number $m+n$ be represented as the sum of exactly n positive integers? Thus for $n = 4$, $m = 2$, there are

$$6 = 3+1+1+1 = 2+2+1+1,$$

two ways, and for $n = 2$, $m = 4$, there are $6 = 5+1 = 4+2 = 3+3$, three ways. The following table was prepared by Leonhard Euler, who studied the recursion relations among the values of this function.

n =	1	2	3	4	5	6	7	8	9	10	11	. . .
m = 0	1	1	1	1	1	1	1	1	1	1	1	. . .
1	1	1	1	1	1	1	1	1	1	1	1	. . .
2	1	2	2	2	2	2	2	2	2	2	2	. . .
3	1	2	3	3	3	3	3	3	3	3	3	. . .
4	1	3	4	5	5	5	5	5	5	5	5	. . .
5	1	3	5	6	7	7	7	7	7	7	7	. . .
6	1	4	7	9	10	11	11	11	11	11	11	. . .
7	1	4	8	11	13	14	15	15	15	15	15	. . .
8	1	5	10	15	18	20	21	22	22	22	22	. . .
9	1	5	12	18	23	26	28	29	30	30	30	. . .
10	1	6	14	23	30	35	38	40	41	42	42	. . .
.	.	.	.	.	.	.	.	.	.	.	.	

With this partition function denoted by $P(n, m)$, the relations of Euler (1764) are: $P(1, m) = P(n, 0) = P(n, 1) = 1$, $P(n, m) = 0$, $(m < 0)$, $P(n, m) = P(n-1, m) + P(n, m-n)$, $P(n, m) = \sum_{s=1}^{n} P(s, m-s)$, and those of M. A. Stern (1840) are

$$P(n,m) = P(n-1,m) + P(n-1,m-n) + P(n-1,m-2n) + P(n-1,m-3n) + \ldots$$

From the simplest tactical considerations (N. M. Ferrers, 1853) of the horizontal rows and vertical columns of a *point diagram* (also called *lattice diagram* or *graph*) such as the following, an important general theorem may be inferred. In this case there are twenty points arranged in horizontal rows containing 5, 4, 4, 3, 2, 2 points and in vertical columns containing 6, 6, 4, 3, 1 points:

. . . . .
. . . .
. . . .
. . .
. .
.

Studies of such diagrams helped to establish the Theorem of Reciprocity (J. J. Sylvester, 1882): *Every partition of* n *into* k *positive summands, of which the greatest is equal to* h, *determines a reciprocal partition of* n *into* h *positive summands, of which the greatest is equal to* k. The following are immediate corollaries: *The number of partitions of* n *into* k *parts is equal to the number of partitions of* n *into parts of which the largest is* k; and, *The number of partitions of* n *into not more than* k *parts is equal to the number of partitions of* n *with no part greater than* k.

The number of partitions of n into any number of parts is written $p(n)$. In the above table, $p(n) = P(n,n)$. Associated with $p(n)$ is the generating function $f(x) = \sum_{n=0}^{\infty} p(n)x^n$. It can be shown easily that $f(x) = (1-x)^{-1}(1-x^2)^{-1}(1-x^3)^{-1}\ldots$ An interesting identity due to Euler is the following:

$$\frac{1}{f(x)} = (1-x)(1-x^2)(1-x^3)\cdots\cdots = 1 + \sum_{k=1}^{\infty} (-1)^k x^{(3k^2 \pm k)/2}$$

A combinatorial proof of this identity, using the Ferrers' graph, was obtained by J. Franklin in 1881. From the identity, $p(n)$ may be calculated recursively using $p(0) = 1$ and $p(n) = p(n-1) + p(n-2) - p(n-5) - p(n-7) + \ldots + (-1)^{k-1}\{p[n - (3k^2-k)/2] + p[n-(3k^2+k)/2]\}\ldots\ldots$ The function $f(x)$ belongs to the class of elliptic modular functions. These functions satisfy a large variety of identities, of which the Euler identity is typical. Using these, G. H. Hardy and Srinivasa Ramanujan showed in 1918 that $p(n)$ is approximately $\frac{1}{4n\sqrt{3}} \exp\left(\pi\sqrt{\frac{2n}{3}}\right)$. In 1937 H. Rademacher improved this approximation to give an exact value.

Theorems on Choice.—Suppose that there are n subsets $S_1, S_2, \ldots, S_n$ of N objects (N finite), and that differently labeled subsets S_i and S_j are allowed to contain the same objects (*see* SET THEORY [THEORY OF AGGREGATES]). Under what circumstances can distinct representatives $a_1, \ldots, a_n$, $a_i \in S_i$, $i = 1, \ldots, n$ be chosen; *i.e.*, $a_i \neq a_j$ if $i \neq j$? The following condition is clearly necessary: *For* k $= 1, 2, \ldots,$ n, *any* k *of* $S_1, \ldots, S_n$ *shall contain between them at least* k *distinct objects.* Philip Hall showed in 1935 that this condition is also sufficient when either N or n is finite. Marshall Hall showed in 1948 that if m is the smallest number of objects in any S_i then the number of choices of distinct representatives is at least $m!$ if $m < n$ and at least $m(m-1)\ldots(m-n+1)$ if $m > n$. He also (in 1956) formulated an algorithm which either constructs a system of distinct representatives or produces k subsets containing between them less than k objects. The theorem of Philip Hall has been generalized in various ways to infinite systems, but the above condition is not sufficient if both N and n are infinite.

A theorem due to D. König is somewhat like Philip Hall's theorem. Consider an $m \times n$ matrix A, and let a "line" of A mean either a row or column. The entries in A are numbers and the only distinction is between zero entries and nonzero entries. The theorem of König asserts that the minimum number of lines which together contain all nonzero entries is the same as the maximum number of cells which can be chosen with nonzero entries such that no two of them are on a line. The theorem of König is equivalent to the theorem of Philip Hall in the sense that either theorem can easily be proved as a consequence of the other.

A further theorem on choice is Ramsey's theorem: *Let* S *be a set containing* N *elements and suppose that the family* T *of all subsets of* S *containing exactly* r *elements is divided into two mutually exclusive families* α *and* β. *Let* p $\geq$ r, q $\geq$ r, r ≥ 1. *Then if* N $\geq$ n(p, q, r), *a number depending solely on the integers* p, q, r *and not on the set* S, *it will be true that there is either a subset* A *of* p *elements, all of whose* r *subsets are in the family* α, *or there is a subset* B *of* q *elements, all of whose* r *subsets are in the family* β. If $r = 2$, Ramsey's theorem can be applied to graphs in the following manner. With N points, each pair of points is joined by an arc and each arc is coloured with one of two colours (α or β). Then if N is sufficiently large there is either a set of p points all of whose arcs are of colour α or a set of q points all of whose arcs are of colour β. In 1955 A. Gleason and R. Greenwood generalized this problem to include any number of colours. They proved the theorem corresponding to Ramsey's and indeed found very sharp limits

on the magnitude of N in many instances.

Theory and Construction of Designs.—A basic kind of design is a Latin square. This is an $n \times n$ square in which each of the numbers $1, 2, \ldots, n$ occurs exactly once in each row and exactly once in each column. Two Latin squares are regarded as being essentially the same if one may be obtained from the other by performing a substitution on the numbers and permuting rows and columns appropriately. With this convention there is only one square for $n = 2$ or 3, and two for $n = 5$. The two for $n = 5$ are

1	2	3	4	5
2	3	4	5	1
3	4	5	1	2
4	5	1	2	3
5	1	2	3	4

1	2	3	4	5
2	1	4	5	3
3	4	5	1	2
4	5	2	3	1
5	3	1	2	4

Two $n \times n$ Latin squares are said to be orthogonal if, when one is superimposed upon the other, every pair of digits occurs once and only once. A number of Latin squares are said to be mutually orthogonal if any two of them are orthogonal. For example, here are three mutually orthogonal 4×4 squares:

1	2	3	4
2	1	4	3
3	4	1	2
4	3	2	1

1	2	3	4
3	4	1	2
4	3	2	1
2	1	4	3

1	2	3	4
4	3	2	1
2	1	4	3
3	4	1	2

The largest possible number of mutually orthogonal Latin squares is easily seen to be $n - 1$. A set of $n - 1$ mutually orthogonal squares is called a complete set of orthogonal squares. A complete set of orthogonal squares is exactly equivalent to a finite affine plane with n^2 points. Suppose the squares to be superposed, and regard each of the n^2 cells as a point. A total of $n + 1$ sets of parallel lines may be passed through these points in the following way. The first set will consist of the rows of the square, the second of the columns. For $i = 3, \ldots, n - 1$ the ith set is formed from the $(i - 2)$nd square. A line of the ith set shall consist of those points (cells) which in the $(i - 2)$nd square all carry the same number. The n^2 points and the $n + 1$ sets of parallel lines form a finite affine plane. By reversing the foregoing procedure a finite affine plane may be used to construct a complete set of orthogonal squares.

For n odd it is easy to construct a pair of $n \times n$ orthogonal squares. For example, in cell (i,j) put $i + j \pmod n$ in the first square and $i + 2j \pmod n$ in the second square. Having done this it is not very difficult to construct a pair of orthogonal $n \times n$ squares when n is a multiple of 4. But for $n \equiv 2 \pmod 4$ the situation is different. Trivially there are no orthogonal 2×2 squares. In 1779 Euler tried unsuccessfully to construct a pair of 6×6 orthogonal squares and conjectured that no pair of orthogonal squares exists for $n \equiv 2 \pmod 4$. By systematic trial G. Tarry showed in 1901 that no 6×6 orthogonal squares exist. In 1959 the Euler conjecture was exploded in a most conclusive manner by the joint efforts of R. C. Bose, S. Shrikande and E. T. Parker. Except for $n = 2$ and $n = 6$ Euler was proved entirely wrong. A pair of $n \times n$ squares exists for every larger n. The following pair of 10×10 squares, given in superposed position, was found by Parker:

00	47	18	76	29	93	85	34	61	52
86	11	57	28	70	39	94	45	02	63
95	80	22	67	38	71	49	56	13	04
59	96	81	33	07	48	72	60	24	15
73	69	90	82	44	17	58	01	35	26
68	74	09	91	83	55	27	12	46	30
37	08	75	19	92	84	66	23	50	41
14	25	36	40	51	62	03	77	88	99
21	32	43	54	65	06	10	89	97	78
42	53	65	05	16	20	31	98	79	87

Among other designs the block designs (full name: balanced incomplete block designs) have been most thoroughly studied. A block design is an arrangement of v distinct objects into b blocks, where each block contains exactly k distinct objects, each object appears in exactly r different blocks and a pair of distinct objects occurs together in exactly λ blocks. These five parameters trivially satisfy the two conditions

$$bk = vr, \; r(k - 1) = \lambda(v - 1)$$

The first of these conditions counts occurrences of objects in blocks in two ways; the second counts pairs involving a particular object in two ways. If $k = 3$, $\lambda = 1$ the design is called a Steiner triple system. Here v is easily shown to be of the form $6m + 1$ or $6m + 3$ and $r = (v - 1)/2$, $b = v(v - 1)/6$. In 1852 J. Steiner proposed the construction of these systems and in 1859 M. Riess showed by a constructive method that there is a Steiner triple system for every v of the form $6m + 1$ or $6m + 3$.

It is true, though not obvious, that $b \geq v$. If $b = v$ then $k = r$ and $k(k - 1) = \lambda(v - 1)$. In this case, the designs are called symmetric designs. A special case of the symmetric designs is that in which $\lambda = 1$. These are the finite projective planes, which are of great interest in their own right. The most important theorem on symmetric designs is the result of the combined work of H. Ryser, R. Bruck and S. Chowla. Using the Hasse-Minkowski theorems on rational quadratic forms, they showed that if a symmetric design exists with parameters v, k, λ satisfying the elementary condition $k(k - 1) = \lambda(v - 1)$, then (1) if v is even then $k - \lambda$ is a square and (2) if v is odd then the equation $z^2 = (k - \lambda)x^2 + (-1)^{(v-1)/2}\lambda y^2$ has solutions in integers x, y, z not all zero. This shows, for example, that with $\lambda = 1$, if $k - \lambda = 6$, 14, 21, 22 or any one of infinitely many other values, no design exists. These necessary Bruck-Ryser-Chowla conditions may conceivably be sufficient, but this is a long way from being known.

Minimal and Maximal Choices.—Two problems involving minimal and maximal choices are known as the assignment problem and the traveling-salesman problem. The first has been solved, but the second has not. The assignment problem involves finding a method for assigning n men to n jobs, given a table of n^2 numbers a_{ij}, $i, j = 1, \ldots, n$, where a_{ij} is a score representing the value of placing the ith man in the jth job. The optimum assignment maximizes the sum of the scores of the assignments. In the traveling-salesman problem, n cities and $n(n - 1)/2$ transportation costs between cities are given. The problem is to arrange a trip for the salesman going through every city and returning to his starting point so as to minimize the transportation cost. The assignment problem may be solved by an appropriate use of the theorem of König. Both these problems can be considered as belonging to a class of problems in which a certain expression (usually linear) must be maximized or minimized subject to certain conditions (usually linear inequalities). A duality theorem due to D. Gale, A. W. Tucker and H. W. Kuhn is of great value in many of these problems. Many problems of combinatorial analysis, in particular the theorems of König and Philip Hall, can be solved by these techniques. This newest part of combinatorial analysis can be expected to develop considerably. *See* also NUMBERS, THEORY OF; PROBABILITY, MATHEMATICAL.

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COMBINE. The term "combine" is in popular use throughout Great Britain and the Dominions as a synonym for what is more commonly spoken of in the United States as a "merger." It is employed to denote the large and probably monopolistic concern which results from the permanent "combination" of a number of smaller concerns in the same line of business. The combine is one form of industrial consolidation. (*See* MONOPOLY.)

In the United States, the term is widely used to denote a machine that harvests, threshes and cleans grain in the field. *See* HARVESTING MACHINERY.

COMBINE HARVESTER: *see* HARVESTING MACHINERY.

COMBING is a process applied to wool fibres in the manufacture of worsted yarn, as distinguished from woolen yarn, and to superior grades of cotton in the production of fine cotton yarn. Regardless of the kind of fibre treated, the purpose is to lay the

fibres parallel, remove dirt and nibs, and eliminate short fibre lengths. Other processing in yarn manufacture contributes to fibre parallelization and removal of foreign matter, but combing is unique in its function of fibre selection. Combed stock with its more uniform fibre lengths permits the spinning of yarns of finer diameters, greater strength in relation to size, and more lustre and evenness than are obtainable from uncombed material.

Development.—The processing of wool is such an ancient art, predating recorded history, that it is not possible to determine when combing first became an integral part of wool manufacture. But since the patron saint of wool combers is St. Blasius, who was martyred early in the fourth century, it can be presumed that the craft dates at least from medieval times. As a handicraft it persisted until the mid-19th century, the complexity of the operation resisting all efforts to mechanize it despite the pressures exerted by the successful mechanization of spinning and weaving and the consequent demand for a greater volume of combed stock.

In the household and handicraft stage combing was accomplished with two hand combs. Handfuls of cleaned, oiled wool were lashed into the teeth of the combs, which were then heated in a comb pot. One when withdrawn was affixed at a convenient height to a "pad post" and with the second in hand the comber then passed the teeth of one through the tuft of wool on the other. By making each in turn the working comb the fibres were gradually smoothed and straightened until the longer combed fibres could be drawn off in the fingers and laid out as a sliver a few feet in length. The short fibres (noils) remaining in the comb heads were collected separately and sold as stock for the manufacture of woolen yarns.

The first successful development in machine combing came near the close of the 18th century through the ingenuity of an English clergyman, Edmund Cartwright. In his first model, called the "Big Ben," he placed a series of hand combs on the exterior of a drum revolving around a horizontal axis in such a manner as to engage and clear out wool held in a fixed, upright comb. Recognizing the limitations imposed by the necessity for recharging the fixed comb with stock, Cartwright later substituted for it a circular comb revolving around a vertical axis. Since wool could be lashed into this supply comb without interrupting the combing action it was possible to produce a nearly continuous sliver of combed material. These machines were of limited practical application because they produced excessive amounts of noils and could not be used for handling fine wools; yet they are notable in that they employed the principles later incorporated in the most widely adopted types of machine combing.

Improvements in combing were introduced in the first half of the 19th century by four English inventors: George Donisthorp and Samuel Cunliffe Lister, who produced the nip-motion comb; Isaac Holden, who with Lister developed the square-motion comb, and James Noble, who with Donisthorp originated the circular or Noble comb. During this same period Joshua Heilman, an engineering student of Mulhouse, France, also patented a nip-motion comb in response to a prize offered by a cotton manufacturer of Alsace. Heilman, whose machine was known as the rectilinear and later as the French comb, succeeded in establishing prior patent rights to the nip-motion principle and brought action against Lister for infringement. The latter was forced to buy out the rights for production in England and in consequence its sale there was suppressed until 1900. The two forms most widely used have been the Noble comb associated with the Bradford, or English, system of spinning worsted yarns and Heilman's, which was commonly incorporated in the French system of worsted spinning and in the cotton industry. (*See* WOOL MANUFACTURE: *Combing.*)

English Method.—The Noble comb employs a large circular comb within which are two smaller circular combs having a diameter less than the radius of the larger circle. The two smaller combs are placed opposite each other and tangential to the inner edge of the larger circle, thus forming two combing positions. Sliver from supply packages on the exterior of the large circle is led over the point where large and small circles touch and is tamped into the combs. As the larger and smaller combs rotate in the same direction their arcs diverge and a fringe of combed stock extends from the inner edge of the large circle and the outer edge of the small circle. This fringe is drawn off by rollers, joined with the similar product from the second combing position and fed out of the machine as a continuous strand of combed top. The short fibres (noils) remaining in the teeth of the small circles are cleared and collected separately. As the larger circle revolves, the supply sliver in the space between the combing positions is lifted, moved forward and tamped down again as it reaches the next combing position.

French Method.—In the French comb the material to be combed is fed in a narrow sliver to a position just above a roll having combing teeth set in one segment of its circumference. Nippers then engage the sliver, holding it fast while the revolving comb engages and clears out that portion of the sliver lying ahead of the nippers. The nippers then rise and drawing-off rollers engage the combed fringe, pulling it through a straight comb that has dropped into the sliver behind the raised nippers. In this fashion a tuft of combed wool is produced, the revolving comb having acted on the first portion and the latter part having been pulled through the straight comb. These tufts are then overlaid and condensed to produce a continuous delivery of combed sliver from the machine.

World-Wide Trade.—The combed top, the product of combing, is accumulated in large balls and in this form, ready for dyeing and for worsted spinning, it becomes a commodity traded extensively in world markets with prices quoted on established exchanges for its immediate and future delivery. Combing normally is applied only to very fine cottons and better-grade wool fibres because the lower grades of stock are not suited for treatment and also because the process increases the sales price of the product since it is an added operation and a significant portion of stock is rejected in the form of noils.

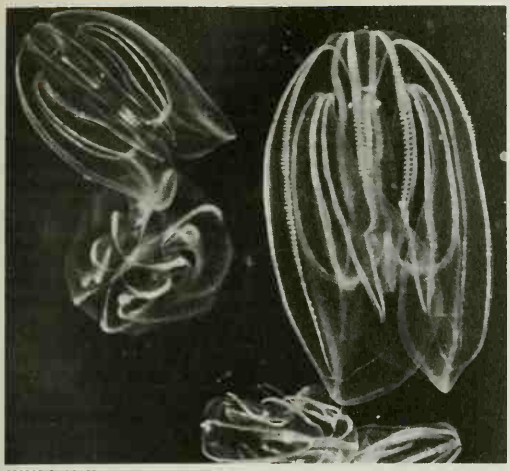
See also COTTON MANUFACTURE: *Manufacturing Processes.*

(H. C. WE.)

COMB JELLY, a common name for small marine invertebrates constituting the phylum Ctenophora. These common denizens of the sea are free swimmers with transparent, gelatinous bodies equipped with comblike plates. Not infrequently comb jellies have been confused in the popular mind with the true jellyfishes (medusae of Coelenterata), but in their structure, actions and evolutionary position they are very different from the coelenterates. Some of the 80 or more known species can live in brackish water, but most live only in full-strength sea water; none can withstand fresh water.

Distribution and Natural History.—*Geographical Range.*—Among the comb jellies *Pleurobrachia pileus* (commonly known as sea gooseberry, sea walnut or cat's eye) and the larger *Beroë cucumis* are cosmopolitan in distribution; they have been found in all the seas of the world, from the tropics to the polar regions. Most species are more restricted in their range, however. Individual species may be tropical, temperate, boreal or polar. Although the majority of the ctenophores occur in coastal areas and in the more superficial layers of water, some species live in the middle of the oceans as well, and specimens have even been collected at depths up to 9,800 ft. (3,000 m.).

Size, Shape and Colour.—Most comb jellies are oval or spherical and range between 0.2 and 0.8 in. (5 to 20 mm.) in length. A few become adults, however, when only 0.1 in. long (*e.g., Tinerfe cyanea*). At the other extreme are some species of *Beroë* that reach a length of about 3.6 in. *Mnemiopsis* species, the lobed comb jellies common along the Atlantic coast of North America, may reach 4 in. (fig. 1). Even larger are *Eucharis multicornis,* which attains about 10 in., and the giant Venus' girdle, *Cestum veneris* (*see* fig. 2) of the Mediterranean, which stretches out to a flattened band as long as 4.5 ft. (1.5 m.). Most of the common comb jellies are more or less colourless, although *Beroë cucumis* is pink and *Cestum veneris* is a delicate violet colour. The colourless species are as transparent as glass, so that except for a beautiful irridescence of their swimming organs (the comb plates) they are invisible when suspended in the water. Many species are so extremely delicate that they are

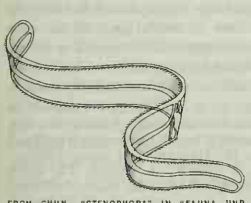


GEORGE G. LOWER

FIG. 1.—SWIMMING LOBED COMB JELLIES (MNEMIOPSIS)

torn to shreds when captured in nets. These forms escape destruction during storms by descending from the turbulent surface waters to the calmer, lower layers.

Modes of Living.—Frequently comb jellies occur in vast swarms, especially in bays, lagoons and other coastal waters. Except for a few creeping species and parasitic species, the comb jellies all float freely suspended in the water, where they swim about feebly by means of their comb plates. They are often carried about willy-nilly by the currents (*i.e.*, they are planktonic). Except for one parasitic species, all of them are carnivorous, devouring myriads of other small planktonic animals, such as copepods, larval shrimps, various small worms, free-swimming larval stages of oysters and clams, etc., as well as the floating eggs and fry of many fishes. It is not unusual to find, when ctenophores are locally abundant, that they have swept the water almost clear of other planktonic animals. By their predation upon larval fish and upon the larvae of species of shellfish and crustaceans valued by man, they are of great direct economic importance to man. By their extensive destruction of the planktonic animals that serve as food for the young fry of most fishes and for the adults of other fishes (herrings, sardines, etc.), the comb jellies are of even greater indirect economic importance. In turn the comb jellies are consumed by the adults of many fishes. Direct evidence for this is lacking: because of the delicate nature of their bodies, ctenophores have seldom been reported from analyses of fish stomachs. Nevertheless, larval stages of intestinal tapeworms of fishes have been observed in some ctenophores; it is thought that entry of these parasites into the fishes could occur only by the larval tapeworms being swallowed along with the ctenophore host.

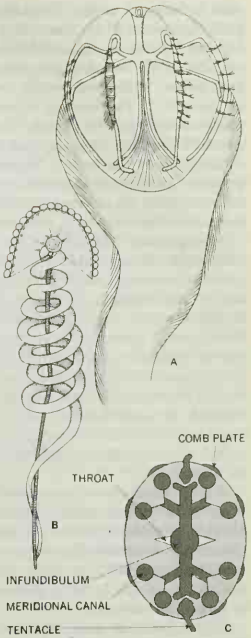


FROM CHUN, "CTENOPHORA" IN "FAUNA UND FLORA DES GOLFES VON NEAPEL"

FIG. 2.—VENUS' GIRDLE (CESTUM VENERIS)

Most, and perhaps all, of the comb jellies are luminescent, some of them exhibiting a nocturnal display of bluish or greenish light that is among the most brilliant and beautiful known in the animal kingdom. The luminescence begins only after the animals have been in the dark for at least 20 minutes and the ability to luminesce is terminated by a short exposure to light. Because of their brilliance, it is almost certain that ctenophores were known to the ancients, but nowhere in the records of antiquity is there any clear distinction between the luminescence of the comb jellies and that of the true jellyfish.

Structure and Function.—*External Features.*—The most primitive existing comb jellies are forms such as *Pleurobrachia* and *Hormiphora* (order Cydippida). The body of *Pleurobrachia* is more or less spherical (fig. 3). At one end (oral) is a mouth and at the opposite end (aboral) a complex sense organ called the statocyst (fig. 4). The latter consists of a cluster of small calcareous (limy) concretions called statoliths attached to four groups of fused cilia. These structures are incased by a dome of fused cilia called the bell. Eight regularly placed longitudinal rows of movable comb-like plates pass from near the aboral pole toward the mouth. Each comb plate is formed by the fusion of a row of large, powerful cilia. It is from these comb plates that the phylum name, Ctenophora (from the Greek meaning comb-bearing) is derived. Swimming is accomplished by the beating of the comb plates in co-ordinated waves from the aboral to the oral end. The effective stroke of each plate is toward the aboral end, so that the animal swims as a rule with the mouth forward. However, the direction of swimming may be reversed when the animal is stimulated (mechanically or otherwise) in the oral region.



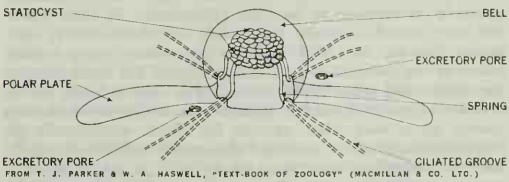
FROM W. KÜKENTHAL, "HANDBUCH DER ZOOLOGIE" (DE GRUYTER)

FIG. 3.—STRUCTURE OF PLEUROBRACHIA PILEUS

(A) Whole animal, showing the two feathered tentacles, four of the eight rows of comb plates, sense organ at upper end and internal canals seen through the transparent body; (B) adhesive cell (colloblast); (C) diagram of transverse section

Between the rows of comb plates on opposite sides of the body are two deep pockets, the tentacle sheaths, at the base of each of which is attached a long tentacle with numerous short branches. The two tentacles can be retracted completely into their sheaths, or they can be extended widely to form a highly efficient food-gathering device. On the tentacles are numerous peculiar cells, the lasso cells or colloblasts; these cells are unique to the ctenophores. The outer border of each colloblast is covered with tiny droplets of an extremely adhesive secretion to which stick any small animals that happen to hit the tentacles. From time to time the tentacles are carried to the mouth, where the captured prey is removed and ingested. It is thought that the prey is quieted by a poison before it is swallowed.

Digestion and Excretion.—The mouth leads into a wide pharynx lined with a continuation of the surface (ectodermal) cells. From the pharynx two main canals pass toward the bases of the tentacle sheaths. These canals branch and form twelve smaller, blind canals, the entire complex constituting the digestive system. A blind canal lies beneath each of the eight rows of comb plates



FROM T. J. PARKER & W. A. HASWELL, "TEXT-BOOK OF ZOOLOGY" (MACMILLAN & CO. LTD.)

FIG. 4.—SENSE ORGAN OF PLEUROBRACHIA, SHOWING STATOCYST (MASS OF STATOLITHS) WITH SUPPORTS

(the meridional canals), two lie parallel to the pharynx (pharyngeal canals) and two pass along the tentacle sheaths (tentacular canals). In addition, another large canal passes aborally to the vicinity of the sense organ and opens to the outside by two tiny anal pores. All these canals are lined with digestive epithelium (endoderm). Preliminary digestion of the food takes place in the pharynx through the action of digestive secretions. Particles of partially digested food are then carried through the various canals to all parts of the body. Digestion is completed within the food vacuoles of individual endodermal cells. Elimination of indigestible material takes place mostly through the mouth, as in the coelenterates, but some passes out also through the anal pores.

Mesogloea.—The bulk of the body of *Pleurobrachia*, as in the other ctenophores and in most coelenterates, consists of a jellylike mass of material, called mesogloea, lying between the thin ectodermal and endodermal layers of cells. As in the higher coelenterates the cells (mesenchyme) in most of this layer are sparsely distributed. However, in at least some portions of the jelly a number of specialized muscle cells are often arranged in bundles. These muscles regulate the size of the mouth, move the tentacles, etc. This organization constitutes a great advance over the structure of the coelenterate body. The scattered mesenchyme cells and the muscle cells together form a true third layer of cells, called the mesoderm, such as is found in all the higher groups of animals.

Nerve Network.—Co-ordination of the activities of the animal is accomplished through a primitive network of nerve cells, comparable in many respects to that of the coelenterates. Although there is no centralization of nerve cells, the network is more concentrated beneath the rows of comb plates. Some of the co-ordination of the body is destroyed when the aboral sense organ is surgically removed.

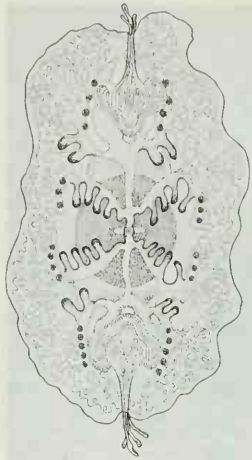
Reproduction and Development.—Reproduction is sexual, that is, by the fusion of sex cells or gametes (eggs and sperms). A single ctenophore produces both eggs and sperm in the endodermal lining of the meridional canals. Investigation has shown that the sex cells, earlier believed to be emitted through the mouth, are actually released by partial rupture of the meridional canals and the body covering over these canals. Fertilization and embryonic development occur in the water.

Embryonic development of ctenophores differs greatly from that of coelenterates in several important respects (*see* INVERTEBRATE EMBRYOLOGY). In *Pleurobrachia* and in other Cydippida development is direct, with no larval stage occurring. More highly evolved ctenophores have a so-called cydippid larva which undergoes a metamorphosis to form the adult. Only in the parasitic *Gastrodes* has a planula larva comparable to that of the coelenterates been reported.

CLASSIFICATION

Ordinal Characteristics.—*Pleurobrachia* is a representative of the primitive order Cydippida. In the order Lobata (which includes *Bolinopsis* and *Mnemiopsis*) the tentacles are greatly reduced and the oral lobes greatly enlarged. The body is somewhat flattened laterally. In the order Cestida the body is greatly extended, forming a thin band. Tentacles are very small in the adults. The cestids include the beautiful Venus' girdle mentioned earlier. In the order Beroida (*Beroë*) the tentacles are lacking, the rows of comb plates are short and the digestive canals are highly branched.

The greatest modification of all from the primitive condition occurs in the members of the order Platyctenea. In these species the body is orally aborally flattened in the adults, and in *Coeloplana* (*see* fig. 5) and *Ctenoplana* the animals creep around, either on the underside of the surface film of the water or upon the bottom and other solid surfaces. The ciliated bands are reduced or absent in the adults. Sperms pass to the outside through special sperm ducts that open on the aboral surface. In the Platyctenea also are to be found the largely immobile *Tjalfiella*, which is parasitic or commensal on the outer surface of some of the sea pens (anthozoan coelenterates), and *Gastrodes*, an internal parasite of salps (tunicates)



FROM L. H. HYMAN, "THE INVERTEBRATES," VOL. 1; AFTER DAWYDOFF

FIG. 5.—ADULT COELOPLANA MESNILI, SHOWING FLATTENED BODY ADAPTED TO CREEPING

Evolutionary Relationships.—The relationship of the ctenophores to other animals has been the theme of much speculation. Formerly they were considered to be a class or subphylum of the phylum Coelenterata (or Cnidaria). Although some textbooks still maintain this classification, most of the more modern authorities separate Ctenophora as an independent phylum. The separation is based upon (1) the lack of the characteristic stinging cells (cnidoblasts, containing nematocysts) of the coelenterates; (2) the existence of a definite mesoderm in the ctenophores; and (3) the fundamental differences in the embryological development in the two phyla.

It is, however, generally conceded that ctenophores and coelenterates were derived from the same evolutionary stem. This is indicated by the primitive radial or biradial organization of the body in both groups, by the extensive development of mesogloea between the ectoderm and the endoderm and by the reported existence of a planula larva (characteristic of coelenterates) in the ctenophore *Gastrodes*.

The creeping species of Platyctenea have suggested to some authorities that the ctenophores are transitional forms lying between the coelenterates and the turbellarian flatworms (phylum Platyhelminthes). Although there is a superficial similarity between the body of the Platyctenea (*e.g.*, *Coeloplana*) and the free-living flatworms and a certain similarity in some aspects of their embryonic development, many fundamental differences between them make it improbable that the ctenophores lie directly in the coelenterate-platyhelminth line of evolution. It is more likely that both the turbellarian flatworms and the creeping ctenophores have evolved in a parallel fashion from different ancestors.

See COELENTERATA for more details on anatomy and physiology.

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COMBUSTION. This term denotes the process of burning in the sense that a combustible substance is consumed by fire and flames. Theories on the nature of fire and flames have played a prominent role in the history of science. During the middle ages, the ancient notion that fire was an element universally prevailed until Francis Bacon classed it among his "phantoms of the market place" as one of these "fictions which spring from vain and false theories" (*Novum Organum*). About 1660 Robert Boyle, with the assistance of his pupil, Robert Hooke, proved with an air pump that neither charcoal nor sulfur burns when strongly heated in vessels exhausted of air, although each inflames as soon as air is readmitted. He also found that a mixture of either substance with saltpetre catches fire even when heated in a vacuum and concluded that combustion depends upon the action of something common to both air and saltpetre. To this was added the further discovery that in the calcination of metals a ponderable "fire-stuff" is taken up. Robert Hooke (*Micrographia*, 1665) stated that flame "is nothing else but a mixture of Air, and volatil sulphureous parts of dissoluble or combustible bodies, which are acting upon each other whilst they ascend. . . ." John Mayow, another of Boyle's pupils, experimented with candles and other combustibles burning in a bell jar of air enclosed over water. He observed that the air is diminished in bulk and that when the

flame expires the residual air is inactive and will not support combustion. He also observed that the respiration of animals in an enclosed space had the same effect, and concluded that respiration and combustion are analogous processes. His views on the subject expounded in his *Tractatus Quinque Medico-Physici* (1674) are nearly correct, and but for his early death in 1679 he might have discovered oxygen.

However, the development of the phlogiston theory by G. E. Stahl at the beginning of the 18th century completely ignored the facts brought to light by Boyle and his students. In essence, the theory proposed that all combustible matter was composed of two principles, one called "phlogiston" (from the Greek, "burned"), which escaped during combustion, and the other, termed "calx," which remained as a residue. The phlogiston theory dominated chemical thinking for a time because it satisfied the need for a common, if wrong, explanation of a great number of otherwise disconnected phenomena; and the period of its existence may properly be regarded as the incubation period of modern chemistry. It came to an end when J. B. Priestley in 1774 (and, independently, K. W. Scheele in 1775) discovered the gas later named oxygen by A. L. Lavoisier. The latter in 1783 denied the existence of phlogiston and advanced instead the theory, amply supported by facts, that oxygen is the active constituent of the air, that it is necessary to the burning process and that it enters into chemical combination with the substance undergoing combustion.

Lavoisier's methods of quantitative experimentation and of scientific reasoning no less than his discoveries initiated the era of modern chemistry. After his time combustion ceased to be a problem of central interest to science, although much work continued to be done to elucidate the physical and chemical processes, or, as it may be called, the mechanism of combustion. Hydrogen burns to water, and certain other fuels burn to carbon dioxide and water; but in the transformation to these ultimate products many steps are involved.

Combustion of Solid Fuels.—In the combustion of wood and coal the first stage is the burning of volatile matter, usually in the form of sooty and turbulent diffusion flames (*see* FLAME). This volatile matter is formed by thermal decomposition of a part of the fuel substance and constitutes a complex mixture of gases and tar-forming vapours, such as is obtained in coal-distillation plants. The residual charcoal or coke burns without flame at the rate at which molecules of oxygen reach its surface, provided that a high temperature is maintained by the heat released in the chemical combination of oxygen and carbon. Various chars and cokes require quite different temperatures to maintain combustion, ranging from about 400° C. for reactive chars to about 800° C. for dense cokes. If the surface of a coke particle loses heat by radiation to some cold surface or open space, combustion stops; however, in the crevices of a fuel bed the radiant heat is absorbed and returned from other incandescent fuel particles, and combustion maintains itself.

When air passes through a coke or charcoal bed, combustion within the crevices is incomplete, the gaseous product being largely carbon monoxide, a dangerous poison. Normally, this gas meets sufficient air at the top of the fuel bed to burn completely to carbon dioxide, forming faint bluish flames. However, there are always chilling surfaces which permit traces of the gas to escape unburned; and when an open coal fire or an overrich gas flame burns in a poorly ventilated room, carbon monoxide accumulates in the air and becomes a serious hazard.

For smokeless combustion of coal in a furnace a moderate excess of air above the fuel bed is required. In addition to the air admitted from below an auxiliary air supply is admitted at the front or rear of the furnace. If a large amount of fresh coal is thrown on the fuel bed, an excess of volatile matter is formed; hence, it is necessary to supply the coal in small quantities at frequent intervals, or continually by a mechanical stoker. The soot-bearing combustion gases must not be prematurely chilled; hence, the furnace must be properly designed to maintain a high wall temperature of the combustion chamber and to allow thorough mixing of air and combustion gases.

Spontaneous combustion, or self-ignition, sometimes occurs when combustible matter is stored in bulk. It begins with a slow oxidation process which, however, releases enough heat to raise the temperature perceptibly. As additional air seeps through the crevices, the temperature is gradually raised until inflammation occurs. Soft coal in small size tends to spontaneous combustion and must be wetted down.

Liquid fuels do not burn as such but only when they are volatilized and thus are miscible with oxygen or air in the vapour state.

Combustion of Gases.—Concerning the nature of the gaseous state, it is known that the molecules of a gas are in rapid motion, or "thermally agitated," and collide frequently with each other. Since at ordinary temperatures the fuel gases can be mixed with oxygen without inflaming or even oxidizing slowly, these molecular collisions per se are evidently entirely ineffective. At high temperatures, collisions involving high energy become more frequent, and this may lead to breakup and chemical combination of the colliding molecules. It was formerly thought that all molecules of oxygen and fuel gas reacted in this way, but with the development of chemical kinetics (*see* REACTION KINETICS) it became known that, at the temperatures of combustion, little direct reaction of this kind occurs. Instead, it has been reasonably well established that combustion occurs generally by reaction chains. For example, a high-energy collision breaks up a molecule into atoms or "free radicals" (*q.v.*); such a molecular fragment reacts with a molecule of fuel gas, which thereby becomes enabled to react with an oxygen molecule; in the latter process, an atom or free radical is again released, thus continuing the chain. Chains are broken when two atoms, or free radicals, combine to form a stable molecule, either in the gas space or, as happens most frequently, after first being adsorbed at a solid surface. Chain reactions may thus be suppressed by introducing fragments of broken glass and the like into the reaction space. Alternatively, the number and the length of the chains may be controlled by regulating the temperature of the reaction vessel and the density and composition of the mixture; or by controlling the rate of flow of a mixture through a heated tube. The term "slow combustion" refers to such controlled reactions. By means of slow combustion, intermediate oxidation products can be obtained; for example, aldehydes and organic peroxides from mixtures of hydrocarbons and oxygen, and hydrogen peroxide from hydrogen and oxygen. During slow combustion of paraffinic hydrocarbons (gasoline vapour, for example), a bluish glow is occasionally observed, which is termed "cool flame" and is caused by chemiluminescent formation of aldehydes.

Explosive Combustion.—If in the chain-continuing step more than one chain carrier is formed, as happens under certain specific conditions, the chain is branched; and if branching is not effectively checked by chain breaking, the combustion of the gas mixture in the reaction vessel becomes self-accelerating. Molecular events being extremely rapid, the combustion is completed in perhaps less than a thousandth of a second; this reaction may properly be termed an explosion and follows the principle of the atomic bomb explosion, where the chain carriers are neutrons and the chain is branched by the release of more than one neutron in the fission reaction of a neutron with the nucleus of a uranium or plutonium atom. However, the energy liberated in a fission reaction is incomparably larger than that in an ordinary chemical reaction. Another cause for explosion arises when the rate at which heat is released in the reaction exceeds the rate of heat dissipation. The temperature of the mixture rises, and the increase in temperature generally accelerates the combustion by shortening the duration of the chain cycles; this effect in turn accelerates the rise of temperature, and so on. Under some conditions explosions are purely of the latter type (thermal); under others they are of the branched-chain type and under still others they are of mixed thermal and branched-chain types. In any particular instance, the kind of explosion which occurs is determined by the nature of the gases, their proportions in the mixture and the imposed confinement, temperature and density.

The explosive reaction initiated by a critical combination of such conditions proceeds simultaneously in every part of the vessel. In contrast, a spark passed at some point of the vessel becomes surrounded by a narrow zone of intense combustion which

spreads as a wave from layer to layer of the gas mixture by heat transfer and diffusion of chain carriers. This process is also occasionally referred to as an explosion. (For combustion waves in gas streams, *see* FLAME.) Turbulent gas motion aids the heat transfer and thus accelerates progress of the combustion wave. In tubes the thermal expansion of the burning gas induces considerable flow with attendant pressure waves. With high-explosive mixtures these pressure waves and the combustion wave merge into a detonation wave, which constitutes a self-propelled shock wave traveling along the tube at a rate exceeding the velocity of sound in the burned gas.

Knock in internal-combustion engines of the four-stroke cycle type is sometimes referred to as detonation; however, it is not caused by the merging of combustion and pressure waves, but by a mixed thermal and branched-chain explosion occurring in the unburned gas ahead of the combustion wave. As the latter spreads from the spark plug through the cylinder head, the unburned gas in the rest of the chamber is compressed and heated; this produces an initially slow but self-accelerating combustion which, with low-octane motor fuels, becomes explosive before the combustion wave has completely overrun the gas mixture. It is conceivable that, under special conditions, the ignition of this end gas may start at a number of points simultaneously and even close to the oncoming combustion wave, and that this effect may result in a markedly accelerated combustion wave through the highly reacting and incipiently igniting gas. The explosion leads to violent gas vibrations which increase the heat flow to the engine cylinder wall—a dangerous condition for aircraft engines which, because of their size, cannot dissipate the excess heat. Tetraethyl lead destroys certain types of chain carriers and thus improves the knock resistance of motor fuels. The speed of the combustion wave is largely determined by the turbulence prevailing in the chamber. Without turbulence, it would be too slow, and the engine could not operate. (*See* also INTERNAL-COMBUSTION ENGINE.)

Catalytic combustion is exemplified by the reaction of hydrogen and oxygen on surfaces of platinum or palladium. Hydrogen molecules diffuse into the metal and dissociate into atoms there; they are thereby enabled to combine with adsorbed oxygen, ultimately forming water vapour. Finely divided metal (platinum sponge) can become so hot that the mixture is ignited. In compact form the metal remains comparatively cool and is thus generally nonincendive. For heats of combustion, *see* HEAT; *see* also references under "Combustion" in the Index volume.

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COMÉDIE FRANÇAISE. The national theatre of France and the most famous of the European state-subsidized theatres, often also called the Théâtre Français or La Maison de Molière, was organized in 1680 by direct decree of Louis XIV issued in his military camp at Charleville. It was originally formed by joining Molière's troupe (amalgamated in 1673 with the Théâtre de Guénégaud, formerly the Théâtre du Marais) with the most ancient Paris company, the troupe of the Hôtel de Bourgogne.

The Hôtel de Bourgogne theatre was surrendered to the Comédie Italienne, and the united French company, called Comédie Française to distinguish it from the Italian troupe, performed at the Théâtre de Guénégaud until Jean Baptiste Lully (*q.v.*) succeeded in dispossessing them. They converted a tennis court (*le jeu de paume de l'Étoile*) in the Rue Neuve des Fossés, St. Germain-des-Prés, into a theatre, which they occupied from 1689 to 1770. Their theatre and location no longer suitable, they moved to the Salles des Machines at the Tuileries, where they remained until a new theatre (later called the Odéon) was erected for them and opened in 1789 in the garden of the Hôtel de Condé, near the Luxembourg palace on the left bank. The conflicts of the French Revolution caused a split in the company of the Comédie in 1791. The revolutionary liberals under the leadership of François Joseph Talma (*q.v.*) seceded from the more conservative group under François René Molé and moved to a new theatre in the Rue de Richelieu, then called the Variétés Amusantes. After the burning of the older theatre on the left bank, the company was again reconstituted in 1799 and has continued since that date to make its home in the Rue de Richelieu. In 1816 Louis Benoît Picard, with a subvention, reconstituted the Théâtre Royal de l'Odéon on the left bank and established a company. The new Odéon, after again being destroyed by fire in 1818, was rebuilt with government aid and subsidized as the second-ranking theatre of Paris. On several occasions in the 19th century the two theatres were united under a single management. After the end of World War II, they were again united under one administrator and placed under the department of arts and letters in the ministry of education; both became branches of the Comédie Française with the two houses designated the Salle Richelieu and the Salle Luxembourg. In 1959 the Salle Luxembourg, renamed Théâtre de France, was again separated and the activities of the Comédie Française were confined to the Salle Richelieu.

The internal organization of the Comédie Française stems from the organization and operation established by Molière when his troupe returned to Paris in 1658. The company was organized as a co-operative society with the chief members, the *sociétaires,* having a direct voice in the operations of the organization, receiving a share of the net profits and being eligible for a pension upon retirement, usually after 20 years' service. The *pensionnaires* were actors hired at fixed salaries "on probation" and without the voting, profit-sharing and pension privileges; from the ranks of the *pensionnaires* new *sociétaires* were elected annually. Louis XIV perpetuated this organization and operation when he established the united company, and Napoleon in his famous Moscow decree, Oct. 15, 1812, substantially confirmed and reiterated the long-standing policy. Externally, as a state institution, Louis placed the theatre under the supervision of the gentlemen of the chamber. Around 1756 this function was taken over by the *intendant des menus* and in 1799 the theatre was placed under the jurisdiction of the department of the interior. The external management changed during the 19th century with the fall and rise of French governments, and various acts and decrees altered and curtailed the powers and duties of the *sociétaires.* With the reorganization after World War II, the administrative head of the Comédie is nominated by the director-general of arts and letters and appointed by the minister of education.

During the period of its monopoly, prior to the decree of 1791 on the liberty of the theatres, the Comédie was the only Paris theatre in which new plays could be produced. After that decree, and especially during the 19th century, it tended more and more to build its repertory from the great masterpieces of French drama of the past, though it never abandoned entirely the production of new scripts and modern plays. In 1900 it gave 267 performances of older classical plays and 419 performances of contemporary pieces; in 1952, by contrast, it presented 567 performances of classic plays and 456 of contemporary. It has produced the plays of all of the great French dramatists and the most eminent actors in the history of the nation have appeared upon its boards. Its fame rests upon an illustrious history, upon the splendid ensemble performances of its actors and upon its conservation and perpetuation of the best in the French theatre and drama. It is cherished by the French people as a national theatre and as a cultural and educational institution.

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COMEDY is a term used of both dramatic and nondramatic literature. As used in the 20th century to describe contemporary drama, it applies to plays written in a light and humorous style, with laughable incidents and characters. This usage, however, is inadequate to cover what has been and still is recognized as comedy in the drama of the past. Comedy for the Greeks was a definite genre which seems to have developed out of rites and celebrations involving song and the wearing of masks. The fact that there was an element of fertility ritual in these origins has led some authorities to accept the tradition that the actors of comedy wore the leather phallus; but other modern experts do not believe

that this actually happened in performance. It is agreed, however, that the earliest forms of Greek comedy apparently developed as a combination of ritual chorus with histrionic episodes. Aristotle says in his *Poetics* that plot and unifying theme were first introduced by Crates. Comedy was first performed as part of the competitive city festival in Athens in 486 B.C. It is usual to talk of three phases of Greek comedy proper, the earliest, Old Comedy, retaining chorus, mime and burlesque from the older forms. Old Comedy, of which the most famous exponent—and the only one whose work has survived—was Aristophanes, included fantasy in its exuberant and high-spirited satire of public persons and affairs. As it was not restricted completely to political satire, it has been suggested that Old Comedy developed quite naturally into what is called Middle Comedy, the preoccupation of which with social themes should not be regarded as a new departure in a new form. (No plays of Middle Comedy are extant.) This phase was followed by that of New Comedy, introduced by Menander (*q.v.*), which deals with contemporary manners and with familiar and domestic themes, with plots composed of intrigue and involving romance (*see* also DRAMA: *Greek and Roman*).

The attitude to humanity and affairs expressed in such art is obviously different from that involved in the expression of heroic themes in tragedy and epic. Aristotle was describing what existed as much as dogmatizing about what ought to exist when he stated that instead of expressing the heroic conception of life, comedy essentially dealt in an amusing way with plebeian characters in everyday situations. It followed that a high and heroic style of writing could not be used to express what had not been conceived in a heroic spirit. These were the fundamental assumptions about persons, attitudes, themes and style which the Romans took over from the Greeks, together with the masks, stock characters and love intrigue of New Comedy. Roman comedy, however, involved more sheer enjoyment; it has been described as amusing, reflective and, in some cases, moral. As satire of public men was too dangerous, ordinary people became the target and social and religious matters were not exempt. In the typical plot a young gentleman in love with a slave girl tries to raise money to buy her; eventually she is revealed as a long-lost child of a family of rank equal to his, who has preserved herself chaste; and so they can be married. From Roman comedy, as written by Plautus and Terence (*qq.v.*), postclassical critics developed a conception of comedy as a play of quality, of good literary style, capable of inspiring morality as well as mirth. The later form, the *fabula togata*, treated of rural and small town society and contributed to the methodical development of a dogma that comedy's function was to teach and delight by exhibiting a picture of ordinary unheroic persons and events in a suitably low or mediocre style of writing. Cicero described it as "the imitation of life, the glass of custom and the image of truth." Traditionally, moreover, its events involved no serious dangers. These ideas combined to inspire the definition, ascribed to the 4th-century Donatus (*q.v.*), that comedy is concerned with private affairs, without violence or danger to life, with unhappiness giving way to a happy outcome in which lost children are recognized and from which men may learn what is useful and what is to be avoided.

The fact that comedy was drama was probably never forgotten completely, but in the early medieval period the term was extended to types of nondramatic literature possessing some of the essential qualities of the dramatic genre. For the Spanish encyclopaedist Isidore of Seville (*c.* 560–636) the genre encompassed Old Comedy, consisting of the plays of Plautus and Terence, and New Comedy, which was undramatic and was composed of the satires of Horace, Persius and Juvenal. Eventually, narrative with a happy ending in a familiar style of elegiac verse was described as comedy; and by the 12th century the term applied to versified narrative. For many, comedy was a poem beginning in sadness and ending in joy; and Dante called his *Paradiso* a comedy partly for this reason and partly because it was written in the "speech of the masses in which even womenfolk converse" and not in heroic Latin verse.

In the Renaissance critics had classical authority for the two dominant conceptions of comedy, which was now a strictly dramatic form again. The first type, associated with Ben Jonson (*q.v.*) in England, is in the tradition of Aristophanic satire, exposing the ridiculous sins of the petty to the punishment of well-deserved derision. This form owes much to the apparent authority of Cicero and the medieval grammarians for the assumption that comedy is critical and realistic in its treatment of the life of ordinary unheroic people, being in Jonson's words, "a thing throughout pleasant and ridiculous and accommodated to the correction of manners." Low style and intricacy of plot was shared by this kind of comedy with the other, which, in the words of Thomas Heywood (*q.v.*), begins "in trouble" and ends "in peace." Each of these kinds of Renaissance comedy avoids the heroic in style, person, incident and theme; and each comes nearer to the realistic in its treatment of its subject, especially in characterization which tends away from the ideal to the individual. To some extent *A Midsummer Night's Dream* has the qualities of the second kind, its intrigue ending in the triumph of true love, passing from unhappiness to joy; but it is quite different in the qualities which make it representative of popular English comedy, for it mingles high and low persons and styles; it involves the heroic as well as the ridiculous and the plot does not avoid danger. English popular comedy, happy in its outcome, can nevertheless include danger and bloodshed. It should not, however, be confused with a strict neoclassical relation, tragicomedy, as practised by Guarini in *Il Pastor fido* (1590) and defined and defended theoretically as a not unclassical compound of fused elements from classical tragedy and comedy, mingling the heroic with the unheroic in style, person and incident, avoiding tragic catastrophe for a happy outcome in which punishment by death or derision gives way to reconciliation. The romantic comedy of Beaumont and Fletcher (*q.v.*) and Shakespeare's *Measure for Measure* and his last four comedies are fundamentally akin to this neoclassical form in their fusion or attempted fusion of the tragic and comic spirits without doing violence to either. Another form of comedy in many ways similar was that of 17th-century Spain, which did not aim at laughter but avoided bloodshed, giving a happy ending to intrigues of love and considering, if superficially, the serious issues of conduct, love and honour which led to misery and bloodshed in tragedy. In France and England the same century saw more attention given to laughter and the correction of follies embodied in individual characters. Not only Thomas Shadwell, Jonson's avowed disciple, but the courtly Restoration dramatists of England treated character in their comedy of manners. In France, Molière treated similar themes and persons, but with more humour and less satirical bite. For him the function of comedy was "to enter rightly into the ridiculous aspects of mankind and to represent people's defects agreeably on the stage." French comedy, before him, had been derived largely from that of the Italians and Spaniards, but he makes his native, despite borrowings, and has a wide range of subjects and themes, treating avarice, jealousy, snobbery, both social and intellectual, but not love as such in a romantic way. He treats the particular and individual with an awareness of the universal, a task more difficult in comedy than in tragedy.

With the 18th century a new element entered into comedy in Europe, that of sentiment. The concentration was now on the story involving unhappiness and virtue beset with troubles which ended happily and which was still not conceived of in a high heroic style but dealt with events and persons in the circumstances of ordinary life. With much less wit and bite than the comedy of manners of the previous century, this comedy of sentiment in England dealt with characters not acting under the predominance of natural feeling, but warped from their genuine bent by the habits, rules and ceremonies of a sophisticated but not heroic high society. The equivalent of what was called "genteel comedy" in England is found in France and in Germany in the plays of such writers as Marivaux and Lessing (*qq.v.*). Where the sentiment degenerated into sentimentality the result was really something approaching melodrama, but avoiding the emotional excitement which is the melodramatic equivalent of tragic tension. The sentimental comedy of England had its counterpart in what was called the *comédie larmoyante* ("sentimental comedy") first made the

vogue by La Chaussée in France: in both, a true comic attitude of any kind is constantly menaced by the superficial exploitation of virtue to produce tears followed by the relief of experiencing the reward of a happy ending.

As comedy has always had a tendency to reject idealization in favour of what seems more real by the standards of everyday life, it was natural that in the 19th century the form responded quickly to the general pressure of naturalism on the arts as a whole, to the growing insistence upon the importance of the individual in scientific, social, political and philosophic thinking and to the gradual disappearance in society and thought of the heroic as conceived in former ages of aristocratic dominance. The form traditionally used to ridicule those who transgressed against accepted conventions and ideas was now employed to attack what had formerly been accepted, when it conflicted with, or ignored, the teachings of the new age. The fundamental ideas of the past were now treated in the spirit of ridicule which had once been turned upon old-fashioned garments, taste and ways of conducting oneself in society. This method was adopted by Dumas *fils* in his comedies of social purpose and by Bernard Shaw in his comedies of ideas. Shaw in particular delighted in exposing the ridiculous element in outworn conventions as shown in relation to a modern world and with such subtlety and exuberance that his audiences found themselves laughing if protestingly. Toward the end of the century it was not unnatural that as the inevitability of change became apparent in Russia, the effect upon the society which recognized it as both welcome and unwelcome should have inspired the particular blend of irony and sentiment of Chekhov's comedy. Exhibiting a realistic picture of an existing society he is both sympathetically understanding of its inability to free itself from the elements of decadence within it, and ironically amused by the essential inadequacy of that society to cope with new times.

From Greek Old Comedy onward fantasy has been associated with the form, particularly when burlesque is present. Fantasy allows the dramatist especially to express his sense of the irrationality of the world, as one which might be regarded as a burlesque of itself. This attitude permeates plays like Johann Ludwig Tieck's *Der gestiefelte Kater* ("Puss in Boots," 1797) and the modern comedy of Eugène Ionesco, with its exposure of the real incoherence and breakdown of what is accepted at its face value by the world as rational communication with one another of members of a society of human and therefore rational beings. As the triumph of naturalism at the end of the 19th century seemed to be taking from the theatre those elements conventionally regarded as "poetic" to serve the needs of drama with a serious purpose, writers of comedy to some extent resorted to fantasy in order to prevent the drama becoming completely drab. The kind of comedy that results is seen in both J. M. Synge (*q.v.*) and Christopher Fry, with the latter grappling with the convention of realistic dialogue while writing verse.

The history of comedy shows it to be a form of drama whose complexity cannot be adequately dealt with by any definition which sees it as aiming simply at exciting laughter. Nevertheless, laughter is undoubtedly associated with comedy, a fact which has led to the discussion of the two together, notably by Henri Bergson, *Le Rire* (1900; Eng. trans., *Laughter*, 1911), J. Sully, *An Essay on Laughter* (1902) and George Meredith, *The Idea of Comedy* (1877). Meredith's thesis that comedy appeals to the intellect and not to the emotions and concerns the social group has rightly been rejected as too narrow. Consideration of comedies as they actually exist suggests that what might be regarded as different kinds derive fundamentally from differences in the attitude of authors toward their subjects, and their intentions with these respectively. When, for whatever purpose, the intention is to ridicule, satirical comedy emerges; when ridicule is turned on persons, the result is the comedy of character; satire of social convention and within social convention gives comedy of manners; social comedy concerns the structure of society itself; and satire of conventional thinking produces comedy of ideas. Progress from troubles to the triumph of love in a happy outcome produces romantic comedy; and Shakespeare's individual brand of this is suffused with a mellow humour rather than wit. The comedy of intrigue derives from a dominant intention of providing amusement and excitement with an intricate plot of reversals with artificial, contrived situations. Such is the comedy of Spain in Lope de Vega, Tirso de Molina and their fellows. Where the author wants to exploit potentially serious issues merely sentimentally, never really approaching anything like the true emotion of tragedy, sentimental comedy results. Of course these kinds are not mutually exclusive; elements of one or more may appear in any.

It has often been observed that comedy flourishes in urban societies, with an established theatre and an agreed attitude toward conventions of conduct. The civilization must be sophisticated enough to allow more reliance to be placed on verbal than on physical comedy. For comedy is essentially a literary form and differs from farce in that the latter, which has been well described as exaggerated comedy, keeps character and dialogue dependent upon crude incongruities and contrived situations, seeking merely to provoke laughter. Nevertheless farcial elements exist in comedy, especially that of the Greeks and Romans. *See* also references under "Comedy" in the Index volume.

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COMENIUS, JOHANN AMOS (JAN AMOS KOMENSKY) (1592–1670), educational reformer, theologian and last bishop of the Moravian Church, was born in eastern Moravia but spent much of his wandering life in religious exile, victim of the Thirty Years' War. His philosophy encompasses three levels: (1) Peace on earth exists only when religious factions cease fighting and unite toward realizing God's will. (2) Such understanding and co-operation can best be achieved through "pansophia," universal education and knowledge among all men and all nations by means of (3) widespread educational reforms in methods and principles of teaching, including a universal language, universal coeducation and a "college of light," a centralized pooling of all learning. Comenius regarded science as religion's handmaiden, not competitor. His *Gate of Languages Unlocked* (1631) revolutionized Latin teaching and was translated into 16 languages. *The Visible World in Pictures* (1658), which was popular in Europe for two centuries, attempted to dramatize Latin through pictures illustrating Latin sentences, accompanied by one or two vernacular translations. *The Labyrinth of the World* (1631), analogous to Bunyan's *Pilgrim's Progress*, was a major source of spiritual consolation to the exiled Moravians. Several of Comenius' pansophical works were published in England by Samuel Hartlib (*q.v.*), who persuaded him to continue writing in England and attempt to establish a pansophical college, with the co-operation of Hartlib's influential group of educators, theologians and scientists. Political turmoil cut short Comenius' stay (1641–42), but his presence initiated discussions that led to the founding of the Royal society (inc. 1662), to which he dedicated an important pansophic work, *The Way of Light*. The German philosopher Leibniz, influenced by Comenius, founded the Berlin Royal society, and similar societies appeared elsewhere.

When John Winthrop, Jr., traveled to Europe to invite some outstanding educator-theologian to become president of Harvard college, he visited Comenius (1642), and he may have asked Comenius to fill this office. New England clergymen were interested in Comenius' views on church discipline and on educating and converting American Indians.

The Swedish government, hoping to promote a national system of education, invited Comenius (1642) to reform the country's schools. His projects there included a series of graded Latin textbooks, widely acclaimed throughout Europe. His activity in several ecumenical conferences irritated Lutheran Sweden, however, and he was obliged to return to his church duties in Poland, where he was consecrated presiding bishop of the Moravians (1648), the last of the Bohemian-Moravian clergy to hold this office.

Invited to Hungary, Comenius established a pansophic school, which he hoped would be a model for a reformed educational system. But personality conflicts and numerous disputes dissipated

his energies and prevented broader adoption of his ideas. His activities became politically oriented in later years, and his thinking and efficacy suffered. Several of Comenius' 200 works, including those mentioned above, are available in English translation. *See* also CZECHOSLOVAK LITERATURE; MORAVIAN CHURCH.

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COMET. A comet is a heavenly body revolving around the sun and consisting of a nucleus, a diffuse envelope or coma and, when close to the sun, a tail that may extend to great length. Minor members of the solar system include the comets, the minor planets (or asteroids), swarms of meteoroids and the multiplicity of finely divided particles that cause the zodiacal light and Gegenschein. Comets usually are distinguished from other members of the solar system by their more or less diffuse appearance and by the character of their orbits, but cases are known in which the distinction between comet and minor planet, for example, is not definite. There is increasing evidence that comets are the parents of meteor swarms and perhaps of all meteors, and the particles of the zodiacal light may also be largely of cometary origin.

Most comets move in very elongated orbits that differ little from parabolas and require thousands of years for completion. Some, in fact, appear to leave the solar system forever because of changes produced in their orbits by the gravitational attractions of the major planets. Other comets have orbits that resemble so closely those of some minor planets that distinction cannot be made between these bodies on the basis of orbital characteristics.

This article is divided into the following sections:

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I. INTRODUCTION

The name comet is derived through the Latin from the Greek word for "hair." It suggests an imagined resemblance between the tail of a comet and long hair streaming in the wind. The term used in China and in Japan, translated "besom (broom) star," may originate either from a comparison between a comet's tail and the bundle of twigs in a broom, or from the sweeping motion of a broom over a floor suggested by the motion of a comet's tail across the constellations.

1. Nomenclature.—Comets may be designated in three ways. The first is by the year of discovery followed by a small letter (in italics) indicating the order of discovery or recovery in the year (*e.g.,* comets 1910*a*, 1927*j*, 1948*l*, 1953*f*). The second is by the year followed by a Roman numeral indicating the order in that year in which the comet passed perihelion, the point in its path closest to the sun (*e.g.,* comets 1910 I, 1925 II, 1948 XI, 1954 IX). A comet might be discovered in one year and pass perihelion one or two years before or after discovery, and hence correctly be given two different year designations. Actually, as fainter and more distant comets are discovered through the use of increasingly powerful wide-field telescopes, discovery and perihelion passage take place in different years fairly often. The second designation supersedes the first when accurate orbital elements have been derived and sufficient time has elapsed to ensure that new discoveries will not upset the order of perihelion passage determined within the year. The third designation is by the name or names of the discoverers of a comet or, less frequently, by the name of a person who has done extensive work on its orbit. Frequently the name is given in conjunction with one of the first two designations (*e.g.,* Comet Latyshev-Wild-Burnham, 1957*f*) but, especially for some of the well-known comets that are observed at repeated perihelion passages (*e.g.,* Halley's comet, Encke's comet), the name alone is usually used.

2. Distances and Periods of Comets.—Distances of comets from the sun vary within extremely wide limits; the comets 1880 I and 1843 I approached within 120,000 km. of the sun's surface, and several other comets approached almost as closely. There appears to be a great reservoir of comets, belonging to the solar system, at distances that are a large fraction of the distance from the sun to the nearest star (40,000,000,000,000 km.). Periods required by comets to complete a single revolution in their orbits also vary enormously. The shortest verified period is that of Encke's comet, $3\frac{1}{4}$ years. The longest computed periods have little real meaning, for comets moving in very large orbits can be observed over so small a fraction of the total path that the value found for the period has little significance. But periods certainly amount to millions of years for some observed comets.

3. Comets in Ancient Times.—Comets appear at irregular intervals and their rapid and often unpredicted movements, combined with the occasional enormous length and brilliance of their tails, have caused them to be regarded with mingled interest and apprehension. Since the belief was long prevalent that the movements of the heavenly bodies influenced the affairs of men, it is natural that comets were once regarded with considerable suspicion and interest. Later they were associated with plague, famine and war. These ideas had the useful result of causing the movements of comets to be noted with great care. Many such records have come down to us, especially in the Chinese annals; they have been useful in tracing the history of Halley's comet back at least to 240 B.C. and in providing probable identification of a few other comets.

In early times there were two schools of thought concerning the nature of comets: one regarded them as true celestial bodies, the other as vaporous exhalations within the earth's atmosphere. The former view was held by the Roman philosopher Seneca, who made the forecast: "Some day there will arise a man who will demonstrate in what regions of the heavens the comets take their way; why they journey so far apart from the other planets; what their size, their nature." Unfortunately, European astronomers for many centuries exhibited less sagacity than Seneca and adopted the view that comets were atmospheric exhalations, though this idea could have been easily refuted by the fact that comets share in the daily revolution of the heavens, rising and setting like the stars. The erroneous view had the effect of causing very little attention to be paid to the positions of comets among the stars, so that up to the 16th century European cometary records are far inferior in accuracy to those of the Chinese. One of the useful achievements of Tycho Brahe (1546–1601) was to establish, by comparison of observations made at two widely separated observatories, that comets are more remote than the moon and therefore must be regarded as heavenly bodies.

II. THE PHYSICAL NATURE OF COMETS

In predicting the motion of comets, the assumption is made that the only force acting is the gravitational attraction of the sun and planets. The assumption is fully justified by the fact that in all cases in which previous appearances of a comet have been well observed, and in which the perturbations have been carefully computed, the observed position has been exceedingly close to that predicted. It is quite clear, however, that material in the comae and in the tails of comets is acted upon by a repulsive force, originating in the sun, which is in many cases much stronger than the gravitational attraction. It is concluded that the material in the coma and especially in the tail is in a much more finely divided state than that found in the nucleus.

1. The Nucleus.—Several lines of evidence indicate that the nucleus is composed of one or a very few solid blocks of the order

of one kilometre in diameter. The fact that the repulsive forces are negligible, in comparison with the gravitational attraction of the sun, in governing the motion of the comet as a whole indicates that the nucleus contains lumps of moderate size. The ability of the nucleus to survive the effects of intense solar radiation during the extremely close approaches to the sun experienced by some comets also speaks for bodies of significant size in the nuclear region. The regularity with which some comets emit halos and the presence of effects that may be caused by rotation of a single nuclear body also argue in this direction. A few comets, *e.g.*, Comet Pons-Winnecke in 1927 and Comet Schwassmann-Wachmann 3 in 1930, have approached the earth so closely that measures of the size of the nucleus could be made directly. On those occasions F. Baldet, V. M. Slipher and others found diameters of the nuclei of about half a kilometre. At the same time, there are facts that argue against much larger nuclear bodies. In the instances in which comets have transited the sun, no body has ever been seen silhouetted against the sun's disk. The total mass of a comet is exceedingly small, and no case is known in which a comet has produced an observable perturbation in the motion of another body.

Lexell's comet of 1770 and Comet Brooks 2 in 1886 passed through the satellite system of Jupiter with severe disturbances to the cometary orbits but without producing any observable effect on the motions of any of the satellites.

The gases evaporated, sublimated or released by explosion from the nuclear body carry with them solid particles, and the nucleus is undoubtedly surrounded by a cloud of meteoric fragments and dust, as well as by the molecules of gas and the very small particles that form the coma and tail. The mass of the nucleus of a comet is quite insufficient to retain particles that become detached from the nuclear body, and such particles pursue independent orbits around the sun. Each trip to the vicinity of the sun costs the comet a permanent loss of material, and the loss cannot be made up by accretion of material in the outer parts of the solar system. The lifetime of a comet is limited, therefore, and the comets that are now being observed cannot have been long-time members of the inner solar system. Comets evidently vary a great deal in the amount of material contained and in the ability of that material to withstand the stresses of a close approach to the sun. To an observer comets show a good deal of variation in the degree of central condensation, but in only the most exceptional cases can the nucleus itself be observed directly.

Double and multiple nuclei are not uncommon but usually are very unequal in size and brightness, and the smaller fragments are quite short lived. Cases are on record, however, in which secondary nuclei have survived for many months or years, an example being Wirtanen's comet in 1957–59. Only very rarely are the nuclei of nearly equal size; the most remarkable example of disruption of this type was that of Comet Biela in the winter of 1845–46. This comet had been observed as early as 1772 and had eventually been recognized as periodic, returning every 6¾ years. Nothing unusual had been noted until the comet was found to have split into two comets shortly after recovery in 1845. The two distinct comets traveled side by side and returned together, but more widely separated, in 1852. The position in the sky was not favourable in 1859, and neither of the two comets that had been seen in 1852 was observed. The circumstances of the return in 1866 were more favourable but, in spite of careful search, no sign of a comet was found then or subsequently. Fragments remained, however, and the presence of the original comet has been manifested in the form of showers of meteors; displays caused by swarms of meteoroids moving in the orbit of the comet occurred on Nov. 27, 1872, and again in Nov. 1885, 1892 and 1898.

Various other showers of meteors have been associated with known comets, examples being the Draconid showers of Oct. 9, 1933 and 1946, with Comet Giacobini-Zinner, and the Ursids of Dec. 22, 1945 and 1946, with Tuttle's comet. Some showers that recur every year also have been associated with known comets; *e.g.*, the May Aquarids and October Orionids with Halley's comet, the Perseids of August with Comet 1862 III and the Leonids of November with Comet 1866 I. Complete disruption of the parent comet is by no means a necessity for the presence of an associated meteor swarm.

Studies of the behaviour of meteoric particles during their flight through the earth's atmosphere have shed direct light on the character of the material in individual comets and have revealed significant differences from comet to comet in the tensile strength and composition of the material. The material is all very fragile, with densities, according to F. L. Whipple, roughly 0.1 that of water. Evidence is accumulating that nearly all sporadic meteors may also derive from comets. Studies of meteors may be expected to be very instructive as regards the composition of comets; perhaps ultimately it may be possible to determine the place and mode of comet formation.

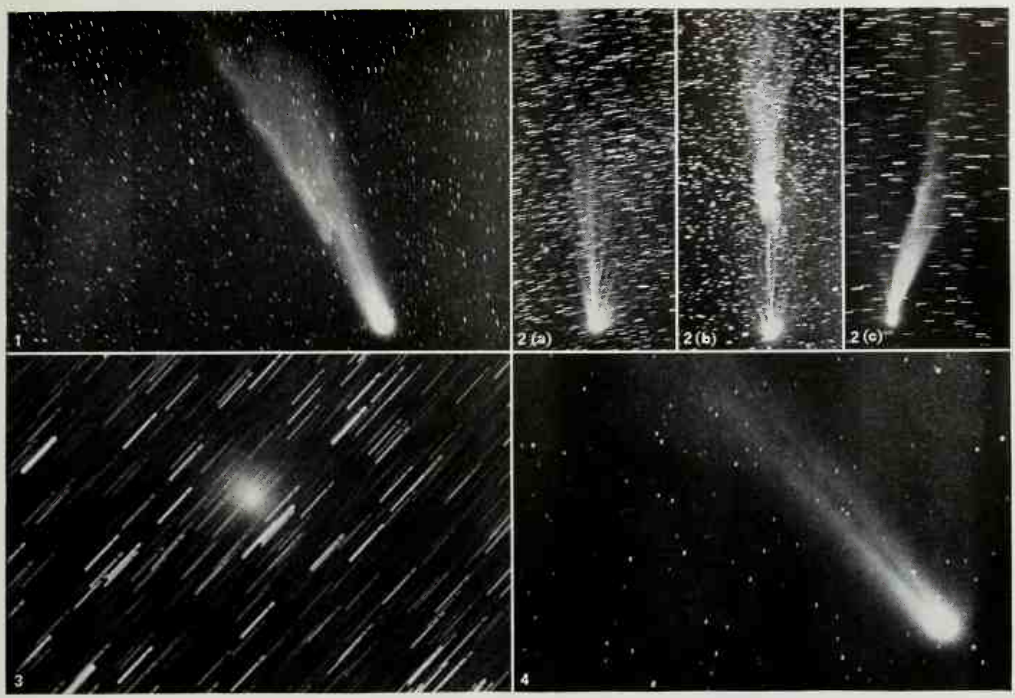
The frequency with which comets disintegrate also suggests material of very low strength. Some comets have literally gone to pieces and become very faint diffuse clouds without central condensation, or have even disappeared, without apparent cause. Comet Ensor became very diffuse and faint in 1926, and Comet Pajdusakova disappeared in Dec. 1953 instead of becoming an object as bright as Sirius, as had been expected for Jan. 1954. Some other comets have been even slightly diffuse in aspect on only very rare occasions, normally being indistinguishable in appearance from minor planets. Comet Neujmin 1 (1913 III) is of this latter type; a trace of coma was evident on only one or two occasions. One indeed is inspired to wonder whether some minor planets may not be cometary in origin, being the remnant left when the volatile materials of a cometary nucleus were exhausted.

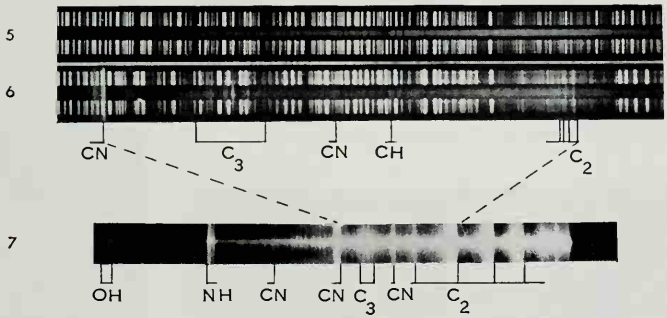
2. The Coma.—The coma is the diffuse envelope formed by the gases and dust driven out of the nucleus by solar radiation. It is an impermanent feature without definite boundary and is frequently present even when comets are observed at very great distances from the sun. The material involved is constantly replenished from the nucleus and is eventually lost to the comet because the gravitational attraction of the small central mass is quite negligible compared with the disrupting forces. When velocities of material in the coma have been measured they have been found to be 0.1 to 2–3 km. per second. The motions are generally directed outward from the nucleus in the inner part of the coma, but are modified in the outer coma by radiation pressure.

The diameter of the coma cannot be precisely defined, partly because of the hazy boundary and partly because the apparent diameter is intrinsically different in light of different colours. Molecules of gas escaping into the coma from the nucleus are broken down from polyatomic "mother molecules" into a succession of simpler compounds. Each molecule radiates in certain characteristic wave lengths of light, and the apparent diameter of the coma measured in the light of a particular colour depends on how rapidly molecules of a given species are broken down by the solar radiation into a state in which they no longer emit light of that colour. The visual diameter of the coma is determined principally by the light of C_2 and is smaller than the photographic diameter, which is essentially that resulting from CN. While a comet is approaching the sun, the coma normally increases in diameter as more gases are released from the nucleus, but the increasing radiation incident on the comet also breaks apart the radiating molecules more rapidly. When the comet approaches the sun closer than about 1.4 A.U. (the astronomical unit, the mean distance of the earth from the sun, is about 93,000,000 mi. or 150,000,000 km.), the coma begins to shrink again. It is nearly always larger than the earth and often is much larger. The coma of Halley's comet in 1910 reached radii up to 200,000 km.

The nucleus and coma together are called the head of the comet. Sometimes structure may be seen in the head, usually in the form of "fountains" or "jets," which occur when dust and gases are ejected from a particular part of the nucleus, or as "hoods," which are produced when the ejection is more symmetrical around the nucleus but takes place unevenly in time.

3. The Tail.—The tail of the comet is formed of molecules and very finely divided dust particles driven out from the coma by the pressure of radiation from the sun. The true tail, which always extends more or less away from the sun, may reach enormous





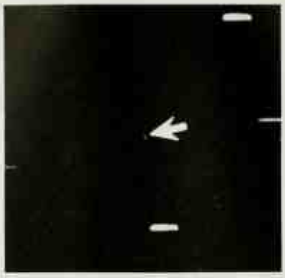
BY COURTESY OF (1, 2, AND 4) THE DIRECTOR OF THE YERKES OBSERVATORY, THE UNIVERSITY OF CHICAGO, (3) DIRECTOR OF L'OBSERVATOIRE FLAMMARION DE JUVISY, (5 AND 6) DIRECTOR OF THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C., AND (7) DIRECTOR OF THE MCDONALD OBSERVATORY, TEXAS, "THE ASTROPHYSICAL JOURNAL" AND THE UNIVERSITY OF CHICAGO PRESS

SOME REPRESENTATIVE COMETS

1. Halley's comet, May 4, 1910. Halley, in 1704, was the first astronomer to establish the fact of a comet's periodic return and to calculate its elliptical orbit. His calculations were verified by the reappearance of the comet in the years 1759, 1835 and 1910, as well as by tracing the history of previous appearances back to 240 B.C.
2. Comet Morehouse, 1908 III, photographed on three successive nights, 1908, Sept. 30, Oct. 1 and Oct. 2, by E. E. Barnard. These pictures illustrate how the tail material moves rapidly away from the comet's head, sometimes producing the rapid changes shown. The speed of recession of features in the tail sometimes reaches 100 km. per second
3. Comet Pons-Winnecke, June 23, 1927. This is a member of the Jupiter family of comets named after Jean Louis Pons who discovered it in 1819 and Friedrich Winnecke who rediscovered it in 1858. The photograph shows this relatively faint comet at a distance of only 4,000,000 miles from the earth. Stars are visible through the transparent cometary envelope (coma). This comet's orbit is changed by perturbations every alternate revolution. The photograph illustrates the general appearance of all comets when at a great distance from the sun
4. Comet 1941c as photographed on Feb. 15, 1941, by Dr. G. Van Biesbroeck with the 24-in. reflector of the Yerkes observatory. This comet was discovered by R. P. de Kock of Paarl, South Africa, on Jan. 15, 1941, but first announced to the world in general on Jan. 23, 1941, by Dr. J. S. Paraskevopoulos of the Boyden station of the Harvard observatory in South Africa. It attained its closest approach to the sun on Jan. 27, 1941. It became brighter than the third magnitude and observers of the southern hemisphere saw it as a bright naked-eye object. In the photograph the head is overexposed to bring out structure in the tail, so the bright pointlike nucleus in the head is lost in the photographic process
5, 6 and 7. Photographs, with the spectrograph, of Comets Peltier (1936a), Whipple-Fedtke-Tevzadze (1942g), and Cunningham (1940c), respectively. These illustrate the differences in cometary spectra. Comet Peltier showed an almost pure solar-type spectrum, the only characteristic cometary band being an extremely faint one due to CN. Comet Whipple-Fedtke-Tevzadza exhibits fairly strong emissions due to CN, C_2, C_3, etc., superposed on a solar type reflection spectra. For Comet Cunningham, the cometary emissions were very much more intense than the solar-type spectra. In (5) and (6) iron arc comparison spectra are shown above and below the comet's spectrum. No comparison spectrum is shown in (7). (5) and (6) cover the ordinary photographic region, from the blue-green down to the far violet. (7), taken with an ultra-violet spectrograph, covers the region from the red far into the astronomical ultra-violet. It shows the recently discovered OH and NH bands in the ultra-violet. Emission bands due to the various compounds are indicated

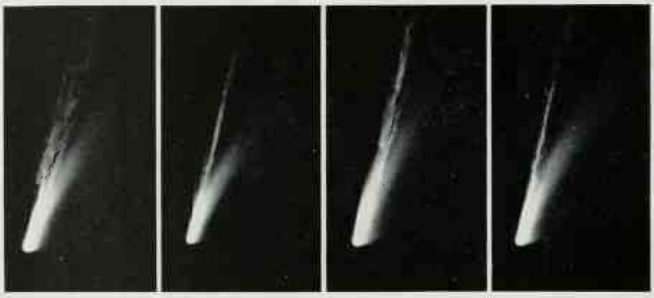
COMET

Comet Mrkos, showing the structure of the head and inner tail, Sept. 15, 1957. This photograph, made with the 40-in. reflector of the U.S. Naval observatory, Flagstaff, Ariz., is on a very much larger scale than that of the photographs of Mrkos below and shows only a small portion of the tail



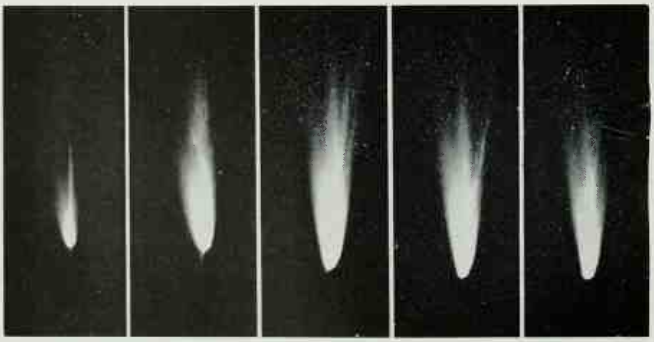
Periodic Comet Arend-Rigaux, Feb. 16, 1958. This comet, like a few others, has been entirely sharp in appearance on some occasions, with no trace of coma or tail. At such times a comet cannot be distinguished from a minor planet, or "asteroid," by appearance alone. Photograph made by 40-in. reflector

Periodic Comet Encke, Sept. 19, 1957, just before its 45th observed perihelion passage. This comet was the second for which an elliptic orbit was calculated and a return predicted. The very asymmetrical location of the nucleus in the coma may lead to systematic errors in the observed position of this comet



Comet Mrkos, photographed with the 48-in. Schmidt telescope, Palomar observatory, Calif., Aug. 22, 24, 26 and 27, 1957. Comets with two or more tails are not uncommon, but rarely are their tails so well photographed. The straight tail with prominent streamers and irregularities is formed of ionized molecules, while the more uniform, curved tail is composed primarily of small, solid particles

Comet Wirtanen showing the double nucleus and a faint tail. The two nuclei were first noticed May 1, 1957, and persisted until the comet became too faint for further observation late in 1959



Comet Arend-Roland, also photographed with the Palomar 48-in. Schmidt telescope, April 26, 27, 29 and 30, 1957. The thin "spike" opposite the normal tail was caused by an edgewise view of particles scattered in a plane of the comet's orbit through which the earth passed

RECENTLY OBSERVED COMETS

BY COURTESY OF (TOP ROW, BOTTOM RIGHT) U.S. NAVY, (CENTRE LEFT, BOTTOM LEFT) MOUNT WILSON AND PALOMAR OBSERVATORIES

lengths. The tail of Halley's comet in 1910 reached a length of 30,000,000 km., and tails as long as the distance between the earth and the sun have been observed. The tail may be nearly straight and pointed almost directly away from the sun, or it may be moderately or highly curved and form a large angle with the antisolar direction. Comets not infrequently have at the same time several tails of differing curvatures. When the comet of 1774 had six divergent tails, this phenomenon was looked on as very abnormal, but photographs in modern times have shown that multiple tails are quite common.

The curvature of the tail is indicative of the strength of the repulsive force driving material outward from the coma. Measurements of the motion of identifiable irregularities in the tails of various comets have demonstrated the presence of repelling forces from a few times to more than 2,000 times stronger than the sun's gravitational attraction. In the interpretation of the measurements, the assumption has almost always been made that the tail lies in the plane of the orbit of the comet, but this assumption may not be valid if significant velocities of ejection of material from the nucleus are present. It is not known whether such ejection effects are important.

The weaker repelling force has been identified with the pressure of solar radiation. This pressure is effective only on particles of very small size. Large accelerations cannot be produced by radiation pressure, and a good deal of evidence exists to support the probability that electrical and perhaps magnetic forces play an important role.

Detailed study of the structure of comet tails began with F. W. Bessel's investigation of the tail of Comet 1835 III. Since Bessel's time many astronomers have attacked the problem, but knowledge of the structure and composition of the tails of comets is still very primitive.

T. Bredichin classified tails into three types depending on the degree of curvature. Straight tails are bluer in colour than the more highly curved ones. They therefore are often of striking prominence on ordinary photographs made in blue light, although visually they are not conspicuous. On the other hand, photographs rarely show more detail in the curved tails than can be seen visually. Straight tails often show much structure in the form of streamers and very irregular distribution of material in knots and clouds. Very profound changes in appearance may occur within a few hours. The extremely active tail of Comet Morehouse (1908 III) was of the straight type; photographs of it are found in practically every publication that mentions comets. Curved tails also may show interesting structure, but such structure is generally confined to a system of rays or streamers. These may be quite narrow and often appear to diverge in the shape of the ribs of a fan; they often have a slight curvature, sometimes concave and sometimes convex to the axis of the tail. The differences in colour and curvature of tails suggested the possibility of differences in composition, but convincing spectroscopic data supporting this view was not obtained until 1957. The more highly curved tails were theorized to be composed generally of neutral molecules and dust, which would be repelled by relatively weak pressure of solar radiation. Straight tails were known usually to be composed of ionized molecules, and it was suggested that high accelerations might be produced by friction between the molecules and the electrically charged particles of solar corpuscular streams. The corpuscular streams, which contain both protons and electrons, are identical with the particle streams associated with geomagnetic storms and the polar auroras. They are directional, vary greatly in intensity and travel with velocities of 100 to 1,000 km. per second. Rapid changes in tail structure might be caused by such ion streams. Furthermore, several comets visible at the same time in different parts of the sky might be affected differently by the corpuscular streams and show vast differences in activity.

Comet Arend-Roland (1956*h*) for a few days late in April 1957 possessed a most remarkable spike or anomalous tail extending in a direction almost exactly opposite to a second tail, a long normal one of moderate curvature. The direction of the spike with respect to the normal tail changed noticeably from night to night, and it was recognized promptly that the appendage was not a true tail but an edgewise view of debris scattered along the orbit ahead of the comet. The spike was visible only for a few days as the earth passed through the plane of the comet orbit. The spectrum of the spike was predominantly of the solar type, indicating the presence of dust and larger molecules rather than the ionized radicals of the normal tail. During Aug. 1957 Comet Mrkos (1957*d*) showed at the same time a very active straight tail and a strongly curved quiescent tail, with the sector between the two tails filled by a very intricate system of narrow rays. The straight tail showed the usual comet-tail spectrum produced by ionized radicals. The curved tail showed principally the solar-type spectrum produced by sunlight reflected and scattered by dust and large molecules.

4. Spectroscopic Observations of Comets.—The history of cometary spectroscopy began with the visual examination of the spectrum of Comet 1864 II (Tempel) by G. B. Donati at Florence, Italy, on Aug. 5, 1864. The first slit spectrogram was obtained photographically on June 24, 1881, of Comet 1881 III (Tebbutt) by Henry Draper in New York and by William Huggins in England. Since that time the spectra of about 70 comets have been photographed.

The light from the nucleus and inner coma of a comet is found to consist partly of reflected sunlight and partly of monochromatic emissions characteristic of cometary gases. The composite nature of the light is evident from the spectrograms, which show a continuous spectrum crossed by the familiar Fraunhofer absorption lines (the solar spectrum) upon which emission bands arising from the luminous cometary gases are superposed. In some objects the solar-type spectrum is more intense than the cometary emission bands; in others the reverse is true. Furthermore, for any one comet the intensity of the characteristic emission relative to the solar-type spectrum may vary with changing distance from the sun. At distances from the sun greater than about 3 A.U., normally only the solar-type spectrum is present, unaccompanied by emission features.

The characteristic cometary emissions almost all arise from molecular compounds. The following molecular radicals, nearly all neutral, have been identified in the heads of comets by their radiations: C_2, CN, CH, CH^+, C_3, NH, OH. The ionized radicals CO^+, N_2^+ and CO_2^+ are the principal contributors to the light of the tail. No unambiguous evidence exists for the presence of neutral molecules in comet tails. Other radicals which may be present in comets, but for which evidence was not sufficient in the late 1950s for positive identification, are NH_2, NH_3, OH^+ and CH^+. All of these compounds, although not chemically stable in the sense that they would instantly combine with others under terrestrial conditions, are physically stable in a very rarefied gas such as exists even near the nucleus of a comet. The emissions of the head have fairly definite extensions; for example, the CH bands are concentrated toward the nucleus, whereas the CN and C_2 bands extend throughout the whole head. The C_2, CN and CH molecules were identified in comets many years ago and the CO^+ and N_2^+ bands somewhat later. Identification of all other molecular emissions mentioned was made after 1940, and certainty of the C_3 identification was established only after 1950.

Atomic emission lines occur in the spectra of the heads of comets much less frequently than do molecular emissions, and generally only when the comet approaches the sun to within less than 0.5 A.U. The elements identified in atomic form by their spectral lines are sodium, iron, oxygen and probably nickel.

The mechanism by which the gaseous molecules in the comet produce the characteristic emission bands is a very interesting one. As early as 1911 K. Schwarzschild and E. Kron suggested that the bands were produced by resonance or fluorescence, the exciting radiation being sunlight. In the resonance mechanism, molecules in the comet absorb solar radiation and re-emit light of almost exactly the same wave length. In fluorescence the molecules absorb light and re-emit at longer wave lengths (*e.g.*, absorb ultraviolet light and re-emit in the visible region). Rather definite proof that the mechanism of emission is resonance rather than fluorescence came from two independent lines of evidence. Most of the emission bands observed in comets show intensity distribu-

tions of the lines of the rotational fine structure that are markedly different from those found in the laboratory. The stronger bands, most particularly the violet CN bands, have been studied in considerable detail. In 1941 P. Swings, supposing the bands arose by pure resonance, showed that the uneven intensity contour of the exciting solar radiation, caused by the presence of strong Fraunhofer absorption lines, offered an explanation of the observed effects. Densities of material both in the coma and in the tail are exceedingly low, never more than 10^6 molecules per cubic centimetre, usually very much less, and collisions are completely negligible. No redistribution of energy can occur, therefore, and the population of the various rotational levels is determined entirely by the profile of the solar spectrum, displaced as a result of the radial velocity of the comet relative to the sun. The correctness of this picture was strongly supported by quantitative intensity measurements on the CN bands of comets 1939 III and 1941 I by A. McKellar in 1942. Additional evidence obtained from high-dispersion spectra procured later supports the earlier conclusions in detail. The second line of evidence came from an almost concurrent investigation by Y. Öhman of the polarization of light in the stronger emission bands in the spectra of comets 1941 I and 1941 IV. He found that the amount of polarization observed was that to be expected if the bands were produced by resonance. This conclusion was fully confirmed by later results. No mode of excitation other than resonance has been demonstrated observationally to take place. If solar corpuscular streams are of importance in the formation of certain types of tails, some molecules may be excited to radiate by collisions. Evidence for collisional excitation may be found when some of the weaker bands can be photographed with sufficient resolution to permit study of the relative intensities of the rotational lines.

5. Comet Models.—After 1950 a fairly consistent picture of the structure of comets developed around the "icy conglomerate" model proposed by Whipple. His model was an extension of suggestions made by earlier investigators combined with some very original ideas. The nucleus is thought to consist of a conglomerate of various ices, hydrates and radicals of the lighter elements, primarily hydrogen, carbon, nitrogen and oxygen, combined with a background matrix of heavier meteoric elements. The nuclei of different comets are thought to range in diameter from several kilometres to negligibly small. Eventually the nuclei undergo complete dissolution through the continuing loss of material as a result of solar radiation. Material near the centres of large nuclei is likely to be relatively more compacted by pressure than is material near the surface or in smaller nuclei, but it is all very fragile. There are differences in composition and density from comet to comet. As the more volatile materials are lost by sublimation, desorption or sputtering caused by electromagnetic or corpuscular radiation from the sun, the meteoric material forms a protective crust that insulates the substance below from further rapid attack. Uneven loss of material and the formation of jets can be explained by local breakdown of the crust in weak spots. Eventually the remains of the nucleus are pictured as a meteor swarm composed primarily of the heavier meteoric elements of the original mass. To permit the accumulation of free radicals, cometary nuclei would have to be formed at places where the density was extremely high compared with the densities of interstellar material, and probably in places where the temperature was less than 30° K.

The coma would be formed by escape of volatile materials from the mass under the influence of solar radiation as the comet approached the sun. Fragments of solid particles presumably would be carried along with the gases and be the source of the solar-type spectrum of the inner coma and occasionally of the outer coma and tail. The icy conglomerate model has presented some difficulties arising from the fact that the vapour pressures of solid H_2O, CO_2, CH_4, C_2H_2, etc., differ by large factors and the model cannot explain the order of appearance with decreasing heliocentric distance of radicals observed spectroscopically. The trouble can be overcome by assuming the presence of solid hydrates, since these have rates of sublimation of the same order of magnitude. In all cases more complicated "parent" molecules are photodissociated to produce the observed radicals.

A somewhat different model of a comet has been proposed by R. A. Lyttleton and others. In their view a comet is composed entirely of small particles, the impression of a nuclear condensation being caused only by the increasing density of particles toward the centre of the swarm. Production of the coma and tail is thought to be caused by collisions between particles of the swarm, the frequency of collisions increasing, for dynamical reasons, in the vicinity of perihelion. Collisions would cause fragmentation of some of the particles, leading to more rapid liberation of gases as well as to an increase in the number of particles small enough to be dominated by solar radiation pressure. The chemical composition of the particles is essentially that of the interstellar medium, from which Lyttleton suggested the comets were formed. Compounds of hydrogen, carbon, nitrogen and oxygen, plus an admixture of metallic constituents, principally iron, make up the bulk of the material. The composition thus resembles closely that of the icy conglomerate model.

Though the appearance of some comets is quite consistent with the particle-swarm picture, other comets present strong evidence for the presence of a rather substantial nuclear body, as was mentioned above.

III. ORIGIN AND EVOLUTION

1. Origin of Comets.—Ideas of the mode of origin of comets fall into three groups: (1) eruptions from the major planets or from their larger satellites (proposed first by J. L. Lagrange in 1814, modified by others and revived by S. K. Vsessviatsky in 1931 and 1952); (2) capture from interstellar space (suggested first by P. S. Laplace in 1813, presented by others in modified forms and revived in an entirely new fashion by Lyttleton in 1948); (3) formation at the time of origin of the solar system in the same general region where the planets were formed (J. H. Oort, G. P. Kuiper and others). Despite the fact that substantial progress has been made on the problem of the origin of comets, definite answers are not available, and previously generally accepted notions have had to be revised continually in the light of new ideas.

The existence of many short-period comets having aphelia (outermost points) near the orbit of Jupiter long ago led to the suggestion that comets might be formed by ejection of material from that planet. Modern knowledge of the constitution and physical characteristics of the major planets and of their satellites casts doubt on the possibility of such violent eruptions as would lead to the escape of material from these very massive planets. The history of the orbits of the known comets that have experienced very close approaches to Jupiter is not consistent with an eruptive origin, nor can the existence of great numbers of parabolic comets be satisfactorily explained in such a way.

Though very convincing arguments in the past have led to the rather generally held conclusion that comets have always been members of the solar system, suggestions made by Lyttleton regarding capture from interstellar dust clouds have made it difficult to reject the possibility of interstellar origin. Lyttleton suggested that as the sun passed through a dust cloud, a large increase in the space density of particles would occur along the accretion axis (*i.e.*, along the velocity vector of the sun relative to the cloud) following the sun. Collisions between particles would lead to disruption and melting of some of them and to dissipation of energy. Elliptic orbits could arise for some particles from head-on inelastic collisions involving destruction of the transverse component of velocity. The probability of collisions would increase in time with accumulation of material along the accretion axis. Particles close to the sun would be captured while particles at large distances would escape, the "capture radius" depending largely on the velocity of the sun relative to the cloud. Lyttleton calculated that tens of thousands of cometlike swarms of particles could be captured during passage of the sun through a single cloud. Initial orbits of nearly all the new comets would be very elongated ellipses, the comet passing at first very close to the surface of the sun and receding to distances of several hundred A.U. The largest comets would be formed at distances near the capture radius and would, on the average, recede to

greater distances at aphelion than would smaller objects. The effect of perturbations, both stellar and planetary, would modify the original orbits considerably in the course of time. According to Lyttleton, comets are composed entirely of small particles, and the newly formed objects would be completely vaporized at the first perihelion passage except in most unusual cases. As the comet receded from the sun it would recondense into a swarm of small particles. Capture of comets from interstellar clouds would provide a means of occasional replenishment of the solar system supply of these objects. Sufficiently detailed analysis has not been made of the mechanics of the capture process to determine whether cometlike objects could be formed in the manner suggested, or whether known characteristics of cometary orbits could be satisfactorily explained by it.

Another suggestion regarding the origin of comets is that they, as well as the minor planets, are remnants of a planet spoiled in the making or somehow destroyed subsequently in the region between the orbits of Mars and Jupiter. An alternative possibility is that comets were formed during contraction of the solar nebula in the region outside the orbit of Neptune, where, it has been suggested, the density of material was too low for the formation of a large body.

Interesting evidence derived from analysis of the present nature of comets and of their orbits, and bearing ultimately on cometary origins, was presented by A. J. J. van Woerkom, Oort and M. Schmidt in a series of papers that appeared between 1948 and 1951, extending the work of earlier investigators. The main part of their investigation was based on a study of certain characteristics of the orbits of all nearly parabolic comets that were sufficiently well observed between 1850 and 1936. The statistical distribution of the values of the original $1/a$ (a = semimajor axis of the orbit), freed from the influence of perturbations in the region of the planets, was examined. It was found that comets are now coming into the vicinity of the sun from distances of 40,000 to 150,000 A.U. The effect of planetary perturbations during even a single previous close approach to the sun would produce a much broader peak in the distribution than was found, and it was deduced, therefore, that these comets were coming near the sun for the first time. Oort concluded that there is a vast reservoir of comets trapped in a sort of deep-freeze storage at the fringes of the solar system. The action of stellar perturbations (the nearest star is at a distance of about 300,000 A.U. from the sun) occasionally sends one of perhaps 10^{11} comets from storage into the region of observability near the sun. Oort and Schmidt called attention to various physical differences between the new comets and old ones that had been close to the sun before. These include differences in rate of disruption, in rapidity of brightening on approach to the sun and in relative strengths of the solar-type and characteristic emission spectra, especially at distances from the sun greater than one A.U. There also may be a greater tendency for new comets to display double or multiple tails. The comets in storage, whatever their origin, share the sun's motion very exactly and definitely are members of the solar system though they are perturbed by the nearby stars. They have been in storage long enough for stellar perturbations to have stirred their orbits thoroughly, and the orbits give no indication of a residual preferential orientation of their lines of apsides.

In regard to the mode of formation of the comets, Oort theorized that they, the major planets and the asteroids might have originated together in the inner regions of the solar system, while Kuiper conjectured that comets condensed from the solar nebula just outside the region of formation of the major planets. Lyttleton's theory of capture from interstellar clouds implies that comets may be formed at distances from the sun of up to 1,000 A.U. Oort demonstrated that whatever their origin, bodies moving in very eccentric or highly inclined orbits in the inner regions of the solar system will gradually be diffused outward by the effect of planetary perturbations, just as comets now on the outer fringes of the solar system are diffused inward by stellar perturbations. In the outward diffusion a large fraction of the original bodies (nearly 90% according to Oort) were lost to the solar system and became interstellar wanderers, but the remainder were caught in the reservoir. Objections to this picture have been raised on the grounds that a very large population of interstellar comets would be produced, considering the contributions of other solar systems, and comets with strongly hyperbolic orbits should be observed occasionally. No such comet had been observed by the late 1950s.

The several dozen known comets of short period all pass at some time close to the orbit of Jupiter and undoubtedly were captured by that massive planet from orbits that probably closely resembled those of comets that now travel from the fringes of the solar system. Details of capture depend strongly on particular circumstances, and the large changes cannot be discussed in a statistical way. It has been stated that the number of close approaches to Jupiter of comets moving in orbits of long period is insufficient to account for the present number of short-period comets. Average lifetimes often adopted for these comets have been much too brief, however, and evidence is accumulating that at least some comets survive thousands of years of repeated perihelion passages and close approaches to massive planets.

2. Gradual Diffusion of Cometary Matter.—Cometary material is gradually scattered by at least two processes. Finely divided matter in the coma and tail is dissipated by nongravitational forces that cause a small continuous loss of mass. Accretion near aphelion cannot make up the loss for observed comets even in the most favourable circumstances. Dispersion of meteoroids away from the nucleus is caused by differing gravitational attractions of perturbing planets on individual meteoroids. The process accelerates as the separations increase but, even so, the large dispersion of some meteor swarms away from the parent body must have taken a very long time. The long time scale of the gravitational disruption is in itself an argument for much longer lifetimes of comets than have sometimes been suggested. The role of internal forces should not be neglected as an initial step in the process of dissolution. Comets may cease to exist as such when all volatile materials have been lost and they no longer are able to produce a coma, or when the nucleus has been reduced to such a scattered swarm of meteoroids that all semblance of unity and coherence has been lost.

IV. ORBITS OF COMETS

1. Law of Gravitation Applied to Comets.—It was impossible to ascertain the true nature of the orbits of comets until the law of gravitation had been established. Isaac Newton proved that, under a force that varied in proportion to the inverse square of the distance, a body would move in one of the family of curves known as conic sections; that is, the circle, ellipse, parabola or hyperbola. It was soon recognized that the observed movements of comets could be explained on the hypothesis that they were traveling around the sun in elongated ellipses or parabolas, being visible only when they described the small portion of their orbits in the neighbourhood of the sun. Newton himself applied the new principle to the brilliant comet of 1680; subsequently he obtained the assistance of Edmund Halley, who in 1704 collected the observations of 24 comets, commencing with that of the year 1337, and calculated their orbits. On studying the orbits, Halley noticed that three, those of the comets of 1531, 1607 and 1682, were practically identical. The interval between appearances of the comets were not the same, the first being longer by 15 months, but Halley saw that the differences could be readily explained by the disturbing action of the large planets Jupiter and Saturn. Examination of the records then revealed another appearance of the same comet in 1456. It was confidently assumed that all four apparitions belonged to a single object, whose return might be expected about 1758. The comet did in fact return in 1759, and again in 1835 and 1910, establishing for the first time the fact of a comet's return. This comet is now known as Halley's comet; the next apparition is expected in 1986.

2. Comets of Short Period.—Halley called his comet a "Mercury among comets," supposing that it had the shortest period of any; this has been known to be incorrect since the discovery of Encke's comet early in the 19th century. By the early 1960s there were over 80 known comets with periods of less than 100 years.

Of these over 60 had periods of between three and nine years. The short-period comets form a very homogeneous group of objects, all revolving around the sun in the same direction as do the major planets, in orbits of low inclination to the plane of the earth's orbit. The aphelia of their orbits all lie close to the orbit of Jupiter. The evidence that these comets were captured by Jupiter from more elongated orbits is overwhelming, and they are considered to be part of "Jupiter's family" of comets.

Efforts have been made by some investigators to establish subdivisions among the somewhat smaller number of comets having periods ranging from 10 to about 150 years and assign them to other major planets as "families." H. N. Russell showed in 1920 that the evidence for the reality of families of comets belonging to Saturn, Uranus, Neptune or more distant planets was very weak. Most comets assigned to the outer planets almost surely were captured from very elongated orbits by Jupiter.

Though a few instances were known prior to 1819 in which a parabolic orbit failed to satisfy the observations of a comet and an elliptical one was deduced, inaccurate observations usually led to a weak determination of the period that failed to be verified by observation of the comet at the next return. On Nov. 26, 1818, Jean Louis Pons, an assiduous comet hunter at Marseilles, France, found a telescopic comet that was observed for 40 days; J. F. Encke, a celebrated German astronomer, undertook the study of its orbit and found that it was an ellipse with a period of 3.3 years. This is still the shortest confirmed cometary period, though an estimated period of 2.3 years was found for Comet Wilson-Harrington (1949 III), which was observed for only six days in Nov. 1949. Encke was able to prove, by laborious calculation of the disturbances caused by Jupiter, that the comets seen in 1786, 1795 and 1805 were identical with the one of 1818; he predicted the circumstances of its return in 1822, and these were exactly verified. From that day to the present time the comet (which bears Encke's name because of the enormous amount of work he performed on it) has been observed at every return except that of 1944. There are two reasons for the nearly unbroken record of observations of Encke's comet. One is that it passes within 0.34 A.U. of the sun, much closer than do any of the other short-period comets, and hence is moderately bright and easy to observe. The other is that a succession of able mathematicians—Encke, F. E. von Asten, Oskar Backlund, S. G. Makower—have calculated the disturbances of its orbit. A peculiarity noticed by Encke was that, after allowances for planetary perturbations had been made, the period was shortening by about 2½ hours each revolution. It was suggested that such an effect might be produced by a resisting medium that would cause the comet to lose energy and travel in a smaller orbit. The effect has decreased progressively and very markedly, however, and was extremely small in the mid-20th century. The acceleration may possibly be explainable by observational effects combined with modifications of planetary perturbations introduced by slightly different starting orbits, values of the masses of the planets or planetary co-ordinates. A few other short-period comets have been suspected of showing slight accelerations or retardations, though no case is beyond doubt. It has been pointed out that small effects could be produced by non-uniform ejection of material from cometary nuclei, and that if the nucleus was rotating, a secular acceleration or retardation would depend on the sense of the rotation.

3. Comets of Long Period.—Unless a newly discovered comet is of the short-period type, observations are generally satisfied for a considerable time by an orbit that is assumed to be exactly a parabola. Such comets are sometimes spoken of as parabolic comets. However, like the circle, a parabola is a very special curve, and even if a comet followed one exactly for an instant, it would not continue to do so because of the disturbing effects of planetary perturbations. In practice, moreover, over the small part of the whole orbit in which the comet can be observed, the difference between a very elongated elliptic or slightly hyperbolic orbit and an exactly parabolic orbit is hardly distinguishable. Determination of the other elements of the orbit often is strengthened by assuming exactly parabolic motion, because one fewer unknown is then to be determined from the observed quantities. Normally this assumption is very sound. Eventually, when all observations have been made and the comet has disappeared from view, a definitive orbit is calculated, including a determination of the eccentricity of the orbit. Not infrequently the uncertainty of the determination of the eccentricity is more than the difference between the value of the eccentricity found and a value of exactly one, which corresponds to a parabola. Planetary perturbations may also cause a comet to have a hyperbolic velocity while it is close to the sun, whereas it may have approached the region of the planets in an elliptic orbit. Original orbits of a number of "hyperbolic" comets have been investigated, principally by E. Strömgren, and in every case the original orbit of approach to the sun was found to be an ellipse when the effect of the planetary perturbations was removed, within the uncertainty of the determination. A certain percentage of comets approaching the sun along elliptic orbits are in fact forced into hyperbolic orbits by planetary perturbations, however, and these comets leave the solar system forever. One must conclude that all comets yet observed, whatever their origin, have been members of the solar system for an appreciable time.

4. Discovery and Observation of Comets.—Most new comets are discovered by professional astronomers on photographs taken with wide-field telescopes for programs not connected with cometary research. Some comets are found as the result of systematic searches by amateur and professional astronomers, but many hours of searching are usually required for one comet discovery. Returns of periodic comets can be predicted, however, and generally only a very limited area in the sky need be examined to ensure recovery of the comet when it becomes sufficiently bright. Such comets are normally recovered when they are still very faint and at large distances from the sun. The brightest of new comets often are first seen very close to the sun in the sky, a region neglected by professional astronomers. Hence they are often found by a casual observer as he looks at the sky at sunset or sunrise. Suspected comet discoveries should always be reported promptly to the nearest astronomical observatory for confirmation and communication of the time of observation, position, rate and direction of motion, brightness and a description of the appearance of the object to astronomers throughout the world.

See also ASTEROIDS; METEOR; PLANETS.

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COMET SEEKER, a small telescope specially designed for use in searching for comets. As comets are usually diffuse bodies with low surface brightness, the essential feature of a comet seeker is a large ratio between the diameter of the lens and its focal length. In ordinary refracting telescopes this ratio is usually about 1:18, while in the comet seeker it is often 1:10 or greater. The focal length of a comet seeker is usually small, for ease of operation, and seldom exceeds five feet. The diameter of the lens is then six inches. The field of view should be at least one degree in diameter.

The comet seeker is supplied with an equatorial mounting and roughly graduated circles. The usual method is to sweep the sky from horizon to horizon in circles of declination, each sweeping overlapping somewhat the preceding one. Coming across a diffuse object the observer compares the field with an appropriate map

of the sky to see that it is not a recorded nebula. A comet betrays its nature by motion in reference to the background stars.
(N. T. B.)

COMIC STRIP, a series of drawings published or done for publication and presenting a narrative, which may or may not be humorous. The progenitors of comic strips are to be found in such works as William Hogarth's *A Harlot's Progress* (1731) and *A Rake's Progress* (1735), or Wilhelm Busch's *Max und Moritz* (1858). The modern comic strip rose in New York and Chicago newspapers between 1894–96 and 1907 from contributions of its diverse characteristics by R. F. Outcault, James Swinnerton, Rudolf Dirks and Clare Briggs. *See* CARICATURE AND CARTOON: *Comic Strips.*

COMILLA, a town and headquarters of Comilla district in the Chittagong division, East Pakistan, is situated on the Gumti river 53 mi. E.S.E. of Dacca, on the main road and railway from Dacca to Chittagong. Pop. (1961) 54,504. It is protected from inundation by an embankment along the bank of the Gumti. The town is on low land and drainage presents great difficulties, the streets being below the level of the river when it is in flood. There are about 400 tanks in the town and its environs, some of which are reserved for drinking water. The splendid Dharmasagar tank, a mile in circumference, was constructed by a raja of Tippera in the 15th century. Comilla is a collecting centre for hides and skins. It has a small match factory and a thermal power station. Cane and bamboo basketry is the main cottage industry. Though poor in appearance, the bazaar is well laid out with wide streets. There is an old public library established in 1885. Victoria college is affiliated with Dacca university and is the seat of the East Pakistan academy for village development.

Comilla district has an area of 2,594 sq.mi., and a population (1961) of 4,388,906. (K. S. AD.)

COMINES, PHILIPPE DE: *see* COMMYNES, PHILIPPE DE.

COMINFORM, a name given in the west to the information office of the Communist parties (*q.v.*). This was an agency of international revolutionary Communism from 1947 to 1956. It was formed in Sept. 1947 at Wilcza Gora, Pol., by representatives of the Communist parties of the U.S.S.R., eastern Europe, France and Italy. On June 28, 1948, the Yugoslavs were expelled from the organization. On April 17, 1956, the Cominform was dissolved, probably to help to improve relations between the U.S.S.R. and Yugoslavia.

See INTERNATIONAL, THE; COMMUNISM.

COMINTERN, the Communist or Third International, established in March 1919 in Moscow to foster the spread of world Communism. It was officially dissolved on May 22, 1943. *See* INTERNATIONAL, THE.

COMITIA, the term applied in ancient Rome to formal elective and legislative assemblies of the Roman people, is the plural of *comitium*, the early "meeting place," and is distinct from *concilium* and *contio*. *Comitia* were organized in regular groups, *curiae, centuriae* ("centuries") or *tribus* ("tribes"), and had to be held on a proper calendar day (*comitialis*), after the taking of auspices and on an inaugurated site (*see* AUGUR). A *concilium* was a meeting of only a part of the people, such as the plebeians, and a *contio* was a public meeting open to all the people for announcements or discussion. But *comitia* came to mean "elections" and was sometimes used of the *concilium* of the plebeians. *Comitia* were summoned only to secure a binding vote on business presented by a presiding magistrate who had the right to act with the people. They could not discuss or amend it. In spite of differences in composition according to the groups in which the people had been organized, and the fact that the patricians were not members of the *concilium plebis*, all the assemblies became valid organs of the expression of the will of the people. They were theoretically sovereign but in fact were limited by the reservation of initiative to the magistrate, the veto of his colleagues and the actual authority of the senate. The early requirement that all acts be formally ratified by the patricians in the senate (*patrum auctoritas*) was reduced to a matter of form in the 4th century B.C. when it had to be given before a law was put to the vote. The major assemblies were the following:

Comitia Curiata.—This was the ancient assembly of 30 *curiae* dating from the period of the kings (*see* CURIA). It met in the *comitium*. In the republic it was politically unimportant, yet formally necessary for the passage of the law which formally granted *imperium* to magistrates (*lex curiata de imperio*). It also met in the Curia Calabra under the *pontifex maximus* to ratify wills and adoptions, to hear religious announcements and to witness the installation of priests. In historical times the 30 *curiae* were represented by 30 lictors (*see* LICTORS).

Comitia Centuriata.—The *comitia centuriata* according to Roman tradition was instituted by Servius Tullius, the penultimate king of Rome, though some date it as late as 450 B.C., as a reform for military purposes. (The *centuria* was the smallest unit of the Roman legion.) All Roman citizens were registered in regional tribes and a census was made of their property. They were then assigned to classes and centuries according to their wealth and the equipment they could provide for military service. From the 5th to the 3rd century B.C. the *comitia centuriata* with its timocratic organization was the major political assembly, presided over only by magistrates with *imperium* and summoned as an army by the military trumpet to meet in the Campus Martius outside the *pomerium* (the boundary within which Roman gods only could be worshiped and civil magistrates rule).

It consisted of 193 centuries, 18 of *equites* (*q.v.*) and 80 in the first and wealthiest class (40 *juniores,* men aged between 17 and 45 years, and 40 *seniores,* between 46 and 60 years). The result was that in the voting, which was by centuries, these two classes had a majority (98) over the combined vote of the other four classes and the supernumeraries (95 in all). About 241 the scheme was adapted to the number of the 35 tribes by assigning a century each of *seniores* and of *juniores* in the first class to each tribe, thereby reducing the number of votes to 70, and a complex recombining of tribes in the centuries of the other classes is revealed by the provisions of the *Tabula Hebana*, an inscription partly recording a *rogatio* in honour of the dead Germanicus (d. A.D. 19). In this rearrangement, in spite of the loss of an absolute majority, the wealthiest classes retained a great advantage, and the assembly remained an aristocratic and conservative body even after the extension of Roman citizenship to Italy, for those who could come to exercise the franchise in Rome belonged mostly to the first class.

The *comitia centuriata* elected consuls, praetors and censors, functioned on appeal as a criminal court in capital cases, and alone had power to declare war. In elections the first century, called the *praerogativa*, at first one of the *equites* but after the reform chosen by lot from all but two of the urban tribes in the first class, had a great influence on the outcome. This assembly was infrequently used for legislation after the rise of the two tribal assemblies with their less cumbersome procedure, and was only briefly restored to primacy in legislation by L. Cornelius Sulla. It continued to elect magistrates under the emperor Augustus, but imperial commendation of candidates and the institution of a preliminary choice (*destinatio*) by senators and *equites* grouped in special centuries made this a formality. It continued to be summoned for the announcement of elections and still met with the old ceremonies in the 3rd century A.D.

Concilium Plebis.—This assembly, which was organized and voted by tribes, consisted only of plebeians and could be summoned and presided over only by the plebeian magistrates, the tribunes. It usually met in the forum or on the capitol. If the Roman tradition is correct (that the election of plebeian magistrates was transferred to it in 471) it existed from or before that date. It grew in importance with the rise of the plebeians, though how far its resolutions (*plebiscita*) were binding on all Roman citizens remains uncertain. This principle was finally established by the *Lex Hortensia* of 287. Simpler procedure and the availability of tribunes to introduce measures made the *concilium plebis* the chief legislative body of the middle and later republic. It became also a ready instrument for the demagogic tribunes of the period from the Gracchi onward. It could validate treaties of peace, and interdict a citizen from fire and water, but its judicial functions were regularly limited to fines for noncapital offenses.

Comitia Tributa.—In contrast with the *concilium plebis*, the *comitia tributa* was an assembly of the whole people, patricians and plebeians. The date of institution is uncertain, but it elected curule aediles (*see* AEDILE) and legislation is attributed to it in 357. Consuls, praetors and, for purposes of jurisdiction, curule aediles could preside. It met in the forum, on the capitol, and in the late republic also in the Campus Martius. Besides curule aediles, it elected quaestors, *tribuni militum a populo* (*see* TRIBUNE) and other minor magistrates, and became a regular organ for legislation by all the people. Its jurisdiction was limited to offenses involving fines. Both the tribal assemblies were increasingly influenced by demagogic leaders and by bribery as members of the rustic tribes swelled the urban population.

Other.—Apart from those listed above, special *comitia* of 17 tribes (one less than a majority) met, with the most recent *pontifex* presiding, to elect the *pontifex maximus*, and after 104 B.C., except from Sulla's dictatorship (82 B.C.) until 63, to elect members of the other priestly colleges, the pontiffs, the augurs and the *quindecimviri sacris faciundis* (*see* PONTIFEX).

The extension of Roman territory and of Roman citizenship too widely for any but a few to attend the *comitia* from distant regions of Italy or the provinces were also factors in the decline of all the *comitia* in spite of the emperor Augustus' provision for local councilors to vote in their towns for Roman *comitia*. The various elective, legislative and judicial functions gradually lapsed under the principate. The last piece of recorded legislation by the *comitia* is an agrarian law carried by the emperor Nerva in A.D. 98.

There were also *comitia* in *municipia* and *coloniae* for the election of magistrates and the passage of local legislation, but authority came to be vested in the councils. These *comitia* also decayed under the empire.

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(T. R. S. B.)

COMITY, courteous practices between nations, specifically the courteous recognition in one country of the laws and customs of another. Comity (Latin *comis*, "courteous") does not have the force of law, but it may be the source of precedents that develop eventually into law. *See* INTERNATIONAL LAW, PUBLIC.

COMMAGENE, in ancient geography, a district in northern Syria whose boundaries were defined by the Euphrates river on the east, Cilicia on the west and Cappadocia on the north. Formerly part of the Seleucid kingdom, it became independent about 162 B.C. when its governor revolted and established a dynasty. Its king Antiochus I submitted to the Roman general Lucullus in 69. In 64 he at first opposed Pompey during the Mithradatic war, but quickly changed sides. After supporting Pompey in the civil war of 49, he joined forces with the Parthians in 38. This king sought to perpetuate his memory by erecting, *c.* 30, an imposing mausoleum on the peak of Nimrud Dag (Turkey); extensive remains have been discovered. The general state of the country at that time was probably similar to that of Cappadocia; that is to say, feudal, with city life little developed and Greek culture and language making only slow progress beyond the court. Indicative of the mixture of cultures is the fact that the kings traced their descent from both the Seleucids and the Persian Achaemenids. In A.D. 17 the kingdom was annexed to Rome. Under the emperor Caligula (Gaius Caesar) the kingdom was restored (38), but in 72 was again annexed, and incorporated in the Roman province of Syria.

See D. Magie, *Roman Rule in Asia Minor* (1950). (R. H. SI.)

COMMAND, a word coined from Latin but borrowed into English from the Old French about 1300, still carries something of its early connotation "to place in hand" (*com* + *manus* + *dare*). Both as a verb and noun it lends itself to many uses. Thus one may command a view, a guided missile (by radio) or a person; or one may exercise command, utter a command, receive a command or be in a chain of command. In one sense, command is the prerogative of a person in authority by virtue of office or of personal prowess. In another, it is equivalent to control or power, as in "he had such command of words as to persuade his enemies." In the military any unit is, from one standpoint, a command; but some units, normally large establishments, are officially called commands, illustrated by the R.A.F. bomber command or the southeast Asia command of World War II or by the continental air defense command, organized in the U.S. in 1954. (WD. A. H.)

COMMANDANT, the commander of a single place or body of men, such as a military school or training unit, or of a larger organization such as a naval district in the United States. In the British army the term colonel commandant refers to the senior officer of a regiment. In the French army a commandant is the commanding officer of a battalion, a rank equivalent to major. Headquarters commandant is a special use of the word to denote a staff officer in charge of the internal administration of a military headquarters, often with emphasis on maintenance and security of buildings and grounds.

The rank of a commandant depends upon the size and importance of his command. The commandant of the U.S. marine corps, for example, is a four-star general and the commandant of the U.S. coast guard is a vice-admiral. (H. C. T.)

COMMANDMENTS, TEN: *see* DECALOGUE.

COMMANDO, a Portuguese word meaning "command," adopted by the Boers in South Africa for military and semimilitary expeditions against the natives. More particularly a commando was the administrative and tactical unit of the forces of the former Boer republics, "commandeered" under the law of the constitutions, which made military service obligatory on all males between the ages of 16 and 60. Each commando was formed from the burghers of military age of an electoral district. These citizen units fought effectively in the South African War of 1899–1902.

In World War II the name was applied by the British to "specially-trained troops of the hunter class," formed in the first instance for raids against enemy-occupied coasts. Their counterparts in the U.S. forces were known as rangers or marine raiders. The first such troops in the British services were organized in June 1940, largely on the initiative of Winston Churchill; the name commando and plans of organization were suggested by Lieut. Col. Dudley Clarke. The distinctive commando symbol later came to be the green beret.

Popular usage to the contrary, a commando was not an individual, but a unit roughly equivalent to an infantry battalion. In the beginning commandos were formed of volunteers from army units; from 1942 onward they were also formed from the Royal Marines. Commandos served with notable distinction in various raids, including that on Dieppe, Aug. 19, 1942, and in the campaigns in the Mediterranean and northwest Europe. After World War II the commando role was reserved exclusively for the Royal Marines, and one Royal Marine commando fought in the Korean campaign. *See* INFANTRY: *World War II: Special Types of Infantry.*

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COMMEDIA DELL'ARTE, an improvised theatrical production that originated in Italy in the 16th century, flourished until the early 18th century and influenced modern theatre in several important ways.

Early Development.—Semipermanent troupes of traveling actors first brought the *commedia dell'arte* to the place of performance (theatre, public square, banquet hall); their repertory of plays, generally comic, was derived principally from classical or neoclassical literary drama. Each member of the troupe played a particular masked stock character; the performance was more or less improvised on a skeleton plot (scenario) in the presence of the spectators. The genre name, loosely translated as "comedy of the professionals," distinguishes the production from the largely amateur, academic, literary drama of the period.

The origin of the form is obscure; attempts to trace it from

prehistoric mime and farce through the dark ages to the Italian Renaissance have failed. Certain social and cultural conditions, however, generally have led professional entertainers in all ages to create a similar form by adding stock characters and situations to their acrobatic displays.

The earliest date associated with an Italian *commedia* troupe is 1545. The Gelosi, headed by Francesco Andreini and his wife Isabella, is the most famous of the early companies, but there were many others during the next century and a half, and both scenarios and stock characters were handed down from their 16th century creators to their 17th century successors. The fame of the companies brought them invitations to perform throughout western Europe. Shakespeare and Ben Jonson in England and Molière in France were the principal non-Italian authors who came under the influence of *commedia dell'arte*, while the Italians Carlo Goldoni and Carlo Gozzi created a literary drama out of its 18th-century remains.

The typical *commedia* company had a stock of scenarios, some commonplace books containing soliloquies and witty exchanges appropriate to various situations and appropriated from various authors, and about a dozen actors, each with his own "mask" or stereotype character.

The Masks.—While each company may have had its special name for the stock types, in general the cast of a play would require the services of: (1) Pantalone (Pantaloon), a lecherous, miserly Venetian magnifico, the parent or guardian to be outwitted by the young lovers, wearing a half mask with a long, sharp, hooked nose, a flat cap and the trousers to which he has given his name. Shakespeare, in *As You Like It*, describes the next to last of the ages of man as "the lean and slipper'd pantaloon." (2) Dr. Graziano, a second parent-character, gullible and amorous, given to malapropism and generally burlesquing some profession, such as the law or medicine. (3) Capitano, the braggart warrior and arrant coward, with the bristling mustaches associated with Spain and dramatic stories of his impossible military feats. A later manifestation of this character is called Scaramouch; he is not necessarily of the military profession but is a boaster whose weakness is exposed by the low comedians. (4) The *zanni*, servants or men of the lower classes, shrewd, impudent and witty, responsible for much of the broad comic action with their jokes and often irrelevant but amusing tricks (*lazzi*). Among the *zanni* were Arlecchino (Harlequin), Mezzetino, Brighella and Pulcinella (Punch). (5) The lovers, unmasked, the colourless necessary cogs in the dramatic machine. Of these only Colombina (Columbine) has remained alive in theatrical tradition.

By the early 18th century the *commedia* had lost its vitality in Italy, but certain elements of the genre found a new life in other countries. In England, John Rich created from it a new form, which he called Pantomime (*q.v.*), that involved the magical exploits of Harlequin, who was transformed from a vulgar serving-man into a mute dancing creature in eternal pursuit of his sweetheart, Columbine. In the 19th century, largely because of the great clown Grimaldi, English pantomime became a kind of musical comedy with topical satire, spectacular transformations and a fairy-tale plot; it is still the traditional Christmas holiday entertainment in the British theatre. A company of acrobats carried Rich's Harlequin pantomime to Copenhagen in 1801 where they developed a repertory of mute comedies in which Harlequin and Columbine were joined with folk stereotypes drawn from the comedies of Ludvig Holberg. Many of these pantomimes are still in the repertoire performed every summer by the company of the Peacock theatre in Tivoli. The French romantic theatre of the 19th century adopted, as Pierrot, the old *commedia* clown Pedrolino, with his loose white costume and conical hat, gave him a sad, white face and made him a character of infinite pathos; he plays a leading role in Leoncavallo's modern opera *Pagliacci*. Pulcinella found his way into the violent and often cruel puppet play of Punch and Judy. The brief comic plays about stock characters featured in American vaudeville and burlesque, and the two-reel comedies of the silent films (especially the comedies of Mack Sennet), may be called the latest generation of the *commedia dell'arte*.

See also HARLEQUIN; SCARAMOUCH; PUNCH; COSTUME DESIGN, THEATRICAL: *Renaissance*.

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(A. S. DR.)

COMMENDATION, approval, a recommendation of one person to the favour of another. *Commendatio animae* is the liturgical term for the office commending the souls of the dying and departed to the mercies of God. In feudal law it was applied to the act by which a freeman placed himself under the protection of a lord.

In ecclesiastical law the commendation or grant *in commendam* of benefices was made temporarily until a vacancy was filled, frequently to persons who, by defect of age or orders, were for the time being debarred from receiving institution. The practice of granting benefices *in commendam* to laymen, or, in the case of monasteries, to secular clerks who enjoyed their revenues and privileges for life, or to bishops to hold with their sees, became very general in the later middle ages.

COMMENTARII, among the Romans, originally notes to assist the memory, memoranda, in domestic and public business. A household kept a diary and account book; *e.g.*, Trimalchio's daybook mentioned by Petronius Arbiter. Public men had notebooks for speeches, legal cases and items of general business. The official use of *commentarii* developed in the priestly colleges to list the details of ceremony and ritual; *e.g.*, in the *Commentarii Pontificum*. This development was an early one, but not so early that the *Commentarii Regum* (Records of the Kings) can be accepted as authentic. The magistrates, too, had their regular notes, *e.g.*, *commentarii consulares, censorii, aedilium*, which enabled them to maintain and pass on the routine of their office. This was important for provincial governors, who also submitted reports to the senate.

Under the empire the *Commentarii Principis* were a register of the administrative acts of the emperor, including constitutions, rescripts, epistles and edicts, all set down with official authority. There were also *commentarii diurni*, a court journal, which later became a system of records known as *ephemerides*. Imperial departments had archives that were under the charge of an official entitled *a commentariis*. The *Commentarii Senatus* mentioned in Tacitus' *Annals* probably represent the *Acta Senatus* (minutes of the senate's meetings).

Memoranda could become memoirs, as public men of noble family drafted personal records of their achievements for the domestic archives. By the 2nd century B.C. such memoirs were written as the raw material of history (*see* ANNALISTS), and much information, often distorted for the greater glory of the family, is derived from these sources. Sulla and Cicero left memoirs as an aid to the historian, and when Caesar published his *Commentarii* for propagandist purposes, his elegant Latinity transformed them into a literary form in their own right. With Augustus, Tiberius and the younger Agrippina this led to imperial autobiography.

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(A. H. MCD.)

COMMERCE, DEPARTMENT OF: *see* GOVERNMENT DEPARTMENTS: *United States*.

COMMERCE, HISTORY OF. Although the term is often used in a wider and less precise sense, commerce means primarily the exchange of commodities conducted on a wide scale and involving transportation over considerable distances. Commerce and trade are in this sense often used interchangeably, but the former stresses the mercantile or free enterprise aspect of these activities, their profit-seeking and risk-taking character, while the latter points more to the physical character of the services performed. This distinction is clear, on the one hand, in the meaning of the adjective commercial, which stands for most of what is characteristic of business in general, and on the other in the use of the

plural trades to include the different manual skills practised by persons in an employed position. It is the same slight distinction that makes one speak of commerce when considering transactions in a free market and to change to trade when the same activities become subject to governmental control. In conformity with this usage, the spontaneous activities of traders are discussed in this article. (For such topics as international trade policies and statistics, *see* INTERNATIONAL PAYMENTS; EXPORTS; TRADE, INTERNATIONAL; etc.)

It has been truly said that commerce begins "where civilization begins." Even the first great steps in the growth of civilization were dependent on essential materials such as flint and metals being brought to people, usually over long distances. The early phases of civilization known by such terms as the Bronze Age and the Iron Age were dependent on materials found only at a few localities and regularly carried over wide regions. Archaeological discoveries of hoards of such objects as flint axes and amber trinkets suggest that at an early time a form of dealing in such commodities was carried on by persons specializing in these tasks. Even certain kinds of food that were found only at particular localities, such as salt-water fish, were in prehistoric times regularly transported and presumably exchanged over considerable distances.

In the near east and Europe, at any rate, civilization at an early stage was based on the utilization of the dispersed resources of a whole continent and remained dependent for its preservation on the continuance of this commerce. Many of the major changes in history undoubtedly were the results of the interruption of established trade routes; nothing perhaps illustrates better the extent to which a decline of commerce inevitably brings about a decline of civilization than the fact that the great metal shortage which arose when commerce dwindled with the decline of the Roman empire caused most of the great bronze works of ancient Greek sculpture to be melted down, and thus lost to posterity.

This account of the development of commerce is subdivided as follows:

I. The Ancient World
  1. Phoenicians and Greeks
  2. Commerce of the Roman Empire
  3. Byzantine Empire
II. The Middle Ages
  1. Italian Trading Towns
  2. Hanseatic League
  3. Characteristics of Medieval Commerce
III. The Early Modern Period
  1. From the Mediterranean to the Atlantic
  2. Sea Route to India
  3. Rivalry of England and Holland
  4. Mercantile System
  5. Industrial Age
IV. The 20th Century
  1. Development After 1914
  2. Trends After World War II

I. THE ANCIENT WORLD

The history of commerce is closely connected with the development of the techniques of transportation and communication. Long-distance trading apparently developed first along desert routes which were advantageous in that comparatively large groups could travel together in caravans and defend themselves against marauders. Oases could be used as ports of call and depots. In this way trade sprang up between two of the oldest civilizations in the river valleys of Mesopotamia and Egypt. A large caravan was required to convey 100 tons and its progress was slow. Therefore, the goods which entered this trade had a high value in proportion to their bulk. They included such things as oriental spices, drugs and dyes as well as fine textile fabrics and a variety of metal ornaments; necessaries played a subordinate role. Caravan trade retained its essential characteristics for centuries. In the course of time, however, it became subordinate to commerce by sea routes.

1. Phoenicians and Greeks.—The first people to add this development to overland commerce were the Phoenicians. From their bases on the Syrian coast they carried goods by sea to Cyprus and Rhodes and, step by step, found their way to the western Mediterranean and beyond. The original cities of Tyre and Sidon and the colonies they founded, of which Carthage became the chief, were true commercial centres. Glassware, textiles and articles wrought in metal were exchanged for tin, copper and silver in the west. The Phoenician merchants apparently made their exchanges on the basis of goods for goods; it remained for their rivals and successors, the Greeks, to spread the use of coined money, which probably appeared in the 8th century B.C. Athens in particular introduced and maintained an excellent silver currency, which won general acceptance because it was not allowed to depreciate. Athens exported olive oil, figs, honey, pottery and small quantities of metal and textile goods. Its trade with the ports on the Black sea was an early example of dependence for essential food supplies (mainly wheat) on regular communication by sea. The fortified harbour of Piraeus also attracted a considerable volume of entrepôt trade, being used by the merchants of Asia Minor and Syria in their dealings with the rest of Greece and with the countries of the west. Greek commercial enterprise was offered new opportunities when the conquests of Alexander the Great opened the way into the heart of Asia. The consequent stimulus to long-distance trade was reflected in the growth of Antioch and Alexandria as great commercial cities.

2. Commerce of the Roman Empire.—In the earlier phases of its history Rome took little interest in commerce. In its origins an agricultural community, it long clung to its traditions. But the series of events which led to the destruction of Carthage (146 B.C.) and the assertion of Roman supremacy over Greece necessarily revealed the possibilities of commercial development. When Augustus put an end to civil dissension and inaugurated a period of peace these possibilities were fully explored. The main currents of trade continued in the direction determined by the Greeks. To Antioch came the chief caravan routes from the east. The commodities thus secured were shipped from its port, Seleucia Pieria, Syr., to all parts of the Mediterranean. They were the traditional articles of trade—spices, drugs, silks, etc., supplying the demand of the wealthier classes.

The commerce of Alexandria, however, was of a more complicated nature. Oriental luxury goods from Arabia and India reached Egypt by way of the Red sea. Augustus took steps to protect this trade by forcing the Arabs and Ethiopians to desist from piracy and by having the navigation canals repaired. The discovery of the periodicity of the monsoon winds of the Arabian sea about the middle of the 1st century A.D. made a direct voyage to India possible and eliminated the need of calling at Arabian ports. There is much testimony to the extent of this commerce in the first two centuries. Pliny complains that the demand for eastern luxuries was so great that it caused a drain of silver from the west to pay for them. But there was another side to the trade of Alexandria. The importation of corn from Egypt was essential for the sustenance of the growing population of Rome. About 20,000,000 bu. were imported annually, part of it being produced on the emperor's domains in Egypt, but most being extracted as tribute from the province. Elaborate precautions were taken to safeguard the supply. The port at Ostia, where the corn was unloaded, was improved by Claudius. Trajan instituted regular sailings and provided granaries for storage. State supervision was thought necessary not only because the trade was vital to the existence of Rome but because of its very nature. There was no true exchange of goods between Rome and Egypt. Even at its zenith Rome was singularly unproductive; it never produced the means of paying for its imports. Little is known of the organization of commerce, as, for instance, of the respective functions of merchants and shippers; but the corn trade was not one in which private enterprise was given free play. Ships which were not part of a convoy were in danger of being attacked by pirates. Weather conditions in the Mediterranean made winter sailing perilous. With favourable winds the voyage between Alexandria and Rome could be accomplished in eight or nine days. When winds were contrary recourse had to be had to coasting from point to point and weeks could easily be consumed. It is not surprising, therefore, that the activities of the private merchant continued to centre in the provinces of the eastern Mediterranean. Some of them found means of extending their trade to the west as the Roman empire promoted the growth of cities where a demand for luxury

goods arose. But the fact that commerce had its roots in the east is proved by the fact that in most cases the merchant discovered in the west turns out to be a Greek, a Syrian or a Jew.

3. Byzantine Empire.—When the Roman empire in the west collapsed under the successive blows of the barbarian invasions the volume of this trade was greatly reduced. Commerce was virtually confined to the eastern Mediterranean where Constantinople enjoyed pre-eminence as the capital of the east Roman or Byzantine empire. Antioch had been sacked by the Persians in 540 and was captured by the Saracens in 638. The rising Muslim tide swept over Egypt, and Alexandria itself capitulated in 640. Constantinople, however, did not fall into the hands of a Muslin conqueror until 1453. Until then it attracted to itself the commerce between Asia and Europe. From the fall of Rome in the 5th century to the age of the crusades it was the great entrepôt of long-distance trade. Unlike Rome, Constantinople and the other cities of the Byzantine empire established a reputation for their manufactures. High-quality textile goods, leatherwork, armour, engraved and enameled metal articles of exquisite workmanship, carved ivories, mosaics and porcelain were among the exports. Corn, wax, furs, amber, salt fish, unwrought metals and raw wool were secured in exchange from the less advanced peoples. Merchants had the advantage of good money—the bezant, a gold piece which was generally acceptable. The principles of banking and the use of credit notes were known. Loans could be raised at a moderate rate of interest. Shipping was assisted by the development of insurance. It is true that from the reign of Justinian I (527–565) there was a tendency to conduct commercial policy in the fiscal interests of the empire. There were heavy duties on the import and export of certain commodities, and taxes were levied on purchases and sales. Justinian also introduced the principle of monopoly in favour of the silk industry which he took pains to set up in order that the empire might be independent of the supplies from the east which were controlled by Persia. Against these restrictions must be placed the influence of the great fairs of Constantinople and Thessalonike at which the merchants who resorted to them from all countries enjoyed great freedom of trade. Concessions were also made to alien merchants by granting them special quarters. The most-favoured of them, such as the Venetians and the Genoese, had extensive privileges; others were subject to restrictions as to the time they were allowed to stay within the empire and their business had to be conducted under supervision.

II. THE MIDDLE AGES

1. Italian Trading Towns.—The heirs of Constantinople were the Italian trading towns. They had developed under the aegis of the Byzantine empire and they profited from its decline. Venice in particular rose to splendour in the middle ages. Situated amid the lagoons at the head of the Adriatic sea, it was at first a place of refuge in the troubled days of the barbarian invasions. A position could hardly have been better chosen to serve as an entrepôt through which the trade of the Levant could pass into central Europe as conditions there became more settled. The merchants of Germany had access to it across the Brenner pass, and goods could also be conveyed along the valley of the Po and by way of the St. Gotthard pass to the growing towns of the Rhineland and the Low Countries beyond. The Venetians themselves, however, operated mainly by sea routes. It was by sea that they imported oriental commodities. To make the sea route to the eastern Mediterranean secure they aimed at gaining control of the coast line and the islands. Advantage was taken of the crusades to pursue this policy. Concessions were exacted in return for shipping services. Although the Venetians were not responsible for the subsequent diversion of the fourth crusade to the capture of Constantinople itself in 1204, they took advantage of the turn of events and claimed large territorial grants. This persistence in strengthening Venice's hold in the Levant indicates the character of its trade. Year by year it was attempting to find new outlets in the west for the goods carried by caravans from the east and the products of Byzantine workshops. As Venice was pre-eminently a sea power it was natural that it would consider a sea route to the west. From the early part of the 14th century a fleet of galleys was dispatched to the countries of the western Mediterranean, and it made its way by easy stages through the Strait of Gibraltar as far as the Low Countries. The voyage, which was usually annual, was publicly organized and controlled. The goods, however, were carried on the account of individual merchants to whom opportunity of securing space on the ships was offered by auction. Since Bruges, Belg., was then the chief mart of northwest Europe most of the cargoes were directed there; but a ship might detach itself from the fleet to call at Southampton, Sandwich or London. By this means such commodities as pepper, cloves, indigo, ginger, etc., were carried to the west at a lower cost than that of the overland route. As a return cargo the galleys took wool, hides and metals which were worked up in Italy for export to the east. Florence was the centre of a flourishing cloth industry organized on a capitalist basis, and Lucca had an important silk industry. Commerce was greatly facilitated by the improved mechanism effected by the Italians in the methods of account keeping and the organization of credit. Bankers, particularly those of Florence, had connections throughout western Europe. The commercial activities of Venice were rivaled, though not equaled, by those of Genoa and Pisa. Genoa strove not unsuccessfully for a share in the Levantine trade and contended with Pisa for the trade of north Africa and Spain.

2. Hanseatic League.—The fact that the Venetians found it worthwhile to make a direct sea voyage to the Low Countries shows that good markets for long-distance trade had grown up there by the 14th century. These had developed slowly from the 9th century onward as new kingdoms had arisen out of the ruins of the Roman empire. Merchants began to enjoy some measure of protection. Charles the Great, for instance, assured Offa of Mercia in 796 that any of his subjects lawfully pursuing their business in his dominions would be safeguarded against oppression. The Norsemen found their way by river routes from the Baltic to the Black sea and obtained supplies of oriental goods. Progress was slow at first. By the 11th century, however, German towns had taken the initiative and the merchants of Cologne were particularly active. The towns of north Germany entered into agreements with one another to co-operate in suppressing robbery on the roads and piracy at sea. Out of such understandings the powerful Hanseatic league ultimately emerged. It was a confederation of towns, mostly though not exclusively in Germany, formed to consult their common commercial interests. The league was in some respects no less than a great commercial state; it had its regular assemblies, its courts and its treasury, and it entered into treaty relations with foreign states. The main purpose was to gain concessions in its favour from the rulers of other countries. Such privileges it strictly confined to its members. In countries where long-distance commerce had not developed the league negotiated for factories or settlements which were at once residences and warehouses. There was a factory at Bergen, Nor., from which the trade with Iceland could be carried on, and another at Novgorod. Russia, where goods could be exchanged for Russian products. In London the league had its settlement called the Steelyard, and it long enjoyed more favourable terms than any other merchants in the payment of customs duties. Still more important was the position it occupied in Bruges where the merchants of northern Europe and the Mediterranean came into direct contact. Bruges was the chief market for English wool and Flemish cloth. The Hanseatic merchants, therefore, were chiefly engaged in exchanging the products of the northern countries—furs, salt fish, flax, timber and tar—for wool, leather, cloth and the commodities in which the Italians specialized. Under the leadership of Lübeck and Hamburg the league established a great prestige which was of first importance in the commercial development of northern Europe.

3. Characteristics of Medieval Commerce.—The total volume of long-distance trade in the middle ages was comparatively small. For the necessities of life most areas were self-sufficing. The goods which entered into international trade were still mainly articles of luxury for the wealthier classes. Oriental products reached western Europe chiefly through the agency of Venice and

Genoa. They were paid for to an increasing extent by the export of high quality woolens. Cloth was the first European product to be carried long distances in considerable quantities. It became worthwhile for special classes of merchants to devote all their attention to its sale. For the most part, however, merchants dealt in a variety of goods. Particular value was therefore attached to the right of retail trading, which local merchant guilds tried to monopolize by forcing outsiders to sell in bulk. The members of the Hanseatic league were extremely jealous of the privilege of retailing where they had secured it.

Medieval commerce was restricted in many directions. Transport remained expensive both by land and sea. By land only small quantities could be carried by pack horse or some such method and frequent tolls were exacted; by sea it was customary to arrange common sailings for the sake of convoy and this meant that the relative cheapness of carriage had to be set against the slowness with which the capital invested was turned over. Local organizations of merchants often succeeded in imposing serious restraints on foreigners. The custom of hosting was common, usually requiring that aliens should have the period of their sojourn in a country limited to 40 days and that they should stay with a native merchant to whom the details of their business should be revealed. Commerce also frequently suffered from regulations imposed in the fiscal interest of governments. The chief goods on which customs were paid had to pass through prescribed staple ports, and the situation and number of such ports were subject to constant change, usually for political reasons. The export of money was often forbidden because special importance was placed on the accumulation of the precious metals within the country. Sometimes alien merchants suffered from popular outcry against the nature of their trade, it being alleged that they were importing useless or harmful luxuries and exporting necessaries. The catalogue of discouragements, whether natural or artificial, seems formidable. It should be remembered, however, that local and governmental restrictions were often relaxed. Reference has already been made to the privileges enjoyed by organizations of alien merchants such as the Hanseatic league. The fairs (*see* EXHIBITIONS AND FAIRS) also gave opportunity for temporary freedom of trade and were resorted to by merchants engaged in long-distance commerce. Among the most notable fairs in western Europe were those of Champagne, France, which were held at Provins, Troyes and other centres, and extended over the greater part of the year. Merchants attending them were guaranteed safe journeys and protection in their lawful enterprise. In the conduct of the fairs a common code of mercantile law was evolved to meet the problem of settling disputes between merchants of different countries without delay. The mechanism of trade was improved. Money changing had to be arranged because of the great variety of coins. From money changing, moneylending was an easy step. The inconvenience of paying debts at a distance by incurring the risk of sending money, when it was lawful to do so, or by dispatching goods which the debtor was willing to accept, was removed by the growing use of the principle of the bill of exchange.

III. THE EARLY MODERN PERIOD

1. From the Mediterranean to the Atlantic.—The conquests of the Ottoman Turks in the 15th century threatened to close the routes by which oriental goods had reached the Levant. Constantinople fell into their hands in 1453, and although Venice succeeded in negotiations for the retention of its trading privileges for a time, the Christian powers looked upon the Turkish advance into Serbia, Walachia, Bosnia and Greece with apprehension. Venice itself was involved in a series of wars with the Turks in the 16th century and suffered heavily from the exhaustion of its resources and the loss of territory. The question naturally arose whether the commodities could be obtained by some other route. The pioneer work of Prince Henry of Portugal was rewarded by the rounding of the Cape of Good Hope by Bartolomeu Dias de Novaes in 1488 and by Vasco da Gama's successful voyage from Lisbon to Calicut in 1498. Meanwhile Christopher Columbus, a Genoese sailor in the service of Castile, sought India by sailing west and discovered a new world lying across his path.

These discoveries were destined to effect a revolution in commerce, but their consequences were not apparent for some time. Portugal and Spain claimed exclusive rights in the exploitation of the new routes. The English endeavoured for a time to find a northern passage to the east. As a result of Richard Chancellor's success in 1553 in reaching Archangel and on the basis of trading concessions made by the tsar of Russia an English joint-stock company—commonly called the Muscovy or Russia company—was formed. It included in the area with which it proposed to trade Armenia, Media, Hyrcania, Persia and the Caspian sea; in other words, it intended to come into contact with the trade routes of central Asia. That this was possible was demonstrated by the celebrated traveler, Anthony Jenkinson, who in 1557–59 went from Archangel to Moscow, along the Volga to the Caspian sea and then found his way to Bukhara, where he saw great numbers of Indians and Chinese buying and selling. The Russia company made good profits from its Persian voyages in the years 1566–81. As to a northwest passage the persistent endeavours of the English to fine one are illustrated by the careers of Martin Frobisher, John Davis, Henry Hudson and William Baffin. But the tendency of the eastern trade to return to its old channels was still strong. An agreement was arrived at with the sultan of Turkey and an English company was formed in 1581 to carry on direct trade with the eastern Mediterranean. It was fully incorporated as the Governors and Company of Merchants of the Levant in 1592. For several years the company did fairly well, particularly by importing currants, but toward the end of the century it met with difficulties.

2. Sea Route to India.—Meanwhile Portugal and Spain had been endeavouring to profit from their discoveries. The Portuguese aimed at controlling for their own advantage the existing Indian trade routes to Africa, the Red sea, the Persian gulf, the Cambay ports and the Spice Islands. The centre of their power was Goa, but they had important settlements at Hormuz, Calicut and Cochin. In 1580 the crowns of Portugal and Spain were united in the person of Philip II. This meant that the Portuguese possessions were at the mercy of the enemies of Spain. The position of the Spaniards in the new world had already been challenged by English sea captains. Spain had concentrated its main attention on the silver mines of Mexico and Peru. The treasure thus obtained by forced labour was expended in Europe in buying commodities from other countries and in the conduct of wars. The treasure did not strengthen the commercial position of Spain. The one general result of its policy, indeed, was a fall in the purchasing power of money with all the social consequences of a price revolution. Francis Drake in his famous circumnavigation of the world in the years 1577–80 showed at how many points Spain could be attacked by an intrepid adventurer. He returned with a cargo of gold, silver, silk, pearls and precious stones. These were the spoils of a daring exploit but provided no foundation for trade.

In the last decade of the 16th century the English and Dutch turned their attention to the cape passage to India. Sir James Lancaster in the expedition of 1591–94 reached the Indian ocean. A Dutch voyage of 1595, commanded by Cornelius Houtman, succeeded in getting a valuable cargo of spices from Bantam. Encouraged by this example, and provoked to action by the high prices the Dutch exacted for spices, the Levant merchants in London took steps to form a new company. A charter was granted to "The Governor and Company of Merchants of London trading into the East Indies" on Dec. 31, 1600. For the first seven years the voyages of the company were directed to the Spice Islands. The trade was lucrative, but presented one serious difficulty—the ships could not take out commodities which the natives wanted. From its inception the company had been given the right to export silver, provided it did not exceed £30,000 in value in any one voyage; but this privilege exposed it to the charge that it was undermining the strength of the country. The company could not but be sensitive to this attack. When their factors at Bantam informed them that there was a good market for Indian calicoes there, they naturally explored the possibility of sending English goods to the Cambay ports, where they could be exchanged for

calicoes, which were acceptable in exchange for spices in Java. So the company sought and ultimately obtained the right to establish a factory or trading settlement at Surat. There they found that indigo could be bought at a price which yielded high profits in Europe, and it long remained one of the chief articles of direct trade between England and India. A footing was also gained in Persia where silk was obtained for export to Europe. The English company, in fact, gradually established itself on the mainland, the growing hostility of the Dutch driving it from the Spice Islands. In the later years of the 17th century the English woolen industry was complaining that the import of Indian textiles was ruining its trade; and later the use of certain Indian piece goods was prohibited in Great Britain. They were imported and offered by auction for re-export and mostly shipped to West Africa. This example shows that the costs of carriage were so reduced by the development of the direct sea route to India that fabrics cheap enough to clothe Negro slaves could enter into the trade.

3. Rivalry of England and Holland.—English commerce had been largely in the hands of aliens, chiefly Italians and Germans, during the middle ages. But two groups of native merchants in the course of time won recognition as distinct companies—the Merchants of the Staple, who exported wool, and the Merchant Adventurers, who sought markets for English cloth. With the growth of the woolen industry the latter became the more important of the two. Their origins are obscure, but by the 16th century they enjoyed the monopoly in the export of cloth by English subjects to the Low Countries and Germany. They came into conflict with the merchants of the Hanseatic league, and in 1578 the Germans finally lost the favourable position they had so long held in England. The Merchant Adventurers themselves had their chief seat abroad at Antwerp, which in the 16th century had succeeded to the position previously occupied by Bruges; but the political disturbances in the Low Countries drove them to seek a centre in the north and they eventually settled in Hamburg. The Hanseatic league monopoly in the Baltic was further challenged in 1579 by the formation of the Eastland company which secured concessions in Elblag at the mouth of the Vistula. The formation of all these trading companies might suggest a successful policy of promoting English commerce. That was not necessarily the fact. The companies were given exclusive rights as far as English subjects were concerned in the areas assigned to them and they were tempted to exploit this privilege for their own ends. There is good ground for contending that the expansion of trade was due to the interlopers who defied the rights of the companies and tried to break their monopoly. At any rate the 17th century witnessed many attacks on the company system because it was alleged to restrict commerce; and the case against it seemed the stronger since Dutch competition was in so many instances successful in depriving the companies of trade in their special areas.

The wealth of Holland rested primarily on the degree of organization it applied to the herring fishery, for this gave it experienced sailors and a commodity for which there was a great demand in the European markets. The fishing season was so arranged that a great fleet was kept constantly at sea and its wants supplied by other ships which brought in the herrings ready salted and packed in barrels. Situated at the mouth of great riverways, the Dutch were able to dispose of this fish on profitable terms. Amsterdam, it was said, was built on herring bones. Fishing led to an improvement in shipping and the building up of the proud position of being the chief maritime carrier in the world. Dutch towns were intimately connected by waterways and each specialized in some direction. Ships were built appropriate for the different kinds of cargoes and their parts were standardized. With a high net tonnage, and managed by a comparatively small crew, specialized ships following a regular course in quick succession could easily offer freight rates with which other countries could not compete. Writing in 1665 Sir Josiah Child gave a list of trades which the English had lost—the Russian, the Baltic, the Spanish, that of the Spice Islands and the far east, even that of Scotland and Ireland—all had fallen to the Dutch. They had, according to him, the advantages of better education, better workmanship, better commercial laws, better ship designing, and above all a better banking system with a lower rate of interest. The English Navigation act of 1651 was designed to damage the Dutch carrying trade by requiring that, as a general rule, goods should not be imported except in English ships or ships of the country where they originated. Contemporaries supposed that this policy did irreparable harm to the Dutch, but their opinion is not supported by the evidence. The Dutch carrying trade survived with little diminution for many years; its relative decline in the 18th century was due to other causes.

4. Mercantile System.—"The ordinary means to increase our wealth and treasure," declared Thomas Mun in the middle of the 17th century, "is by foreign trade, wherein we must ever observe this rule—to sell more to strangers yearly than we consume of theirs in value." This meant that a government should see that the value of the commodities exported was greater than that of those imported; the difference, it was supposed, would have to be paid in treasure; *i.e.*, coin or bullion. The means adopted to secure a favourable balance of trade in this sense constituted the so-called mercantile system (*q.v.*). The trade with foreign countries in general and each country in particular was examined to discover whether the general and particular balances were or were not favourable. If a balance was considered to be unfavourable, steps had to be taken to correct it. In France Louis XIV's minister, Jean B. Colbert, set himself to promote French commerce on these principles; he accordingly tried to restrict trade with England and Holland. English mercantilists, on the other hand, regarded trade with France as disadvantageous and it was subjected to the prohibitive tariff of 1678 until William Pitt initiated a more liberal policy in the commercial treaty of 1786. It was also found that the importation of naval stores—tar, pitch, resin and timber—from the Baltic meant that England had a permanently unfavourable balance of trade with Sweden and Russia; consequently an attempt was made to stimulate a new source of supply by offering bounties on the production of these commodities in the American colonies. In fact colonization seemed to offer to the countries of western Europe a way of escape from the supposed disadvantages of unfavourable balances of trade. The colonies might either produce the commodities which had otherwise to be imported from a foreign country, such as naval stores, or send to the mother country some staple goods, such as tobacco or sugar, which could be re-exported to foreign countries and thus give it a firmer position in their markets. It was for this reason that the English Navigation act of 1660 "enumerated" certain articles which had to be sent in the first instance to England, a list which included sugar, tobacco, indigo and ginger. The mother country was to be the entrepôt for these goods. It followed that the highest value was put upon the colonies which produced them; *i.e.*, the West Indies, Virginia and Maryland. The New England colonies were looked upon with suspicion because they produced commodities similar to those of the mother country. There is no doubt, of course, that England would have made high profits had it been able to monopolize the new staples which were now entering into long-distance trade. For a time England supplied the European markets with sugar, but in the 18th century Dutch and French producers were able to undersell it. The aims of mercantilism had been defeated by the course of events. The revolt of the American colonies in 1776 made a serious breach in the system, and the publication of Adam Smith's *An Inquiry Into the Nature and Causes of the Wealth of Nations* (1776) supplied the classical refutation of its fallacies.

5. Industrial Age.—The great importance that was at that time attached to the trade in sugar and tobacco and the East India company's monopoly in tea, is an indication of the change which had come over long-distance trade. Commerce was now supplying the necessaries of the many rather than the luxuries of the few. Since these necessaries were only to be obtained in exchange for other goods, the increasing demand promoted industries in the trading countries. This was particularly the case in Great Britain where commercial expansion led to an industrial revolution. A country which had attempted to use colonial staples in order to become "a nation of shopkeepers" found itself converted into "the workshop of the world." Its position as a great ocean carrier, the

financial system which had been built up, the freedom of movement for persons and goods within its boundaries and the natural resources in coal and iron all contributed to this conversion. Perhaps one of the most significant results was the change in the direction of the flow of textiles. Until the end of the 18th century the trade with India had been looked upon with some disfavour because it involved considerable imports of calicoes and muslins and a comparatively small export of English woolens. The introduction of machinery in the Lancashire cotton industry completely altered the position. Raw cotton was now imported in large quantities from America and machine-made piece goods were sent to India where they were sold at such prices that the native products could not compete with them. The application of steam power to transport enormously enlarged the scope of commerce. Railways opened up the interior of the continents and so brought to the ports commodities which would not otherwise have entered into long-distance trade, or in many cases indeed would not have come into existence. The steamship reduced the length of voyages and construction in iron—and later in steel—greatly increased its carrying capacity; services were also more regular than in the old sailing days. When the Suez canal was opened in 1869 it provided a much shorter route to the east particularly suited to the steamship.

All these changes naturally reacted on commercial policy. Great Britain between 1820 and 1860 abandoned the restrictive system which had survived from the 18th century. To sell its manufactures in the markets of the world it opened its ports to the raw materials and foodstuffs which other countries could supply. It was also able to put its financial resources at the disposal of those who undertook the building of railways and other projects abroad and thereby helped to multiply the goods which entered into commerce. Railways and low ocean freights made it possible for wheat grown in the Mississippi valley to be sold in Great Britain at prices which drove British farmers to reduce arable cultivation. A rapidly growing population depended to an ever greater degree on the import of food from overseas.

IV. THE 20TH CENTURY

In the later decades of the 19th century the process of industrialization made rapid progress in other countries, particularly in the United States and Germany. They possessed deposits of coal and iron—the essential prerequisites in the first phase of industrialism—and became great manufacturing centres. A country cannot develop such resources on a large scale and remain independent of other countries; for the ideals of self-sufficiency and industrial development are incompatible. The reasons are obvious enough. An industrialized country is an urbanized country; the industries require raw materials and wide markets for manufactured goods and the population needs food supplies which must be sought elsewhere. So there emerged a system which was an uneasy combination of rivalry and interdependence. For while the industrial countries competed with one another in supplying nonindustrial countries with manufactured articles and in trying to gain access to the tropical products, such as rubber, which were beginning to assume importance, they also found the widest scope for the exchange of goods in the trade among themselves, because highly organized communities naturally offer the best markets for a great variety of commodities. Before World War I, for instance, Great Britain sold more to Germany than to any country except India, and bought more from Germany than from any country except the United States.

These commercial ties seemed to some to preclude the possibility of war between the great powers. This proved to be wrong. Still war revealed the fact of the real interdependence of nations. It showed that great industrial communities cannot inflict damage on one another without suffering themselves in the process and indeed endangering the whole economic structure on the preservation of which the standard of life of their dense populations ultimately depends. A world economy must necessarily mean that it is only a degree less disastrous to win a war than to lose it. The fundamental fact in the modern world is the revolution in the means of transport and communication. Before the industrial age the movement of men and goods was difficult and therefore exceptional; it has become easy and usual. And while modern inventions have greatly speeded up transport they have practically annihilated distance with respect to the sending of information. The sale of goods in large quantities can be effected at great distances. Where grading is possible they can be sold by description even before they have come into existence; for speculators engage to deliver goods at a given price at a future date in the expectation that they will be able to buy at a lower price when the time comes to deliver. In these and other respects the mechanism of modern commerce tends to establish a world market in certain staple commodities.

1. Development After 1914.—Although what once had seemed the certain approach toward universal free trade had already been interrupted and partly reversed in the last quarter of the 19th century, it was only World War I which finally destroyed these hopes, and ushered in a new period of controlled trade governed by motives not unlike those of the mercantilist period. For a time the disturbances caused by the war and its aftermath were regarded as temporary and an ultimate return to normal was expected and for a short time even seemed within reach. But as a whole the interval between World Wars I and II must appear in retrospect as a period of continued disorganization and disorientation, dominated wholly throughout its second half by the great depression. At least in Europe trade policies were governed by the new trend in internal economic policy, the increasing tendency of governments to control economic life and especially their inflationary monetary policies dictated by financial needs, while in the United States the period was marked by a return to high protection culminating in the Tariff act of 1930. An attempt to restore the international gold standard on which the relatively free flow of commerce in pre-World War I days had been based—an attempt unfortunately combined with the endeavour to bring the depreciated pound sterling back to its former value in terms of dollars—broke down in the financial crisis which in 1931 accentuated the sharp downward turn economic development had taken in 1929.

During this later part of the interwar period, under the stress of the depression, the very character of the commercial policies of the nations changed. While until then, custom tariffs had been the main obstacle to the free flow of goods, quantitative restrictions in the form of import quotas, licensing and outright prohibitions became the main instruments of commercial policy until a free trader meant someone who desired that only tariffs should be used for the control of trade. Commercial policies became increasingly subordinate to monetary policies and in particular dependent on the practices of foreign exchange control, which had become an almost universal institution. The outstanding new development of the period was a strong tendency toward bilateralism, attempts to balance the volume of trade between any two nations, with the inevitable result that the greater part of international trade which depends on triangular or multiangular relations between nations became increasingly difficult and the total volume of international trade tended to shrink even more than corresponded to the reduction of internal trade caused by the depression.

Yet the dependence not only of prosperity but of continued industrial progress on commerce remained as great as ever. It had often been argued that modern technological progress with its increasing substitution of synthetic for natural raw materials, and the growing independence provided by the possibility of manufacturing particular articles formerly available only from special locations, would more and more reduce the importance of commerce but this view proved unsound. Just as the industrialization of new countries such as Germany or Japan made them not only new competitors but also the best customers of the older industrial countries, so the technological developments if anything increased rather than decreased the advantages and opportunities of profitable international exchange. The tendencies toward national self-sufficiency which showed themselves during the interwar period, were everywhere the artificial results of deliberate measures of policy which came increasingly to be recognized as the main obstacles to a return of prosperity. Yet each government, aiming at short-term results and responding to the ever-changing policies of

other governments, had little possibility of extricating itself from the accumulated results of emergency measures which had a paralyzing result on trade in general. Little had been achieved to break this vicious circle when World War II intervened and, even more thoroughly than had World War I, brought to an end all international commerce of a spontaneous and undirected character.

2. Trends After World War II.—The state of opinion and general political conditions after World War II made a simple return to a system of free private commerce seem even more impracticable than it had been after World War I. For a time the retention of a system of state trading in many of the major staple commodities even by some of the leading commercial nations such as Great Britain threatened to force the adoption of similar practices on nations who would have preferred to leave international commerce to free enterprise. But the reaction against the tendency to increasing state control which set in a few years after the war led to new efforts to reduce trade barriers and to free the flow of private commerce. If anything had been demonstrated by the largely abortive efforts in this direction made during the period between the wars it was that neither the independent efforts of individual states nor bilateral negotiations carried on between two states at a time offered much hope in this respect. The whole system of regulations and commercial treaties had grown far too complex, and the interdependence of the obligations entered and concessions made by particular nations toward each other far too great for any prospect of rapid improvement by the traditional method.

The new approach was based on an endeavour to bind as many nations as possible by a single general agreement to reduce or abolish all quantitative restrictions of trade, especially all those of a discriminatory character; to aim at a progressive lowering of tariffs; and to set up for that purpose, a permanent machinery which would make it possible for the different nations to negotiate renewals of their commercial treaties at periodic meetings held at one place and one time. As a result of these endeavours in 1947 and 1948 a General Agreement on Tariffs and Trade (G.A.T.T.) was concluded. Formed at first by 23 nations on a temporary basis, G.A.T.T. later expanded and was renewed and in a series of meetings achieved not inconsiderable success toward a general reduction of international trade barriers. Assisted by an unusually long period of high prosperity the volume of international commerce in consequence rapidly recovered and far exceeded the prewar volume.

And although for a time after the war it seemed as if political uncertainty and the dependence on the U.S. foreign-aid program would be the source of lasting instability, the prospects of a gradual establishment of a new and fairly stable pattern of trade adapted to the new conditions steadily improved.

See COMMERCIAL TREATIES; DUTCH EAST INDIA COMPANY; EAST INDIA COMPANY; FREE TRADE; GUILD; HANSEATIC LEAGUE; NETHERLANDS, THE: *History;* PORTUGAL: *History;* ROMAN HISTORY; SPAIN: *History;* TARIFF; TRADE, PRIMITIVE; TRADE ROUTES.

See also references under "Commerce, History of" in the Index.

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COMMERCIAL COURT, in England, a court presided over by a single judge of the queen's bench division, for the trial, as expeditiously as possible, of commercial cases. It is not a distinct court or division or branch of the high court of justice and is not regulated by any special rules of court made by the rules committee. It originated in a notice issued by the judges of the queen's bench division in Feb. 1895, the provisions of which represent only "a practice agreed on by the judges, who have the right to deal by convention among themselves with this mode of disposing of the business in their courts" (per Lord Esher in *Barry* v. *Peruvian Corporation*, 1896, 1 Q.B. p. 209). The court's chief feature is the speed with which causes assigned to the Commercial list can be concluded. It is for the judge in charge of the list to decide, on application from one of the parties, whether an action is to be included in the Commercial list or not. The work of the commercial court decreased in volume after World War II, partly because of the increased use of commercial arbitration for the settlement of trade disputes. (W. T. Ws.)

COMMERCIAL FEDERATION: *see* ECONOMIC UNION.

COMMERCIAL LAW: *see* BUSINESS LAW.

COMMERCIAL PAPER, a term used broadly to describe the many kinds of short-term negotiable instruments for the payment of money, such as notes, checks, bills of exchange and the like. In the United States the term also applies, in a strict sense, to negotiable notes, with maturities usually of from four months to one year, which are issued by corporations with good to excellent credit ratings in even denominations of, say, $5,000 or $10,000 and sold through brokers to the public, *i.e.*, principally to insurance companies, banks and other corporations with idle short-term funds to invest. These notes are referred to as prime commercial paper when interest rates are reported in the financial pages, and the aggregate volume outstanding is an index of business activity.

It is necessary to distinguish commercial paper from investment paper (*q.v.*), or, more commonly speaking, from corporate or investment securities. Both are money instruments, issued generally in negotiable form; both may be either for a short or a long term; both may be issued in even denominations and be secured or not by collateral; both are in some measure a medium of investment. But while it is difficult to draw a sharp line, as for example, between a particular promissory note and a debenture, the business community regards the two classes of paper as having quite different qualities and as serving different purposes. In general, bonds, debentures, share certificates, collateral trust notes, equipment trust certificates and so on are regarded as investment securities.

Bill of Exchange.—The earliest and most complex form of commercial paper is the bill of exchange or draft. It has been defined in England as an unconditional order in writing addressed by one person to another, signed by the person giving it (the drawer) and requiring the person to whom it is addressed (the drawee) to pay on demand or at a fixed or determinable future time a certain sum of money to, or to the order of, a specified person (the payee) or to bearer. In the United States the definition is the same, except that there an instrument may only be made payable "to order or to bearer." If the drawee assents to the order and accepts the bill, which is done by signing his name (or his name with the word "accepted") across the face of the paper, he is called an acceptor. The person to whom a bill is transferred by endorsement is called the endorsee. Any person in possession of a bill, whether as payee, endorsee or bearer, is termed a holder, and if he is a bona fide purchaser, a holder in due course.

The bill of exchange probably grew out of so simple a matter as the letter of a seller in one country, addressed to a buyer in another, by which the buyer was advised of the shipment of goods and was requested to pay the price—or a given sum of money—to a person named or to the bearer of the letter. In time the request, or order to pay, became separated from the letter and, as Marius says in his *Advice Concerning Bills of Exchange*, published in 1651, emerged as a mere slip of paper "not more than three or four fingers wide." The letter to the buyer has continued in use, mainly in foreign commerce, as an advice of drawing.

The significant thing is that the bill thus became a separate instrument for the payment of money, to be dealt with as such quite apart from any underlying transaction. According to Sir W. S. Holdsworth, something very like the modern instrument, capable of being transferred from hand to hand, was in use among the Arabs by the 8th century A.D. But the bill in its present form first attained wide use during the 13th and 14th centuries among the Lombards—merchants, traders and money-changers of northern Italy—who carried on a considerable foreign commerce. Probably the English merchant of the time was also well acquainted with

the bill; the first reported case, though, is that of *Martin* v. *Boure,* decided by the exchequer chamber in 1603.

During the 17th century the bill became widely used in domestic or inland transactions, first by merchants but soon by everyone. In fact the case of *Burton* v. *Davey,* decided by the court of the staple in 1437, shows that, much earlier, there was some domestic use of wordy instruments comparable to bills. As in foreign commerce, the bill afforded a needed means of settling accounts quickly and without the risk and trouble of using currency. Moreover, the common-law courts, by recourse to the "law merchant" (the mercantile law previously administered in the courts of the fair), were able to give rulings favourable to its general use. Thus, in *Chat* v. *Edgar,* 1663, the drawer was put under an obligation (the drawee having refused payment) to pay a payee who had taken the bill in course of trade, although the drawer had received no consideration for his signing. This was an early authority for the point, which has long since become a settled attribute of negotiability, that fraud, nondelivery and other personal defenses among prior parties are cut off upon negotiation to a bona fide purchaser.

There appears to have been little early practice to draw bills payable to bearer; in fact Marius had warned (*Advice,* p. 13), "Never make your bills of exchange payable to such an one (naming his name) or to the bearer hereof, which is very dangerous. . . ." But at sometime early in the 17th century it became usual to make bills payable to order, or to so-and-so or assigns. This was a change of great significance, for, prior to that, while a drawer might sell his bill to a remitter who in turn could deliver it to the payee, as happened in *Chat* v. *Edgar,* that was the end of the journey. By making the paper transferable by endorsement, however, it could be used in many successive transactions, while at the same time each holder, under a special endorsement to himself, was protected against loss in that no rights could be acquired to the paper except through his further endorsement. Bills, of course, like other commercial paper, were and still are made payable to bearer on occasion.

The courts had difficulty assimilating the merchant's endorsement. In the first place, what was his contract, since he had simply signed his name on the back of the paper with the words "pay to so-and-so"? This was solved fairly soon by assuming that the endorser had really drawn a new bill on the drawee, payable to order of the endorsee. Thus if the bill was not paid upon due presentment, and proper notice was given the endorser, he could be made to pay as a drawer. It was more difficult to state the rights of the endorsee against prior parties. On the face of it the transaction looked like an assignment (*q.v.*), and the common law had long held that a chose in action (intangible personal property, as a debt or other obligation owed to the assignor) could not be assigned. But this, too, was solved in time, for it was possible to say—since the bill was payable to order or to bearer—that the endorsee really was a party to the acceptor's contract. Also this made it easier to free the endorsee from defenses good between prior parties; he was not an assignee in the same situation as his assignor, but the holder of an independent contract.

The bill or, for that matter, any piece of commercial paper is thus a bundle of separate but related contracts. When the drawee accepts a bill, one more contract is added; the acceptor thereby obligates himself to pay the bill according to its tenor or, if his acceptance is qualified, according to the tenor of his acceptance. Like the maker of a note, the acceptor is described as a primary party, and in general no presentment for payment is necessary in order to hold him liable. But presentment and notice of dishonour (of nonpayment or nonacceptance) are necessary, unless such proceedings have been waived, in order to charge secondary parties, *i.e.,* the drawer and any endorsers. When such steps are taken, however, a holder may sue any or all prior parties, in such order as he may see fit, until recovery is had. An endorser may qualify his contract by signing "without recourse," in which case he will be liable, if at all, for breach of warranty, irrespective of presentment or notice of dishonour.

The foreign bill of exchange is one of the most cosmopolitan of instruments. By definition it must be drawn in one country or in one state of the United States on a drawee in another country or state; but in the course of its journey prior to payment it may well be endorsed in two or three others. Several systems of law, therefore, may be called into play to construe the contracts of the parties. Also different currencies may be involved. Thus, if an endorser is sued in the United States upon a bill drawn, say, in Australia in pounds sterling, the dollar value of the pounds must be determined before judgment can be given. The measure is the buying rate of exchange for sight drafts (those payable on demand) at the place of payment on the day of breach.

Protest is necessary to charge secondary parties on a foreign bill. The holder, upon dishonour, must hand the bill over to a notary public who re-presents it and, if it is again dishonoured, draws up an affidavit stating the facts. This practice serves two purposes: it gives needed assurance to secondary parties that a real effort was made to effect payment; it also supplies necessary evidence, for the notary's certificate or affidavit is admissible in most places as prima facie proof of the matters stated in it. Protest is not required to charge secondary parties on other commercial paper, but it is nevertheless widely used when it is thought that suit may become necessary.

Due to uncertainty of the mails, a practice developed very early to draw bills of exchange in sets, as bills of lading are drawn, one part to go forward by one mail, a second by the next and the third or other parts perhaps to be retained. While this practice adds further complication, it has resulted in little litigation. In concept, the several parts represent but a single bill; successive purchasers of different parts have title to the bill according to which first acquired a part; payment to the holder of any part discharges the drawee on the bill. The case of *Lloyd* v. *Sigourney,* 1829, shows that the practice may also have other advantages. There the master of a vessel, upon releasing a cargo to a buyer, took payment in a bill on London, one part of which he sent, unendorsed, to agents there to obtain acceptance; another, endorsed, he sent to his principal in the United States; the third he retained. Thus, since the endorsed part carried title, the principal was given control of an accepted bill at an earlier stage in the transaction than might otherwise have been possible.

The following is an ordinary form of foreign bill of exchange, drawn in a set of two, and made payable at a future time:

$1,000. Chicago, Ill.
Jan. 1, 1960

Three months after date pay this FIRST of exchange (Second being unpaid) to the order of Mr. J. Jones the sum of one thousand dollars for value received.

Brown & Co.

To: Messrs. Smith & Sons
Liverpool, England

A bill of exchange is payable on demand when it is expressed to be payable on demand or at sight. In calculating the maturity of bills payable at a future time, it is required in some countries that three days, called days of grace, be added to the nominal due date. Thus, if a bill payable one month after sight is accepted on Jan. 1, it is really payable on Feb. 4, not Feb. 1. So, also, when a bill or other instrument falls due on a holiday or a Saturday, there are a variety of legal provisions to determine whether it must be paid then, on the day before or on the next business day. In the U.S., days of grace have been abolished in most states.

Acceptances.—The accepted bill, like the promissory note, is primarily a credit instrument. When goods are shipped and the bills of lading are sent forward with a draft or bill of exchange drawn on the buyer at, say, 90 days after sight, it is customary to release the shipping documents upon acceptance of the draft. The buyer thus has 90 days in which to dispose of the goods and to obtain the funds to meet his acceptance when it matures. This is known as a self-liquidating transaction. In England, acceptances arising from such transactions enjoy an excellent credit standing and are traded in by bill brokers, much as notes are sold in the U.S. on the commercial paper market.

There never has been an extensive bill market in the U.S. Sales

of finished goods by manufacturer to dealer have traditionally been carried on open account. And, while the bill is used extensively in the sale of raw materials, the usual course is for the seller to take his bill to his banker, either for discount or to be handled on a collection basis. Thus, when early in the 20th century the federal reserve system (*q.v.*) sought to promote a bill market by the introduction of a draft called the trade acceptance, it met with only partial success. The trade acceptance is an ordinary draft carrying the legend: "The obligation of the acceptor hereof arises out of the purchase of goods from the drawer." Partly to encourage the use of such paper, which has an excellent credit standing, the federal reserve banks will rediscount it at favourable rates.

The banker's acceptance arises typically in an export or import transaction. For many years in England, and since World War I in the U.S., it has been customary for buyers to provide their foreign sellers with a banker's commercial credit. Thus the seller, as beneficiary of the credit, draws his drafts upon the buyer's bank rather than on the buyer, and the documents are released to the bank upon acceptance, to be thereafter turned over to the buyer upon trust receipt or as may be arranged. Such acceptances have the highest commercial credit rating, but are more likely to be held to maturity by a bank than to be sold on the bill market. In the U.S. a bank's promise in writing to accept a draft to be drawn upon it may be binding, *i.e.*, irrevocable, as a virtual acceptance; in England, while such acceptances are not recognized, much the same result was reached in *Re Agra and Mastermans Bank*, 1867, on other principles. Under the Federal Reserve act, trade acceptances and other eligible commercial paper, together with gold certificates in a specified ratio, may be transferred to the reserve board as a basis for the issuance of new federal reserve notes.

Promissory Note.—The promissory note, like the inland bill, came into general use in England in its modern form during the 17th century. It is not altogether clear what its precursors were, but Gerard Malynes, in his *Lex mercatoria*, 1686, describes a "bill obligatory," which, though it was phrased like a bond ("I, A. B., Merchant of Amsterdam do acknowledge by these presents to be truly indebted to the honest C. D., English Merchant dwelling at Middleborough, in the summ of," etc.), was nevertheless made payable to "the said C. D. (or the bringer hereof)." There is evidence, moreover, not only that such instruments were in use during the 14th and 15th centuries but that they were transferred from hand to hand. If these were early forms of the note, a considerable change in wording, and probably in concept, was to take place before the clean form, which Judge Gibson once described as "a courier without luggage," evolved.

The following is a typical form of interest-bearing promissory note payable at a bank:

$1,000. Jan. 1, 1960

One year after date I promise to pay to Chas. Dawes, or order, one thousand dollars, with interest at 6%, value received.

Payable at the
First Bank of New York

Abe Blum

The note differs from the bill mainly in that it carries only a single obligation, the promise of the maker. This has given rise to the phrase, single-name paper, to distinguish the note from the accepted bill, which in turn is called two-name or double-name paper since the payee may have recourse against both drawer and acceptor. But this is a loose distinction at best, for additional names may easily be added to a note, either as comaker or endorser, and whether for accommodation or as borrower. Moreover, since a bill may be drawn to the order of the drawer, it likewise may be held as single-name paper. Most continental countries customarily do not use the note, but make the bill serve both as a means of collection and remittance in goods transactions and as an instrument of debt for money borrowed. That is, the lender may simply draw on the borrower and hold the latter's acceptance to maturity, as a lender would hold a note in Anglo-American practice.

By the end of the 17th century the legal standing of the note was still uncertain. In *Clerke* v. *Martin*, 1702, it was urged that a payee might recover from the maker as upon a specialty, *i.e.*, an obligation under seal, thus cutting off the defense that there was no consideration or benefit to the maker, but Lord Holt strongly opposed the action and said that the note in question could not be a bill of exchange. The result of the case was correct enough since even a foreign bill is not a speciality; but when, in *Buller* v. *Crips*, 1704, Lord Holt used the same reasoning to subject an endorsee to defenses between maker and payee, for otherwise "it would impower one to assign that to another which he could not have himself," there was a considerable outcry. Parliament soon passed the Statute of Anne, 1704, to put promissory notes, and inland bills as well, on the same footing with foreign bills. This statute had great influence in shaping the early law in the U.S.

Lord Holt said, incidentally, that notes were "only an invention of the goldsmiths in Lombard-Street." While this is dubious history, except in the sense that they may well have been responsible for stripping away much verbiage from the bill obligatory, it is true that goldsmiths' notes—soon to be called bank notes—were in general use at the time. A half-century later, Lord Mansfield, in *Miller* v. *Race*, 1758, held that an innkeeper, who had taken a stolen bank note in the usual course of business, was to be given good title, much as if he had taken money. This was a decision of great importance. In the ensuing years it became a settled attribute of the concept of negotiability, applicable alike to bills of exchange and other forms of commercial paper.

The practice of making paper "payable at" a bank is not confined to notes, for acceptances likewise are so domiciled. In England the clause was held from the first to constitute an order on the banker to pay. In the United States the older commercial states adopted the same rule, but in a few states—less impressed at the time with commercial usage—an opposite rule was adopted; thus an instrument was made payable at a bank, they said, in order to fix the place where presentment should be made to charge endorsers. Moreover, even in the majority states, since no presentment is ordinarily necessary to charge the maker or acceptor, it is held, contrary to the rule with respect to checks, that insolvency of the bank of payment is at the risk of the maker or acceptor, even though the holder was very dilatory. The deposit, or cover, as it is called, thus constitutes no more than a tender or offer of payment.

The note has changed substantially, both in form and use, during the 20th century. Many clauses have been added: to authorize the sale of collateral; to permit acceleration of payment in event of default; to provide for confession of judgment (judgment against debtor without a trial); to waive presentment; to permit extensions of time; to pay attorneys' fees. The clean form is still used, but these and other clauses have become commonplace in collateral notes prepared by banks for their customers. They are also used in the notes given in installment-sales transactions, amounting in the aggregate to billions of dollars. Moreover, the old "open account" practice has been breaking up. First, it became respectable for the manufacturer or dealer to make a bare assignment of the account receivable, either to a bank or finance company, but increasingly the debtor, or buyer, has also been asked to sign a long-form note. These developments have raised many questions concerning negotiability.

Checks.—The check came into use in England during the latter half of the 17th century. Childs bank has a check drawn upon it in the following terms:

Bolton, 4th March, 1684, At sight hereof pray pay unto Charles Duncombe, Esq. or order, the Sum of four hundred pounds, and place it to the account of

Your assured friend
Winchester

Thus the check is simply a bill of exchange drawn on a bank payable on demand, and it has long been so defined. But it took many years to acquire this status, in fact to acquire a name. There are early references to it as a "drawn-note" or a "bill." And in *Grant*

v. *Vaughn*, 1764, Lord Mansfield used the terms "cash-note" or "note," possibly to make it easier to apply the law of *Miller* v. *Race*, mentioned above, relating to bank notes. But by the end of the century the word "check" had come into general use, though in England toward the middle of the 19th century the spelling was changed to "cheque."

Since the check could be regarded as a simple direction by a depositor to his banker, there was doubt whether it was a negotiable instrument. The drawer could stop payment; the bank could be held liable for slander of credit; the drawer was under a special duty to prepare his checks with care. These were incidents of the bank-depositor relationship, and not necessarily inconsistent with negotiability. In England, however, it was seriously argued as late as *Keene* v. *Beard*, 1860, but without success, that a holder could not recover against a prior endorser, as upon a negotiable bill. In the U.S. the courts ruled in the early 1800s that the check is a bill, with only one important difference: the drawer is not to be fully discharged upon a failure of the holder to make timely presentment, as in the case of a time bill, but only to the extent of his loss.

Also, the certification of a check by a bank was held in *Willets* v. *Phoenix Bank*, 1853, to obligate the bank as upon the acceptance of a bill. It is reported that by 1870 the average circulation of certified checks in New York was not less than $100,000,000 daily. Brokers and others receiving large payments by check, and not wishing unnecessarily to assume the risk of a drawer's continued solvency, simply presented the checks for certification. While this had the effect of discharging the drawer, the holder obtained the obligation of the bank in negotiable form, and the check, so certified, could readily be used in further transactions. When a check is certified for the drawer, he continues to be liable as a secondary party. English banks have never adopted the practice of certifying checks, and it is likewise unknown on the continent.

The importance of the check not only as a convenient means of making payments but as a part of the currency system is hard to overestimate. Banking, in the modern sense, began in the latter half of the 17th century when, in legal concept, the goldsmith became a "debtor" rather than a "bailee." But the goldsmith, in his new role as banker, became much more than a mere lender of money, his own and that of his depositors. He had discovered that by keeping only a percentage of his customers' deposits in the till, in currency, he could make loans which aggregated twice or more the amount of all cash deposits. That is, he loaned not money, but credit, at interest. And the instrument which made this possible was the goldsmith's note or bank note. So long as he was free to issue these and they were accepted in the market place in lieu of cash, his banking system worked.

The check achieved prominence as the bank note came under strict governmental regulation. In the U.S., after a long chaotic experience with notes issued by state banks, such notes were legislated out of existence. In their place the national banks were authorized to issue notes, but only when backed dollar for dollar with specified security. The banks, however, had already found that the check would serve their purposes much as had the bank note. In short, they were free to loan their credit to their customers, keeping only so much money on hand as experience had shown to be necessary to meet payments. Since loans to customers were invariably carried as deposit liabilities, available by check, it followed that the check in a very real sense represented a sort of currency and, moreover, a kind which could be expanded or not, more or less as business or banking considerations demanded. But government here too has intervened and, through a system of required reserves, has asserted control over the mechanism.

The clearinghouse (*q.v.*) as first established by London bankers, greatly facilitated the check system. At the start it was merely a device to permit bank clerks to meet together at some central place, such as a coffeehouse, to exchange checks drawn on their banks. But by 1773 it became the practice also to set off one batch of checks against another and to make a provisional settlement at once. Not only did this save time but it obviated the risk of using currency; the few not-good items could be returned later. Moreover, the banker must have noted that it made the least possible drain on his cash needed for counter payments. In the U.S., the federal reserve system extended the practice to the clearing of items between member banks in different cities, each member's reserve account being credited or debited as the case might be. Thus, it was possible to speed up collections still further and to reduce what the banker calls "float."

In England the early stamp tax upon checks adversely affected the development of the system there; from 1791 until 1853 (when the tax was reduced to one penny), "order" checks were virtually driven out of use. Forced to use "bearer" checks, drawers and holders contrived a system of crossing—two transverse lines across the check face, usually with "& Co." written between—which required the drawee to pay only to a banker. Thus if a check were stolen from the mails, some protection was afforded since the thief, or bearer, would have to make arrangements with a banker for collection; he could not simply demand cash from the drawee at the window. When it became apparent, in 1853, that "order" checks would soon displace "bearer" checks and would be issued in great numbers, the banker got worried, for he did not like the prospect of having to take losses should payments be made upon forged endorsements. A provision was accordingly inserted in the Stamp act, s. 19, which exempted banks from liability. Subsequent enactments have extended the exemption. Accordingly, the crossing device, for what little protection it affords, is securely fastened on English practice.

The crossed check is not used in the U.S. From the first, checks were issued to order, not often to bearer, and hence drawer and holder have always been protected by the rule that only an authorized endorsement will pass title. Moreover, by the time of the *Canal Bank* case, 1841, the right of the drawee to recover from anyone collecting paper through a forged endorsement was clearly established. Since then, by use of the "prior indorsements guaranteed" stamp, recourse has been carried back through agent collecting banks. Thus if a check is stolen from the mails and the holder's endorsement is forged, the ultimate loss falls on the person who took the item from the thief, not on the innocent loser, as in England. The result is that most payments are made by check; business and personal checks alike are customarily sent by mail, uninsured, to any part of the country and with relative safety. As one index of general use, clearings in Chicago alone at the middle of the 20th century were on the order of $1,000,000,000 a week.

Banks in the U.S., as elsewhere, sell their customers (at a small fee) different forms of checks or drafts for special uses. Thus a cashier's check, so-called, may be purchased to make a local payment of importance. As its name implies, the cashier's check is simply an order by a cashier upon his own bank. Bank drafts are often purchased to make payments in other cities, and they (or a cable transfer) are used almost exclusively when foreign remittances are made. The bank draft is indistinguishable from a check except that it is drawn by a bank rather than by an individual; both are drawn upon a bank and are payable on demand. A third type is the traveler's check, which may take the form of a cashier's check but is distinctive in that two spaces are provided so that the customer may sign at the time of purchase and again when cashing the check, as an aid to identification. (*See* also CHECK.)

Uniformity.—The Bills of Exchange act, drafted by Sir M. D. Chalmers, was adopted by parliament in 1882. Essentially it was a work of codification, designed to state in an orderly fashion, without innovation—except interstitially—the law of bills, notes and checks as found in the court decisions and the fragmentary legislation of the previous two or three centuries. The result was admirable; stated in simple language and in short separate propositions, the act was readily understandable by lawyer, banker or anyone concerned and has brought substantial uniformity throughout the British Commonwealth.

In the U.S., in 1896, the newly constituted commissioners on uniform state laws appointed John J. Crawford, of the New York bar, to draft similar legislation to be submitted to the several states for adoption. Crawford's draft, the Negotiable Instruments law (N.I.L.), was patterned closely upon the English act both in style and wording. In large measure the law of the two statutes is the same, as Crawford made changes only where the course of

development in the U.S. had clearly taken a different direction. But the N.I.L., unlike the English act, had to pass in 50 different legislatures in order to achieve uniformity, and not all of these were happy to see the special rules which had grown up in their states changed. Nonetheless, in the years 1897–99 the N.I.L. was adopted in 15 states; since then it has been adopted in all, though with some changes in text. By and large, the N.I.L. also has been an excellent statute.

One significant departure from the English act was made. The N.I.L., as its name implies, was not restricted to the law of bills, notes and checks but was drafted to admit any instrument, then in use or to be developed later, which could meet the several tests stated. Thus coupons, travelers checks, certificates of deposit, debentures and even most bonds were negotiable within the act. But the act also had a limiting effect. In *Manhattan Co.* v. *Morgan*, 1926, it was urged that interim certificates for bonds-to-be-issued should be treated as negotiable. They clearly did not satisfy the N.I.L. test since, for one thing, they were not payable in money. And Judge Cardozo held that the words of the statute, "An instrument to be negotiable must conform . . . ," also made it impossible for the court to look to the custom of the financial community to discover negotiability, as the English court had done in *Goodwin* v. *Robarts*, 1875.

There were more serious difficulties; for special legislation could be provided for interim certificates, as for other investment paper. The growing penchant on the part of many legislatures to amend the statute in one way or another could not be met so easily. Some of these amendments were useful; most were hastily drafted; but whatever the case, their effect was to destroy uniformity. Equally troublesome was the considerable contrariety among court decisions. Even when construing identical texts, there have been many divergent holdings, and with respect to important sections of the statute. If it were possible to take these cases before a single court of appeal, as in England, such conflicts could be resolved. But in *Erie R.R.* v. *Tompkins*, 1938, the U.S. supreme court abandoned a jurisdiction it had exercised since *Swift* v. *Tyson*, 1842, by which it applied a single law in commercial matters.

The next step was the preparation of the Uniform Commercial code (1952), by the commissioners on uniform state laws and the American Law institute, under the direction of Karl N. Llewellyn, chief reporter. Art. 3 of the code, which deals with commercial paper, solves the problem posed by the *Manhattan Co.* case, by providing that "any writing to be a negotiable instrument *within this article* must. . . ." Thus the code does not block court recognition of new forms of paper. Secondly, a new statute, art. 8, was proposed for investment securities. The result has been to preserve much of the clarity of the N.I.L. and, at the same time, to provide a uniform text covering some of the special legislation and resolving most of the conflicting decisions of the preceding half century. The code has been adopted in Pennsylvania, Massachusetts, Illinois and several other states.

But art. 3 also will not achieve uniformity unless it is well construed. Many courts, with a similar text before them, have abandoned the sense of direction and purpose which guided the earlier judges, as if codification and the common-law tradition were completely hostile to each other. Thus in *Jones* v. *Warring and Gillow*, 1926, the house of lords declared that a payee of a check (taken in good faith from a remitter) could not be a holder in due course. It reached this result, by no means a necessary one, by disregarding the fact that, at least since *Chat* v. *Edgar*, 1663, the courts, in the absence of statute, had held that it was essential to trade that payees should be given protection in that situation. The same construction, if applied to a bill, would overturn the long-established rule that a payee's rights are not to be subject to defenses between drawer and acceptor. The code deals with the problem—for there have been many equally troublesome decisions in the U.S.—by stating that a payee "may" be a holder in due course.

The law pertaining to bills of exchange in non-English speaking countries is similar in many respects to Anglo-American law. Since both derive from a common source, the early trade between merchants of different countries, this was to be expected. But legislation came much earlier on the continent; French law, for example, was codified in the 17th century by the "ordonnance de 1673." In England, as we have seen, it was during the next two centuries that the courts, on a case-by-case basis, wrote much of the law which was codified in the Bills of Exchange act of 1882. Necessarily, there are differences not only in text but in the way the law is regarded in the two systems. The continental lawyer and commentator tend to reason mainly from concept, the Anglo-American lawyer and writer from the economic or business purposes which the instrument was designed to serve.

The Geneva conferences of 1930 and 1931 (the first session related to bills of exchange and notes, the second to checks) made considerable progress toward unifying the law of the commercial world outside the Anglo-American system. Thirty-one countries were represented at the first session and 30 at the second, with the U.S. as an observer at each. Twenty or more countries promptly signed each of the conference conventions. Moreover, some progress was made toward bringing continental and Anglo-American law into closer alignment. The most serious obstacle to a complete rapprochment is the Anglo-American rule that no title may be had through a forged endorsement. Continental countries, following a concept of full negotiability to its logical end, protect the good-faith purchaser, which ultimately forces the person whose name is forged to seek redress from the forger rather than to put that burden on the person who dealt with him. This difference may contribute to the fact that commercial paper is less extensively used on the continent than in Anglo-American countries.

Early in the 18th century Jeremy Bentham was an outspoken advocate of codification. But his main reason, that the courts should apply law and not make it, ran counter to a long tradition to the contrary. It would have better served his cause, perhaps, if he had stressed the need for uniformity, at least in the commercial paper field, and so have enlisted the business community in his support. The U.S. experience has shown that, so long as the spirit of free legislative enterprise persists, codification will not result in undue crystallization of the law. (R. T. S.)

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COMMERCIAL TREATIES. A commercial treaty is an international agreement on trade and related matters. In modern usage the related matters have included not only those on shipping but also many subjects having to do with the status and rights of persons. In its broadest sense, the term commercial treaty might apply to any of a number of different types of arrangements between governments, including even a simple agreement that trade might go on between the parties. Used in a more technical sense, as here, the term denotes an arrangement that applies to some things besides exports and imports, and is, therefore, more than a mere tariff treaty or trade agreement. In the constitutional sense, it is a formal agreement requiring for its legal effectiveness approval by such processes as the national constitutional plan prescribes.

Traditionally bilateral in form, a general commercial treaty (which has often been referred to as a treaty of friendship, commerce and navigation) has commonly included as establishment provisions the principles or rules which apply to nationals of one country who reside in another country's territory and who carry on commercial or other activities there. Protection of these persons against discriminatory treatment in such matters as property, taxation, access to courts and basic human rights, has been an objective of this type of treaty. Since no state would be likely to allow resident aliens to have all the rights and privileges which its own citizens have, it has not been uncommon for commercial treaties

to contain specific exceptions clauses in order to keep the treaty commitments in line with policies of the respective signatory states.

Commitments on trade and on treatment of persons have not appeared exclusively in commercial treaties. They have sometimes appeared, for example, in treaties of peace or in arrangements for the transfer of territory, to be applicable either indefinitely or pending the conclusion of full-length commercial treaties between the states concerned.

Scope.—While stating long-recognized principles to apply to exports and imports and to vessels, commercial treaties have varied considerably in their establishment clauses. Some of these clauses have touched on matters on which there were applicable rules of public (customary) international law, such as the general protection of admitted aliens. Others have related to matters on which there have been international agreements in multilateral form, as on patents or foreign-exchange control. Still others have been on matters which lie clearly within the field of national state policy, such as the permitting of aliens to acquire real property (land or buildings, etc.), or to carry on mining operations or to organize (or invest in) corporations. Navigation clauses in commercial treaties have commonly provided rules on matters not covered by more general international law, such as provision of pilots for foreign vessels, or the basis on which vessels of one party state may engage in the coastwise trade of the other party state.

As compared with what in the strict sense of the term are called trade agreements, commercial treaties ordinarily contain no schedules of tariff reductions or "bindings" (which are characteristic features of trade agreements), and are designed to be longer-term instruments. The general commercial treaty which Great Britain concluded with the United States in 1815 was still in effect in the 1960s.

The contents of commercial treaties tend to be affected not only by changing methods of doing business across national frontiers but also by changing ideas concerning state functions, the legality of war, and means of preserving the general peace. For states having a monopoly of their export trade as in the U.S.S.R., the effect upon their commercial treaty making has been obvious; when state trading has not proceeded to this extent, but states have engaged directly in some commercial activity as in the case of a number of European countries by the mid-20th century, there has been some effort through the provisions of commercial treaties to provide some fair basis of competition between government agencies engaged in business and private foreign traders. With respect to war and neutrality, many commercial treaties of the early 19th century included detailed provisions on contraband of war, and some indicated the parties' position on the principle of "free ships, free goods." After 1920 there was reflected in various treaties the parties' resolve to keep these bilateral agreements from conflicting with duties which the states concerned had accepted as members of international organizations designed to safeguard the peace.

Developments Prior to 1860.—In ancient times there were many instances of treaty arrangements which regulated foreign intercourse. The texts are extant of provisions on commerce and navigation which Carthage concluded with Rome in 509 B.C. and again in 347 B.C. Aristotle mentions that peoples were connected by commercial treaties, and other classical writers refer to such arrangements. Under Roman imperial rule, laws or usages acquiring the force of law provided regulation. With the contraction of the empire and the weakening of the imperial authority, there was again need for some kind of international agreements. Edward Gibbon cites treaties in force at Constantinople in the 10th century for protection of "the person, effects and privileges of the Russian merchant."

In western Europe, commercial intercourse, trade and navigation went on, at first tacitly by usage derived from Roman times or under permission which rulers gave to foreign merchants who resorted to their courts. Later, formal documents (such as royal letters, charters, laws and other instruments having legal force and effect) provided some security for the trader. In the history of English commercial relations, the letter of Charlemagne in 796, the Brabant charter of 1305, and the Russian ukase of 1569 are illustrative. Medieval truces or treaties of peace sometimes contained clauses permitting in general terms the renewal of personal communication and commercial relations which had gone on before the hostilities. These arrangements were precarious, sometimes not continuing beyond the lifetime of the contracting rulers.

The practice of city states in Italy provided some precedents for later treaty making in this general field. Such well-organized communities as Genoa, Pisa and Venice were in keen rivalry. Conditions prevailing in foreign territories with which these cities had dealings made it desirable to have formal agreements for the greater security of commerce and navigation. The convention which Pisa concluded with the sultan Saladin in 1173 affords illustration of such arrangements effected in the 12th century. Greater definiteness and security were presumably obtained under such agreements than would have been assured under mere usage or under grants from foreign rulers, and the practice of utilizing formal undertakings to provide for security of traders came to be general in Europe. In western Europe, a treaty of accord and alliance which Brabant concluded with Cologne in 1251 contained provisions illustrative of the growing practice. The first agreements with comparable provisions which the Hanse towns made with foreign entities were arrangements made by guilds of merchants, rather than by public authorities acting as governing bodies. For a considerable period the treaty system did not entirely supersede conditions under which commercial intercourse depended upon the foreign trader's having permission from political authorities.

England's earliest commercial treaty (with Norway, 1217) provided that merchants and men of each signatory country might freely and without impediment visit the territory of the other party. In the course of the next two centuries England made treaties of this general type with Flanders, Portugal, Baltic cities, Biscay and Castile, Burgundy, France and Florence. By the 17th century the practice of concluding commercial treaties had become widespread. The bilateral form of the undertakings permitted the fitting of wording to the situation obtaining between each pair of signatories, but the effect upon relations with third states was naturally a consideration, and in the course of the modern development certain "standards" of treatment were to come into wide use.

Of central importance among these standards has been that of most-favoured-nation treatment. The term is a misnomer, since it might seem to suggest preferential treatment, whereas its meaning is essentially that treatment shall be no less favourable than that accorded any third state. An obvious characteristic is the contingency involved; *i.e.*, a state obtaining a pledge of the treatment acquires nothing substantive unless some foreign state receives rights or privileges falling within the matters to which the pledge applies. The national treatment standard also involves contingency, since a state agreeing to it becomes committed to accord treatment no less favourable than its own nationals (or goods or vessels, as the case may be) receive. Modern treaties have sometimes provided, on particular subjects, national and most-favoured-nation treatment.

Still another standard is that of reciprocity (not to be confused with mutuality in the application of provisions). There have been commitments to give "equitable" treatment, or to pay "just" compensation for property taken, or (especially in connection with basic human rights) pledges to allow treaty aliens to enjoy certain freedoms without specific reference to whether other foreigners or even nationals enjoy them. There has been, as with respect to diplomatic or consular privileges and immunities (matters which have sometimes been the subject of provisions in commercial treaties), specification of international law or international usage as the measure of treatment.

An early modern example of most-favoured-nation assurance on a one-way (rather than a mutual) basis was in the Turkish capitulations, which began with respect to France in 1535. Mutually operating clauses embodying the same standard were in the treaty of 1641 (of truce, as well as commerce and navigation) between the

Netherlands and Portugal and in Oliver Cromwell's treaty of peace (1654) with Sweden. Lending itself to use either in broad terms applicable to various subject matters, or in terms that are quite specific as to what is covered, the most-favoured-nation idea has sometimes been mentioned many times in a single treaty. Application may be limited to what is accorded to named third states. Thus Spain agreed, in a treaty of peace signed with France in 1659, that French subjects should have the same liberties that Spain had granted to the English; in 1661 Denmark agreed with the English (in a treaty of alliance) that the latter should not pay more or greater customs charges than people of the United Provinces or any other foreigners paid, Swedes alone being excepted. By a treaty of commerce in 1703 Portugal agreed to remove prohibitions upon the importation of English woolens, and England to permit importation of Portuguese wines on payment of one-third less duty than was charged on French wines. The latter concession led to difficulties for the English with the Portuguese when, in connection with the peace of Utrecht (1713), it was proposed to accord most-favoured-nation treatment to products of like nature from any other country in Europe.

The United States made its first commercial treaty in 1778, with France, in connection with the treaty of alliance which the parties signed on the same day. In this treaty the most-favoured-nation pledge was on a conditional basis, in that "any particular favour . . . in respect of commerce and navigation" which either party should grant to a third state was to be granted to the other party "freely, if the concession was freely made, or on allowing the same compensation, if the concession was conditional." Evidence seems to indicate that this conditional formula was proposed by the French. In any case, the conditional form of the commercial most-favoured-nation concept continued to be a feature of United States commercial policy until 1923, when the country changed to the unconditional form. The conditional form leaves possible the withholding of a tariff concession (from a country with which there is a most-favoured-nation pledge) on the ground that the country to which the concession is made has given something in return for it. Difficulties in determining whether concessions have been gratuitous, when a state claiming them has in fact offered "the same or equivalent" concessions, and what considerations of propinquity or close political relationship might enter into findings of conditionality, may make the applicability of tariffs at a given time uncertain.

There was no common pattern of commercial policy in Europe prior to the middle of the 19th century. There was effort by France, beginning in 1786, to accomplish tariff reforms, but the wars of the French Revolutionary period interrupted this effort. Prohibitions and differential tariffs featured international commercial relations during the first half of the 19th century.

Developments From 1860 to 1914.—The making of the Anglo-French (Cobden-Chevalier) treaty of 1860 marked the beginning of a new era in western commercial policy. There was provision for most-favoured-nation treatment with respect to import duties; Great Britain eliminated protective tariffs, and France granted to British products rates lower than those which the French general tariff imposed. Soon France came to have most-favoured-nation relations with various other countries. One of these was Germany, with which France agreed that each of the parties would allow the other the benefit of tariff reductions granted to Great Britain. Before the end of the century, however, the French government negotiated (after 1892) a series of commercial treaties in which it agreed to accord minimum tariff rates to countries which granted satisfactory rates to France. Tariff bargaining went on in a protective atmosphere.

In the period from 1892 to 1894 Germany made what were called the Caprivi treaties, securing reductions of foreign tariffs on German goods on condition of Germany's not applying the highest rates of its general tariff. States which did not follow the lead of France and Germany in this field were Great Britain, Belgium, Denmark and the Netherlands. Having no tariffs on some products and low rates on others, they were not in position to bargain and sought most-favoured-nation treatment for their exports. The United States, despite its already-noted adherence to the principle of conditionality, and despite some special arrangements such as those with Canada (1854–66), Hawaii (after 1875) and Cuba (after 1903), followed, in general, a policy of not discriminating against foreign goods because of their national origin.

The growing network of commercial treaties helped toward bringing about a situation in which a large part of the world's trade, in the half century before 1914, was on a basis of unconditional most-favoured-nation treatment. The principle applied for a time under the British flag to intra-empire trade, and non-British goods entered the British colonial empire on the same terms as goods from other British lands. Adoption by Canada in 1898 of an imperial preference plan led, however, to Great Britain's termination of its existing treaties with Belgium and Germany, respectively. The replacing treaties did not require the British dominions to admit non-British goods at the same (preferential) rates which might apply to British goods.

In this period was discernible also a tendency toward highly elaborate classifications in tariffs, sometimes with the object of favouring particular countries over others. A frequently cited example of this was Germany's designating (in its customs tariff, and in connection with its treaty of 1905 with Switzerland) large dappled mountain cattle or brown cattle "reared at a spot at least 300 metres above sea level, and which have at least one month's grazing each year at a spot at least 800 metres above sea level." Such classifications might facilitate denial of a favourable rate to states desiring to secure it on the basis of a most-favoured-nation pledge in terms of "like" products.

Particularly through their establishment provisions, commercial treaties provided elements of law to supplement the rules of the developing law of nations. The latter imposed upon states no obligation to admit either products or migrants from other states. Once a state had admitted aliens, there was legal responsibility for their protection. Customary international law in the 19th century did not, however, preclude a state's subjecting admitted aliens to discriminations of various kinds. Commercial treaties were able to fill the gap to a considerable extent through national-treatment and most-favoured-nation treatment clauses. Employment, in the 19th century, of certain "stock" clauses had the effect of providing in a measure, as suggested by Arthur Nussbaum in *A Concise History of the Law of Nations* (Macmillan, 1947), "a substitute for norms of . . . international law."

Treaties of this type also figured in a limited way in the development of thought concerning the peaceful settlement of international disputes. Two groups of commercial treaties signed in the 1860s contained clauses whereby the parties agreed to arbitrate disputes between them. The first group included treaties which Hawaii made with Belgium, Switzerland and Italy, respectively; the provisions on arbitration covered all disputes which might arise between the parties. The second group comprised commercial treaties which Siam concluded with Belgium, Italy, Norway, Sweden and Austria-Hungary, respectively; in each case the arbitration clause covered only disputes concerning the interpretation and application of the particular treaty.

In the last half of the 19th century and the early years of the 20th there were some commercial treaties with clauses which were of one-way application. This was notably true of some arrangements between certain western states on the one hand and, on the other, countries in which these western states obtained extraterritorial privileges for their nationals. In general, however, the principle of mutuality (the rule of two-way application) has characterized this type of treaty.

Developments of the Interwar Period, 1920–1939.—While world conditions from 1914 to the end of World War I were not very propitious for the making of commercial treaties, the years which followed saw renewed effort in this direction. All states were not equally vigorous in promoting nondiscrimination in tariff matters. France, for example, which had in 1918 announced its intention to terminate all of its commercial treaties, did in fact allow many of its old treaties to remain in force, but in new treaties agreed to the application of the most-favoured-nation principle only to particular groups of articles. Other European states evinced reluctance, after 1920, to extend most-favoured-

nation treatment. The United States, in 12 commercial treaties signed during the period between World Wars I and II, the first of which was with Germany in 1923, emphasized its change from the conditional to the unconditional form of most-favoured-nation commitments. In furtherance of its new policy the United States government also announced that it would not request Brazil to extend for a longer time the preferential rate which that country had for some years given to a small number of products from the United States. Under authorizing legislation of 1934, the United States began to conclude reciprocal trade agreements. These contained tariff schedules and pledges of most-favoured-nation treatment, but with exceptions for preferential rates which the United States accorded to Cuban products.

Some preferential practice also featured British commercial policy. The Ottawa agreements of 1932 dealt largely with imperial trade preferences in the form of tariff rates, but included some quota arrangements. In 1933 Great Britain concluded with Argentina the so-called Roca-Runciman agreement, which related to tariff rates and also to British quotas, as well as to the administration of Argentina's exchange control in such a way as to favour British commerce. Other British commercial arrangements of this same period, particularly with countries of northern Europe, resulted in special treatment of British trade, and were in contrast to some earlier emphasis upon nondiscriminatory treatment of foreign goods in general.

In the period between World Wars I and II the making of commercial treaties was affected by resort to new methods of trading and the introduction of new techniques in state control of trade, as well as new types of restrictions upon economic activities of resident foreigners. Whereas previously the problem had been largely that of securing equal tariff treatment of trade that was largely in private hands, there came to be questions of how to achieve nondiscriminatory treatment when governments themselves engaged in commerce on a considerable scale. The Soviet Union, in commercial treaties of the period with such countries as Germany and Italy, sought to provide for the operations abroad of its trading delegations. With the economic collapse of 1931, new forms of economic nationalism worked against traditional liberal concepts of international trade. Along with state trading, there were quota restrictions upon imports, and monetary regulations. In the 1930s quota or exchange restrictions, or a combination of these, largely replaced tariffs as effective controls in France, in eastern and southern Europe and in South America. New type provisions against discrimination came into use both in commercial treaties and in trade agreements.

There was also development and expansion of provisions on certain establishment matters. There was, in commercial treaties of the United States, for example, extensive use of the national-treatment standard. In some instances rights given to aliens to engage in listed types of work applied even to practice of the professions, and there were treaty pledges for extending benefits of workman's compensation laws to treaty aliens on a national-treatment basis. In the matter of companies' rights, commercial treaties which the United States signed provided for each party state's recognizing the juridical personality of companies organized under the laws of the other party, and made a beginning of allowing aliens to organize local companies (on a most-favoured-nation basis); but the actual functioning of foreign corporations in the territory of each party state was left within the control of that state.

The Post-World-War-II Period.—Of the principal commercial countries of the world, the United States was in by far the best position, after the cessation of hostilities in 1945, to advocate liberal principles in commercial policy. Obstacles to the restoration of world trade included the practices which various countries followed in discriminatory use of exchange controls, quantitative restrictions on imports, and the carrying on of commercial activities by governments themselves. The United States, which had made no use of exchange control and very limited use of import quotas, took the initiative in efforts looking to a new multilateral arrangement on trade, as well as in the conclusion of new bilateral treaties. The latter were in terms consistent with the multilateral approach to international trade while also putting into practice some new establishment provisions designed to provide more adequate security for investors (as well as traders) and for nationals of one party state residing in the other party state.

Effort for a multilateral agreement took the form of a project for an international trade organization, the actual formulation of the scheme being undertaken through conferences held under auspices of the economic and social council of the United Nations. Fifty-four states signed the charter of the International Trade organization, an instrument designed to cover the whole field of international trade but not to fix or bind tariff rates, the latter activity being left for handling in separate negotiations. As finally elaborated at Havana, the charter contained not only provisions on commercial policy, but also chapters on such other matters as employment and economic activities, economic development and reconstruction, restrictive business practices, and intergovernmental commodity agreements. While the charter as such did not come into force, most of its provisions on commercial policy did become operative through the General Agreement on Tariffs and Trade (G.A.T.T.) which 23 states negotiated in 1947 (*see* TARIFF). The agreement came into force provisionally in 1948; by the early 1960s 38 states were contracting parties and several others participated under special arrangements. Under the agreement, and through a series of conferences, pairs of states negotiated reductions in tariff rates. The failure of the states to bring the International Trade organization into existence left an institutional gap which occasioned further effort. In 1954 a plan was projected looking to an Organization for Trade Cooperation, the essential purpose of which would be to administer the General Agreement on Tariffs and Trade.

Less spectacular, and more easily relatable to well-known methods in international economic relations, was the program which the United States launched for the making of new bilateral commercial treaties. Since the United States appeared to be the only major state undertaking such a program on a wide geographical basis, provisions of these treaties represented U.S. policy rather than a universal trend; at the same time the treaties presented some new formulas for correlating international pledges with national policy and integrating bilateral with multilateral engagements.

From the broad provisions on nondiscriminatory treatment of exports and imports, there were exceptions clauses to cover the long-standing preferences which the United States had given to Cuban products and also preferences to Philippine products during the period of United States wardship which began in 1946. Exceptions provisions also related the new bilateral instruments to existing multilateral engagements. For example, commitments under the commercial treaties were not to preclude action (on the part of a signatory which was a party to G.A.T.T.) that was required or specifically permitted under the General Agreement. In the field of exchange control, there were provisions in the commercial treaties designed to secure nondiscriminatory treatment, but by special wording these were not to alter the parties' obligations to the International Monetary fund; nor did the bilateral engagements preclude the imposition of particular restrictions when the fund should authorize or request a party state to make such restrictions.

In the establishment parts of the new commercial treaties there were both innovations and adaptations of long-used rules. Of the former, perhaps most conspicuous were those providing for rights of companies. These went further than had provisions in earlier treaties requiring the recognition of juridical personality, for, with considerable variation, they permitted companies organized in one party state to engage in broadly listed types of activities in the other; the standard agreed to was, in general, national and most-favoured-nation treatment, but with reservation (to parties) of the right to limit the extent to which aliens might engage in transport, communication, public utilities, certain types of banking or the exploitation of natural resources. Other provisions allowed nationals and companies of one party state to organize or acquire interests in companies of the other party state. A permissive reservation allowed a party to withhold benefits under the bilateral treaties from companies of the other party which were owned or

controlled by nationals or companies of third states; most of the treaties made it clear that such withholding would not apply to the basic rights of having juridical personality recognized, or having access to courts.

Protection of property from uncompensated taking for public use had long been an object of commercial treaties. Treaties of the United States after 1945 went further than most of the country's earlier treaties had gone with respect to aliens' acquisition of property. Whereas, for example, the pattern employed in the German-American treaty of 1923 had contained broad provisions on the leasing of land for treaty-permitted purposes, the new treaties made some application of the national-treatment standard for the acquisition of land, with some regard for the principle of reciprocity. Legal and policy questions arose, particularly in the case of federally organized states. Such property as could be acquired by treaty aliens was, in any case, the subject of rather specific protection provisions; for that which was taken by a party state for public purpose, there was to be prompt payment of just compensation, and the latter was to be in an effectively realizable form.

In many of the treaties there were provisions for national and most-favoured-nation treatment in the matter of selecting enterprises for government control or for nationalization. Government agencies engaging in business activities within the other party's territory were not to claim jurisdictional immunities therein and there were other clauses designed (within limits) to protect private business enterprises from the destructive effect of government-subsidized competition.

In the realm of human rights, there were in most of the new treaties provisions on liberty of conscience and freedom of worship. With some signatories the United States agreed to certain limits upon the drafting of treaty aliens for compulsory military service. Most of the treaties contained clauses on freedom of reporting, a subject which had not been covered in earlier treaties of the United States.

Security considerations also figured in the making of the treaties, which by their terms were not to preclude measures "necessary to fulfill the obligations of a party for the maintenance or restoration of international peace and security" or necessary to protect national security interests. In each treaty there was provision whereby disputes over its interpretation or application could, unless the parties should arrange them by other pacific procedures, be referred to the International Court of Justice.

During the 1950s and early 1960s numerous efforts were made to reduce or eliminate trade barriers among the nations of various geographic areas. A most important commercial treaty, for example, was signed in 1957 (became effective Jan. 1, 1958) by six European nations to establish the European Economic Community (E.E.C.), popularly known as the Common Market. In 1960 a similar organization known as the European Free Trade Association (E.F.T.A.) was formed by a treaty signed by seven European countries that were not at that time members of the Common Market group. In the same year a treaty was signed by seven of the leading trading nations of Latin America looking toward eventual establishment of a free trade zone. Another similar association was entered into by three small Central American states, Guatemala, Honduras and El Salvador. *See* also ECONOMIC UNION: PAN-EUROPEAN MOVEMENT.

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(C. M. K.; F. W. F.; R. R. WN.)

COMMISSARY, a person to whom special authority or a special duty has been committed or delegated. An ecclesiastical commissary, for instance, is an official who in certain circumstances exercises the jurisdiction of a bishop (if appointed by the pope he is called a commissary apostolic). In English military contexts commissariat means the supply of food, transport, etc., to an army, the official responsible being formerly known as the commissary; the U.S. equivalent is logistics (*q.v.*), the term commissary being confined to a type of canteen (*q.v.*) selling foodstuffs. In continental armies in the 17th and 18th centuries "war commissaries" had extensive powers of surveillance, on their government's behalf, over the conduct of officers and troops and over an army's expenditure. In the U.S.S.R. the designation people's commissar (Russ. *narodny komissar*) was used for the head of a government department till March 1946, when the people's commissariats were reorganized as ministries.

COMMISSION is the term used to describe a multiheaded governmental agency created to perform a particular function, such as special investigation or governmental regulation of business. In Great Britain the term is most commonly used to designate commissions of inquiry, which investigate particular matters; such commissions are distinguished, according to their terms of appointment, as royal, statutory or departmental. Investigating commissions have been less frequently employed in the United States, where their functions are largely performed by legislative committees. Most commissions in the United States, on the other hand, are charged with the execution or enforcement of statutes. The most important commissions are vested with regulatory powers. They control different aspects of the economy, having either regulatory authority over an industry (*e.g.*, the Interstate Commerce commission over railroads) or over particular practices throughout the economy (*e.g.*, the Federal Trade commission over unfair trade practices).

The first U.S. regulatory commissions were set up in the states to regulate railroads. The federal government followed their example with the creation of the Interstate Commerce commission in 1887 and later with other federal commissions set up to exercise government control. While the name commission is commonest among such agencies, it is by no means universal; some of the most significant regulatory powers are exercised by the Civil Aeronautics board, the federal reserve board and the National Labor Relations board.

United States.—The most important federal regulatory commissions (and boards) regulate land, water and air transportation, electric and gas companies, wire and wireless communications, banking, investment markets and trade and labour practices. They range in size from 5 to 11 members. They are appointed by the president (subject to senate confirmation) and serve for staggered terms of from 5 to 14 years. Commissioners are given substantial security of tenure, since they cannot be removed from office except for cause (*i.e.*, "inefficiency, neglect of duty, or malfeasance in office"). In most commissions, the law provides for bipartisanship by requiring that not more than a majority may be from the same party.

The relationship of the commissions to the president poses many problems. Because the commissions are vested with quasi-legislative and quasi-judicial as well as executive functions, it is deemed undesirable for these agencies to be placed within the executive branch. Instead, they are set up as independent bodies, not subject to the direction or unrestricted removal power of the president. But this, in turn, places difficulties in the way of effective co-ordination of over-all executive policy. In the words of the 1937 report of the President's Committee on Administrative Management, the commissions constitute a "headless fourth branch."

The need for effective co-ordination has led to important presidential controls. The commissions' budgets must be channeled through the bureau of the budget in the executive office of the president, which controls the appropriations that the commissions may request. In addition, the commissions must clear their legislative and investigative demands with the budget bureau. The president can designate the chairmen of all the regulatory commissions except the Interstate Commerce commission. The chairmen may be removed from their chairmanships at the president's

pleasure. Under 1950 reorganization plans, the presidentially controlled chairmen were, in most of the commissions, made the administrative heads, with control over personnel and the day-to-day work of the agencies.

Besides the regulatory commissions, there are other federal multiheaded agencies that regulate internal government operations (*e.g.*, the Civil Service commission), dispense benefits (*e.g.*, the Railroad Retirement board) and engage in operating activities (*e.g.*, the Atomic Energy commission). There are also government corporations (*e.g.*, the Tennessee Valley authority) that are plural-headed, though with a different legal status than ordinary commissions.

The commission form is used in such state agencies as utility commissions, workmen's compensation boards, boards of health and education and unemployment compensation commissions. In local government (they appear principally in the fields of health and education. *See* also ADMINISTRATIVE LAW; REGULATORY AGENCIES. For the commission form of local government, *see* CITY GOVERNMENT.

See Robert E. Cushman, *The Independent Regulatory Commissions* (1941); U.S. Commission on Organization of the Executive Branch of the Government, *Task Force Report on Regulatory Commissions* (1949); President's Committee on Administrative Management *Report* (1937); Marver H. Bernstein, *Regulating Business by Independent Commission* (1955); Bernard Schwartz, *The Professor and the Commissions* (1959). (B. SZ.)

Great Britain.—In Great Britain the term commission may refer to a financial, executive or quasi-judicial body or to a committee of inquiry, especially a royal commission. In general it designates a body appointed for a particular purpose, or for the carrying out of administrative functions consequent upon legislation that can only be given effect through an administrative organ. A commission is appointed when it is desired that administration shall be independent of the government department concerned. Another purpose in appointing a commission is to ensure objectivity; therefore this type of body is favoured where financial claims are involved. Commissions appointed for financial work include the Charity commission, the Title Redemption commission and the War Damage commission. Others, appointed for nonfinancial purposes, include the forestry, prison and national park commissions. The name can also be given to a public corporation administering a nationalized industry, for example, the British Transport commission.

The instrument establishing the commission may also lay down the manner of its appointment. When nonpolitical, it may be appointed by the crown; when judicial, by the lord chancellor; when nondepartmental, by the prime minister; and when departmental, by a minister. Funds are likely to be on the departmental vote concerned. Members of a commission are not generally known as commissioners; this term is usually restricted to those appointed to undertake semijudicial functions. The traffic commissioners, for example, are appointed by the minister of transport to administer the vehicle licensing systems, but are not subject to his direction.

See J. A. G. Griffith and H. Street, *Principles of Administrative Law* (1952); Committee on Administrative Tribunals and Inquiries, *Report* (1957). (E. A. J. D.)

COMMISSIONER. In English-speaking countries, the term commissioner is often used to designate a member of a multiheaded governmental body created to perform a particular function, such as special investigations (commissions of inquiry) and personnel management (civil service commissions).

The term commissioner appeared at the end of the 15th century in reference to officials charged by royal commission or warrant with specified duties. Under the Statute of Sewers (23 Henry VIII, c. 5) commissioners were appointed to make regulations and levy assessments. In the 16th century the crown named commissioners to hear and determine controversies affecting private rights. In 1643 the administration of excise laws was vested in commissioners authorized to punish violations. The use of commissioners rather than judges to enforce excise laws was opposed strongly. In the 19th century the phrase "government by commission" was used to criticize the determination of private rights by officials acting in a nonjudicial manner and without common-law safeguards for property rights. J. Toulmin Smith (*Government by Commissions Illegal and Pernicious*, 1849) referred to commissions as "the chosen instruments of schemers and of the enemies of public liberty."

In some British possessions the head of government is called high commissioner. Under the Commissioner for Oaths act, 1889 (as amended), the lord chancellor appoints commissioners to administer oaths to persons making affidavits. The high court may order a witness to be examined on oath by an officer of the court or a commissioner in lieu of attendance in court.

In United States usage the term refers mainly to officials serving on state and federal administrative boards that regulate business conduct. The first state commissioners served on commissions established in Rhode Island in 1836 and in New Hampshire in 1844 to regulate railroads. The first federal regulatory commissioners served on the Interstate Commerce commission beginning in 1887. In states, regulatory duties are sometimes vested also in single commissioners, such as a commissioner of banking and insurance. In the federal departments of the treasury, justice, the interior, commerce, labour and health, education and welfare, some major component agencies are headed by commissioners. The title is also conferred upon certain judicial officers, such as the inferior federal officers known as United States commissioners and members of temporary state supreme court commissions. Executive officials comprising the governing bodies of some U.S. counties and commission-type municipalities are also called commissioners. *See* also COMMISSION; REGULATORY AGENCIES. (M. H. B.)

COMMODIANUS, an important Christian Latin poet, probably of African origin (Palestine and Gaul are also suggested), is likely to have flourished in the middle of the 3rd century (the 4th and 5th century also find support). He was apparently a convert to Christianity: the last poem of his *Instructiones* gives the acrostic signature (in reverse order) *Commodianus mendicus Christi*, and this description together with the epithet *Gazaeus* occurring in the poem's title may point to tenure of a curatorship of a fund of offerings (though the word *Gazaeus* has been used to suggest that Commodian came from Gaza in Palestine). No evidence supports the fragmentary testimony of the Middlehill manuscript of the *Carmen apologeticum* that he was a bishop. In the *Carmen apologeticum* he expounds Christian doctrine, dealing with the Creation, God's revelation of himself to man, Antichrist and the end of the world; in his other work, *Instructiones*, comprising 80 poems in two books, all (except two abecedarian poems) acrostic in form, he attacks pagan deities, criticizes Jews and admonishes Christians. The absence of poetic quality from Commodian's verse may be due either to didactic zeal or to realization of the unlettered nature of his audience. His idiom is that of vulgar Latin; his metre, though based on the quantitative hexameter, frequently neglects quantity and no underlying principle has been established for his verse; the view that it is based on word-accent is untenable, and though there is some monosyllabic rhyme his verse less resembles rhythmical verse than the metrical inscriptions preserved from Africa (this resemblance is the strongest evidence for Commodian's African origin). Whether these important peculiarities of language and versification result from Commodian's ignorance or are intentional and attributable to his desire to facilitate communication with his audience (a view supported by his recognition of the mnemonic value of the acrostic form) cannot be determined.

See edition by J. Martin, *Corpus Christianorum, series Latina*, vol. 128 (1960). *See* also M. Simonetti, "Sulla cronologia di Commodiano," *Aevum*, vol. xxvii, pp. 227–239 (1953). (D. R. BR.)

COMMODITY MARKET. A commodity market deals with the transfer of goods from producers to processors, manufacturers or ultimate consumers. Its main function is the determination of prices and the exchange of title. The term commodity usually refers to a special class of goods encompassed in the term "foodstuffs and raw materials." Wheat, corn or maize, rice, tea, coffee, sugar, rubber, tobacco, tin, lead, zinc and copper are examples of commodities.

A commodity market may be defined in a physical sense and in a functional sense. Physically, it is a specific area where buyers and sellers meet to transact business. This may be a building, a group of offices, a small town or even an assembly of huts where buyers and sellers meet. From the functional point of view a market represents the operation of economic forces, usually referred to as demand and supply, which result in the determination of prices. In this sense the market is the community of buyers and sellers and, with the aid of the telephone and telegraph, may encompass the whole world. Commodity markets are of two main types: spot or physical markets where actual goods are traded, and futures markets where trading is in contracts for future delivery.

The Evolution of Commodity Markets.—Wherever the division of labour and the specialization of processes take place the need for exchange arises. Because of the high cost of transportation the ancient markets were mainly local. Most of the staple commodities required for everyday use were produced in the immediate vicinity; only precious metals and high-priced luxury goods such as jewelry, silks and spices could afford the high charges involved in trade over long distances. By the time that the Greek and Roman empires flourished, commerce had advanced to the point where foodstuffs and other raw materials were traded in volume on an interregional basis. (*See* COMMERCE, HISTORY OF.)

The medieval market place was a direct descendant of the Greek agora and the Roman forum. Interregional trade throughout western Europe was carried on through the medium of fairs. The Champagne fairs, in what is now France, and similar fairs in other regions had their heyday in the 13th and 14th centuries. Merchants from all over Europe met to exchange the raw materials or finished goods of western Europe, the Mediterranean and the east. Lesser regional fairs supplemented the international fairs. Regional and local fairs traded in local produce to a greater extent.

Expansion of European trade warranted the establishment of more permanent markets by the 15th century. Merchants and trading companies gradually set up branch houses. Trading centres called bourses or exchanges were at first general market places dealing in all types of commodities. Later, some of these markets and branch houses specialized in particular commodities.

Improvements in transportation and communications resulted in an expansion of the network of world trade in early modern times. Luxuries were replaced by the cheaper staples. Commodities such as sugar, tea, coffee and cocoa were imported in greater volume from tropical areas and the grain markets widened to encompass all of Europe and later the whole world.

Throughout the 19th century and well into the 20th century the network of world trade in commodities developed largely through the initiative of private enterprise working within the framework of free-trade principles. The incidence of two world wars and the depression of the 1930s, however, created conditions in which free markets could not function properly; surpluses and wide fluctuations in prices occurred. As a result of these factors, plus the growth of state intervention in the economic sphere, few commodity markets in the world remained free from government regulation.

Physical Markets and Marketing Agencies.—The movement of agricultural commodities is generally from a large number of producers to many small primary markets. Supply is further concentrated by shipment to central markets where the commodity is sold to processing organizations or to wholesalers, supermarkets and retailers. In the case of ores and metals the initial process of assembly is not as widespread because the ore is usually shipped directly from the mine to the smelter or the fabricating plant.

Commodity markets are linked through the buying and selling activities of the various marketing agencies. Offers to sell and bids to buy are sent by telephone or telegraph from the local to the central markets and vice versa. Prices tend toward equality in each market, subject to differences in transportation costs. Spot or present prices differ from futures prices because of the costs of storage, insurance and financing and because of shifts in the outlook for supply and demand.

The centre of commodity trade consists of the mercantile houses, brokers and agents located at the central markets. The nucleus is usually the building that houses the exchange or trade association. These associations promote orderly trading by formulating rules, establishing standard contracts and arbitrating disputes.

Many different grades or qualities of a commodity are available for sale at terminal markets. The buyer is usually able to acquire the exact type and grade of the commodity he wishes from the huge volume stored there or at nearby points. The majority of the purchasers at such markets are the large consumers, such as spinners for cotton and wool, packing houses for livestock and millers for wheat. In export markets, brokers or other agents of foreign importers are also important buyers.

In former days trading on the physical market took place in actual sight of the goods because of the primitive nature of the marketing services and the lack of recognized standards of quality and systems of grading. Goods are now sold on description by grade, with arbitration facilities available in case of dispute. Contracts on various markets are standardized and each trader knows the terms on which he is dealing. The goods need not be on hand at the market but may be in transit or stored in a warehouse. There is also little need for buyers and sellers to meet in person. Quotations are known to prospective buyers who may submit bids by telegraph, telephone or mail without actually seeing the goods. Payment is by check and title passes with the transfer of a warehouse receipt or bill of lading. The concept of a market as a place where the actual transfer of commodities takes place, therefore, is nonexistent in the case of many commodities, particularly after the assembly stage at country markets is passed.

In the country markets the local dealer is usually the principal buying agent and the producer is the seller. The dealer buys, usually for cash, at the local market or he may visit each farm individually and conduct his purchasing operations there. Among the other marketing agencies that operate on the numerous local markets are co-operatives, representatives of processors, large merchant traders, storekeepers and moneylenders.

On central markets a variety of market agents are also at work. A producer who wishes to bypass local markets may consign his goods to a commission agent on the central market. Local dealers sell to processors or large merchant firms on the central market. Large co-operatives have their sales offices there and large producers sell through an agent. Foreign importers and processing houses also have representatives in large export markets who will purchase from local merchant firms or they may even extend their organizational lines back to the producer. Jobbing firms on central markets purchase in large quantities and then break them up into smaller quantities for sale to small purchasers.

Where the marketing agent purchases the commodity outright and takes title to it his remuneration is in the form of profit or markup on the selling price of the goods over his purchase price. The country dealer, wholesale merchants, processors and retailers all are remunerated in this manner. Other marketing agencies may have possession of goods but they do not have legal title. A broker and a commission house are examples of independent agents who perform marketing services for their principals, who retain title to the goods. Their remuneration is obtained in the form of a fee or commission.

Commodity Exchanges.—The function of a commodity exchange or futures market is different from that of a commodity market. The latter is concerned with trading in a specific quantity and grade of a commodity for present or forward delivery; the former is concerned with the purchase and sale of an enforceable contract to deliver a commodity at some future date. The seller of a contract on a commodity exchange does not normally intend to deliver the actual commodity nor does the buyer intend to accept delivery; each will, at some time prior to the date of delivery specified in the contract, cancel out his obligation by an offsetting purchase or sale.

The reason for this behaviour is clear enough. The parties do not wish to enter into the physical operations of marketing but to engage in one of its aspects, namely the assumption or delegation of the risk involved in a change in price. A businessman normally earns his income through the performance of some service such

as assembling a commodity, storage, delivery to a consuming area, fabrication, etc. He usually has insufficient capital to assume the risk of loss through a change in price while he has title to the goods. To avoid this risk he has recourse to the futures exchange, where he can pass on the risk of price change to someone else. The method by which this may be done is easily understood. A middleman who buys a commodity may sell at the same time a futures contract for an equivalent amount, *i.e.*, he assumes an obligation to deliver at a future date. Sometime later he sells his holdings of the commodity; simultaneously he purchases a futures contract and thus cancels out his obligation on the futures exchange. In the interim between the purchase and sale of the actual commodity its price may have fallen. Normally the price of the futures contract will also fall. He would lose money on the physical transaction but would make a profit on the futures transaction because he would be able to buy back his futures obligation to deliver at a lower price than he sold it. Had the price of the commodity risen, he would have profited on the physical transaction and lost on the futures transaction.

A similar transaction may occur when a processor contracts to sell a certain quantity of a manufactured product at a specified price for future delivery. When the time of manufacture arrives he must buy specified amounts of raw materials. To protect himself against a rise in the price of the raw materials in the interim, as compared with the price prevailing when he contracted to deliver the manufactured goods, he purchases a futures contract which he will close out with a sale when he buys the physical raw materials sometime later.

Such transactions on the futures exchange are made possible through the presence of speculators. Their operations on both sides of the market result in a greater volume of transactions than the actual volume of physical transactions. This makes for a more continuous market. The speculators are constantly on the alert for abnormal spreads between different futures exchanges as, for instance, at New York city and London, or between different delivery months on the same exchange.

Futures exchanges are thus ancillary to commodity markets. They do not compete with or supersede the spot or physical markets but rather complement them by performing functions which the latter cannot. They provide insurance against the risk of price changes and also provide a basis for the determination of prices at which commodities are actually traded.

Exchanges are incorporated as nonprofit organizations. Membership is by election and the purchase of a "seat." Members are privileged to trade on the exchange for their own account or for the account of their clients subject to the rules of the exchange. Trading is in terms of a unit of a standard contract. For instance, on the New York Coffee and Sugar exchange there are two coffee contracts: a B contract for 32,500 lb. of Brazilian coffee and an M contract for 37,500 lb. of mild coffees, each of a designated basic grade.

The settlement of contracts made between members of an exchange is effected through clearing associations affiliated with each commodity exchange. At the end of each trading day, every member's net market position is determined. Thereafter the clearing house assumes the responsibility for all accepted contracts and guarantees performance.

Futures contracts relate to a specific month, several of which are traded in at any one time. When the actual month of delivery arrives all outstanding contracts must be settled by delivery of the commodity. Any seller of a contract who has not closed out his position by choosing to make delivery may do so on any trading day he selects during the month in question. A transferable notice to this effect is forwarded by the seller to the clearing house for each contract outstanding. These notices are delivered by the clearing house to members who are net purchasers for that particular month. Each such purchaser, should he not elect to accept delivery, may sell a contract for that month and thus cancel out his net position and pass the notice on to the buyer of the contract after endorsement. This may occur throughout one business day until some purchaser decides to take delivery and "stop" the notice.

TYPES OF MARKETS

Grain Markets.—Before the depression of the 1930s most grain was handled on a free international market. In the Canadian system the farmer usually delivered his grain to the country elevator and sold it for cash or shipped it to a terminal market such as Winnipeg, Man., or Vancouver, B.C., for sale there by a commission house. The grain purchased by private companies was usually hedged on the Winnipeg futures market and sold to exporters at the ports. Large co-operatives played an important marketing role. In the United States grain was handled in a similar manner. Kansas City, Kan., and Minneapolis, Minn., were leading spot markets but most transactions, particularly on the futures market, took place in Chicago, the world's largest grain market. Shipment for export took place through Duluth, Minn., the Atlantic ports (particularly in winter) and the Gulf of Mexico ports.

Both Canadian and U.S. grain was sold on government grade and certification, usually in bulk. In Australia and Argentina the prewar trade was in bags and sale was by a standard of "fair average quality." Australian wheat was sold on description by the state in which grown or, if without description, as "all ports." In Argentina standards were established for three districts: "Rosafe" for wheat grown near to and shipped from the ports of Rosario and Santa Fe, "Baril" for the types grown near Buenos Aires and "Barusso" for wheat grown around Bahia Blanca.

The leading import market was the United Kingdom, with London and Liverpool as its centres. The grain for these markets was usually purchased on a free on board (f.o.b.) port-of-shipment basis and sold at a price that included cost, insurance and freight (c.i.f.). The trade was handled under traditional and standardized forms of contract developed by the Corn Trade association. In addition, there were facilities for trading in futures which, in London, were located in the Baltic Mercantile and Shipping exchange and controlled by the London Grain Futures Association, Ltd.

In the 1930s marketing boards and other agencies were established to handle the mounting surplus problem. During World War II and in the immediate postwar period international allocation of exports was adopted. This was followed by the revival of the International Wheat agreement as a means of guaranteeing markets for exporting countries and supplies for importing countries within a certain price range.

The marketing of wheat and some coarse grains in exporting countries came to be largely controlled by governments. In the United States the prices were maintained at a relatively high level through the granting by the Commodity Credit corporation of "non-recourse" loans, with stored grain as collateral, and by direct purchases. The level of price support was established annually under the authority of the Agricultural Adjustment act according to a formula based on the prices of goods farmers buy. Participating producers in the marketing agreement were assigned acreage quotas or allotments. The acreage reserve program of the soil bank also provided compensation for farmers who reduced their acreage below the allotment level. By these means acreage was curtailed, excess production was held off the market and domestic prices were maintained above international levels. Sales abroad, therefore, could be made only if subsidies were granted. Surplus grains were also exported under various aid programs which provided supplies to importers with payment in local currencies or, in some cases, free of charge.

In Canada the internal marketing of most grains was placed under the control of the Canadian Wheat board but the selling function at the terminal market was in private hands except for intergovernmental contracts. Also, internal handling, storage and shipment functions were carried out by the trade acting as agents of the board. Wheat, barley and oats were placed in annual pools in which producers shared the profits. No rigid production controls were maintained but a delivery quota system was based on each producer's certified acreage. There was no futures market for wheat but the board established daily selling prices, in line with competitive world prices, and permitted a deferred pricing policy on export sales whereby the purchaser had the opinion over a cer-

tain period of time to close the sale at the price on the day of purchase or on any subsequent day.

In Australia all wheat was marketed through the Australian Wheat board on a pool basis. Most barley was sold through state marketing boards, also on a pool basis. The marketing of oats and maize was largely in the hands of private traders.

In Argentina prior to 1946 local grain marketing functions were performed by merchant brokers and the large export houses. During the ten-year period of control by the I.A.P.I. (Instituto Argentino para Promoción del Intercambio) it was handled by producer cooperatives and all grain marketing was controlled by the I.A.P.I. Grain exchanges and future markets were closed down. The National Grain board assumed control over internal grain marketing. This board, the sole purchaser of wheat at fixed prices, sold to the trade for export. The board also stood ready to purchase coarse grains at guaranteed prices and such grains purchased by the trade could be exported only with the approval of the board. All export sales were under the "aforo" system which determined how much of the foreign exchange that an exporter received had to be exchanged for pesos at the relatively low official rate of exchange and how much could be exchanged at the relatively high free market rate of exchange. By varying the "aforo" the export price could be controlled. The board also sold wheat directly to foreign governments under bilateral agreements.

Rice production and consumption is largely restricted to the far east where 95% of the world's rice is produced. Most rice is consumed in or near the area of production so that the volume entering into international trade is small. The main far eastern exporting countries are Burma, Thailand, Vietnam and Cambodia. They supply low-quality grades for export to nearby countries. High-quality rice for the European market is supplied largely by non-Asiatic exporters such as the United States and Italy.

Unhusked rice or paddy is purchased in the villages at harvest time by millers' representatives, dealers, local moneylenders and merchants. It is usually shipped to the mills in small boats which ply the canals and streams in the deltas of the main producing areas. Most mills supplying the export trade are located at ports such as Rangoon, Bangkok and Cholon. Sale for export is usually made on the basis of examination by the buyer or his agent. There is no rice futures market or well-organized spot market.

After World War II there was a considerable degree of government market intervention. In Burma the State Agricultural Marketing board was given control of exports, a large proportion of which were sold on an intergovernmental contract basis. Paddy was purchased by the board from the producers at fixed prices and milled under contract. The board also purchased rice from the mills. The rice was sold at a price that yielded profit to the state. In Thailand a sizable export tax channeled a large sum of money into the state treasury. In importing countries also there was a considerable degree of control over both import and domestic markets.

Fibres Markets.—Many types of fibres enter into marketing channels but cotton and wool are the most important. The United States is the largest supplier of medium-staple cottons, which represent the bulk of the trade; it is followed by Mexico, Brazil and Pakistan. Egypt is the chief supplier of long-staple cotton. The main international markets are western Europe and Japan.

The chief U.S. physical markets for cotton are at Memphis, New Orleans, Dallas and Houston. Most Mexican cotton is concentrated and shipped through Brownsville, Tex. Important markets for other cottons are in Alexandria, Bombay, Karachi and São Paulo. Large markets in cotton-importing countries are in Liverpool, Le Havre, Bremen, Milan and Osaka. The most important futures markets are at New York, Chicago, New Orleans and Liverpool.

In the United States there are three principal types of cotton markets: local, central and mill markets. The cotton merchants operating on the central markets perform an important function in being able to supply a wide variety of cotton qualities to buyers on short notice. The mill markets are found mainly in New England and the southeastern states. Here are located the offices of the mill buyers and of the various sellers of cotton.

The United States market witnessed the entry of the government as the foremost buyer and seller of cotton through a price support program similar to that outlined above for grains. Domestic prices were maintained at levels higher than the international price. The export trade, therefore, was dependent upon government subsidies.

Liverpool spot and futures trade is concentrated at the Liverpool Cotton exchange. The city is also a mill market because spinners usually place their orders there. The cotton dealers include agents of foreign exporters operating on a commission basis, merchants or importers on their own account and mill buying brokers.

Wool production may be classified as carpet wool and apparel wool. The former is produced largely in Asia, New Zealand and South America; the world's exportable supply of apparel wool comes mainly from five countries: Australia, New Zealand, South Africa, Argentina and Uruguay. Apparel wool is classified into grades according to its fineness. The best and finest wools come from Merino sheep, medium types from crossbreeds of Merino and English breeds and coarse wools from non-Merino breeds. The chief import markets are Europe, the United States and Japan.

In Australia, as in New Zealand and South Africa, wool is sold at a series of auctions. The wool is clipped, classed and pressed into wool packs in the shearing shed. The bales are then shipped to brokers in the auction centres. The broker catalogues the wool he has to offer and displays representative bales on the show floor for examination by prospective buyers. Similar auctions are held in London, the main distributing centre for wool in Europe. In Argentina and Uruguay the wool is forwarded to brokers or commission agents in seaport towns and sold to foreign exporting firms or dealers.

Boston is the recognized central market for the apparel wool trade in the United States. Business is conducted in imported and domestic wools. The latter are usually sold shortly after shearing time to traveling buyers of Boston firms and manufacturers' agents, although some wool is sold under contract before shearing. Wool is also consigned by producers to Boston commission agents or growers' co-operatives.

There was little government intervention in world wool trade—apart from World War II—and the system of pricing permitted wool to be freely traded on international markets. Sharp changes in the demand for wool resulted in severe fluctuations in prices. U.S. wool producers were granted special aid in the form of a subsidy, which represented about 40% of the wool growers' returns but production continued to decline slowly.

Beverages.—The three most important beverage commodities are coffee, tea and cocoa. Coffee is produced largely in Brazil, Colombia, Central America (including Mexico), numerous countries in Africa and in Indonesia. The chief import markets are the United States and western Europe. Three types of coffee are principally produced: the high quality mild arabian types of Colombia, Central America and parts of Africa; Brazils, a generally soft arabica coffee of medium to low quality; and robusta, a low-quality coffee produced largely in Africa. Important export markets are Santos and Rio de Janeiro in Brazil and Medellín and Manizalez in Colombia; other markets of lesser importance exist in all exporting countries. The chief import centres are New York, Le Havre and Hamburg, although many other markets exist. Futures markets operate in New York, Santos, Rio de Janeiro, Le Havre and London. The two latter deal only in robusta coffee.

Uniform contracts for transactions in green coffee have been adopted by various trade associations such as the Green Coffee association of New York. In the United States a large proportion of the coffee is purchased on an f.o.b. basis although African coffees are usually traded on a c.i.f. basis.

Large U.S. roaster firms purchase and import about 60% of the coffee; the remainder represents imports by nonroaster importers and exporters' agents. In Europe the importer plays a much more important role because the roasters do not operate on such a large scale as in the United States. The U.S. importer-jobber buys coffee in foreign ports, usually through a branch office located there or through an agent, and sells it to roasters or other importers.

The exporters' agent sells coffee owned by a shipper in the exporting country to importer-jobbers and roasters. Trade is usually transacted on the basis of samples which are roasted, brewed and tasted by the purchasers prior to sale.

The world coffee market is subject to long production and price cycles which have been aggravated by government intervention measures. In the 1920s Brazil adopted permanent measures to "defend" its coffee market. Prices were maintained at artificially high levels by holding coffee off the market. This generated a coffee boom which produced vast surpluses and low prices during the 1930s. During World War II capacity was reduced and in the postwar years production was insufficient to meet the demand. The consequent price rise caused another boom in planting which again resulted in surpluses. Brazil, Colombia and 13 other Latin-American producers then attempted to restrict exports through a stockpiling program in order to slow down or halt the decline in prices.

World tea production includes green, oolong, brick and black teas. The latter is by far the most important in international trade. Black tea is produced mainly in India, Ceylon, Indonesia, Pakistan and Kenya; the United Kingdom is by far the largest consumer. Black tea production is largely a plantation industry. The tea companies are grouped into associations and usually have their head offices in Europe. They are well organized for concerted action in the furtherance of their interests. At the other end of the marketing chain, particularly in the United Kingdom, the market is dominated by a relatively few firms that blend, package and distribute tea.

Black tea sale is by auction. The three most important markets are London, Calcutta and Colombo. The London auctions held at Plantation House, Mincing Lane, are the most important. Tea is put up for auction by selling brokers who sample, catalogue and exhibit it. Purchasers at auctions are usually buying brokers who act for their clients. They estimate the value of the tea on the basis of the brew made from the samples. Buying brokers also purchase on their own account and resell to dealers and blenders.

Tea prices have fluctuated less than the prices of other commodities because of the control exercised over supply. In 1933 a voluntary International Tea agreement was formed by the tea associations of India, Ceylon and the Netherlands Indies (now Indonesia) in order to control the volume of tea placed on international markets. Export quotas were determined and administered by the International Tea committee in London. The agreement was extended for five-year periods into the postwar years but was then allowed to lapse.

World cocoa production is concentrated in west Africa and Brazil. Less important producing areas are in Ecuador and in the Caribbean. The import markets are largely located in Europe and North America. The most important cocoa markets are New York and London.

Before World War II cocoa marketing was in private hands. The market was dominated by large buyers and large processors. After the war government marketing boards in Ghana and Nigeria and the Cocoa Marketing department of the Bank of Brazil dominated the supply. A considerable proportion of sales was made directly to the manufacturers through private treaty. The manufacturers also utilized the services of brokers, some of whom bought on their own account for resale to small manufacturers. After the advent of the cocoa marketing boards in Ghana and Nigeria the assembly of cocoa in the producing areas of these countries was regulated. Buying prices were usually fixed for each season and the producer sold to licensed buying agents.

Sugar.—Sugar is produced in tropical countries from the sugar cane plant and in temperate zone countries from the sugar beet. As most importing countries produce either sugar beet or sugar cane, the industry is generally protected in the interests of domestic producers. In addition a number of protected areas known as "preference" markets exist. The two most important are the United States and the Commonwealth of Nations. Such preference markets account for about 60% of the sugar entering into world trade. Producers within these markets are normally allocated a quota of the consumption in the respective metropolitan markets where sugar prices are kept high. The remaining world supply moves at low prices on the "free" market, a term referring to those exporting and importing countries not directly affiliated with any political system.

The free market was in a more or less chronic state of overproduction during the first half of the 20th century, except for a few years following World War I and again after World War II. One reason for this was that in times of scarcity countries turned to the free market for their residual supplies. Thus, following the two world wars, western Europe imported heavily from tropical sugar cane producers while its own sugar beet industries were being rehabilitated. Similarly, preference markets have relied upon the free market for their marginal supplies and for additional supplies during periods of temporary shortages.

In consequence of these market forces—and also technological improvements in production—the free market suppliers have expanded their capacity beyond the "normal" requirements of the free market importers. During the 1930s and the 1950s overproduction, surpluses and relatively low prices were characteristic of this market. The result was the formation of an International Sugar agreement in 1937, and its revival after the Korean war. Under the agreement exporting countries were assigned annual export quotas in line with prospective demand in order to maintain the price of sugar at a remunerative level.

Metals.—Trade in metals and minerals differs somewhat from that in agricultural commodities for several reasons. Mineral resources are more highly concentrated than agricultural resources and may be exploited by larger operating units; capital requirements for metal production may be exceedingly high and call for an integrated operation through to the fabrication stage. Thus in the aluminum industry there are three large companies in the United States and one in Canada. The latter supplies the United Kingdom with most of its requirements plus the residual requirements of the United States. In view of this high degree of integration most trade in aluminum is carried on directly between fabricators and the large aluminum manufacturers. The steel industry is similarly integrated. About 85% of the iron ore produced in the United States is shipped directly to affiliated companies. Most iron ore trade is based on long-term contracts; spot purchases are relatively unimportant. In copper the degree of integration is less than in aluminum and steel, but the supply is largely in the hands of a few companies. In the United States four companies operate about 90% of the smelting capacity and two of them control the Chilean output. Two firms in Canada and a few in Africa control most of the world's remaining output outside the U.S.S.R.

The largest metals markets are in London and New York. The London Metal exchange and the metals section of the Commodity exchange in New York are futures markets dealing in copper, tin, lead and zinc. The London exchange price is widely used for spot trading in copper and tin. In the United States, however, two sets of copper prices are used. Quotations of the large integrated copper producers are used largely for these companies' own operations. Those of the custom smelter more closely reflect market conditions. Another world copper quotation of importance is that of the Union Miniere du Haut Katanga in the Congo. It is fixed independently but varies in line with the London metal market and the U.S. customs smelters' prices.

The Singapore and Penang tin smelters match daily production with bids received during the previous evening and early morning. The highest bid which will close out the available supply for the day becomes the price at which the tin is sold to all successful bidders. The tin market differs from other metal markets in that an international agreement among the main suppliers outside the U.S.S.R. is in force. An attempt is made to control daily spot prices at London within a range through purchases and sales from a buffer stock. This is supplemented by export quotas.

PRICE FLUCTUATIONS AND SURPLUSES

In deciding on an appropriate level of output, producers are guided by the prices of commodities relative to their costs of production. Favourable prices and expanding markets will nor-

mally call forth increases in production; unfavourable prices and contracting markets will cause decreases in production. Generally speaking, however, the capacity to produce basic commodities is not easily expanded in a short period of time.

Commodity markets were plagued during the first half of the 20th century by World War I and economic devastation in a large part of Europe, by depression of the 1930s and by World War II. These phenomena caused large general fluctuations in commodity prices. During the phase of rising prices the prices of commodities exported by raw-material-producing countries rose relative to the prices of the manufactured goods they imported. Thus their "terms of trade" improved. Conversely, during the falling price phase their terms of trade declined. Long-term basic economic factors such as changes in demand or taste, the development of substitutes, improvements in technology, new discoveries of resources and cheaper transportation facilities have affected individual commodity markets and specific producing areas in addition to the general movements caused by war and the business cycle.

Primary producers have been reasonably successful in expanding capacity to meet a growing demand but usually have been unable to reduce capacity in response to a decline in demand. Hence during periods of low prices and surpluses producers often combine to force political action in their favour. Such tactics are usually successful in cases where the producers as a group are politically powerful but represent a small segment of the economy of a nation so that they can be subsidized without unduly burdening the rest of the economy. An example of this situation is seen in the United States. Producers of certain commodities, such as cotton, corn and wheat, have been successful in maintaining relatively high prices for their products through subsidies and intervention in commodity market operations in spite of surpluses.

Another example of interference in commodity markets occurs when exporting countries are dependent for a large proportion of their foreign exchange earnings on one or a few commodities. Falling prices and surpluses have, in such circumstances, often forced intervention. Where one country has control over a large proportion of the world supply of a commodity such action may be unilateral. Where, however, a number of countries control the supply, international agreements or cartels are resorted to. Both of these situations have occurred on the world coffee market.

It is usually advantageous for smaller producing countries to avoid such agreements because they stand to benefit from any price support measures adopted without being hampered in expanding their exports. Such advantage is lost, however, if too many countries abstain. An example occurred in the world cotton market where the United States attempted to maintain relatively high cotton prices. Other countries took advantage of this situation by expanding their exports at slightly lower prices. Such tactics resulted in a progressive decline in United States' cotton exports. Thereafter the United States adopted a policy of subsidizing exports, which lowered world prices for all.

Countries that import raw materials and food stand to benefit directly from surpluses and low prices in world commodity markets, although they may lose indirectly in the form of shrinking markets for their own manufactured goods. Generally speaking, importing countries have been reluctant to enter into international commodity agreements unless some special interest is involved. Thus they joined the first International Wheat agreement in 1949 because at that time wheat was in short supply and the agreement guaranteed certain minimum quantities at a price below the prevailing price outside the agreement. On the other hand, the United Kingdom refused to participate in the second agreement presumably because it felt that it was being used by exporting countries to maintain artificially high wheat prices. The United States has traditionally been opposed to international cartel agreements and, for instance, refused to participate in the Stevenson plan for the restriction of rubber exports in the 1920s.

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COMMODUS (LUCIUS AELIUS AURELIUS) (A.D. 161–192), Roman emperor 180–192, was born at Lanuvium on Aug. 31, 161, son of the emperor Marcus Aurelius. His reign ended 80 years of internal concord in the empire. It is true that he inherited a protracted and costly war, and the aftermath of a devastating plague. The war had started (167) as a punitive expedition against troublesome peoples across the middle Danube. The Roman attack was totally defeated; the enemy overran the greater part of the region now known as the Balkans and invaded northern Italy for the first time in four centuries. By 172, however, the line of the Danube had been recovered, and the Roman armies crossed the river with the intention of incorporating the border peoples in the empire. After three years of heavy fighting the campaign was sharply interrupted. Believing a rumour that Marcus Aurelius had died on the Danube, the commander in chief of the armies and provinces of the eastern Mediterranean, Avidius Cassius (*q.v.*), marched on Italy to seize the person of the young Commodus. The rumour was soon disproved, and Cassius was killed by one of his officers. The motives of the parties are obscure. Cassius moved against the commander of the Danubian armies, Claudius Pompeianus, who favoured victory at any price. The nobility of the wealthy provinces of the east were still in a decisive minority in the senate and the imperial council, but contributed the larger share of imperial taxation, while their interest in the annexation of the territory north of the Danube was remote. How far these and other causes were active factors in the dispute is uncertain, but one contemporary north African inscription refers to the rebellion of Cassius and its aftermath as "the rising of the east" (*motus orientalis*). Marcus judged it prudent to leave the Danubian front for an 18 months' tour of the east, allaying the tensions behind the trouble. Returning in 176, he took Commodus to the front and proclaimed him joint emperor with himself. Two opposing principles had hitherto governed the succession; the senatorial aristocracy wished the emperor, in consultation with the elder statesmen, to choose "the best man" among themselves as his successor. The army, and the bulk of the provincials, apprehensive of the risk of civil war that attended a doubtful succession, preferred a hereditary succession. The conflict of ideas had been masked for three generations since none of the four previous emperors had been survived by a son. This decision, clearly inspired by the threat of civil war provoked by the rumour of Marcus' death, made Commodus the embodiment of the concept of hereditary succession, as opposed to the principle of choice by emperor and senate of "the best man" among the elder statesmen.

Commodus was still on the Danube, aged 18, when his father died on March 17, 180. His accession speech, presumably drafted by Pompeianus, proclaimed the aim of "extending the Roman empire as far as the ocean [the Baltic]" but he soon abandoned this formidable project. The restored Danubian frontier was not again seriously breached for almost 80 years, and Commodus' other wars were few. The most serious was in Britain where one of the walls was breached *c.* 180. Though the enemy was expelled, the army was demoralized and intermittently mutinous for 15 years.

After the war, the emperor and the Latin aristocracy of the senate became opposed. Commodus made Aelius Saoterus, a Bithynian, his principal minister. The son of Claudius Pompeianus attempted to murder Commodus, and Saoterus was assassinated, to be replaced by an Italian knight, Tigidius Perennis. He was removed in 185–186, when the senatorial officers of the insubordinate army of Britain sent 1,500 lancers to Rome to demand his execution, on a charge of plotting for the throne. Commodus agreed, and replaced him with the Phrygian Cleander.

The return of political violence, absent since the murder of Domitian in 96, was not confined to the aristocracy. After the long war, the west was full of deserters and runaway slaves. Maternus, an ex-soldier, raised a peasant force and seized many towns in Gaul and Spain. He was put down in a full-scale "War

of the Deserters" by the future emperor Pescennius Niger, but his guerrillas tried to seize Rome. The plan was betrayed only just in time, the prelude to a long series of peasant rebellions.

Commodus' part in these dramatic events was slight. Toward the end of his reign his eccentricities turned to insanity. Dressing as Hercules, he renamed Rome "the colony of Commodus" and spent much of his time with gladiators and in the arena. With the death of Cleander (*c.* 190) political influence passed to the emperor's mistress Marcia, the prefect Laetus and the chamberlain Eclectus. The veteran Pertinax became city prefect, while his friend and associate Septimius Severus, with his brother Geta, were given command of five legions on the Danube. The army of Britain went to Decimus Albinus, that of Syria to Niger. Commodus proposed to assume the consulship on Jan. 1, 193, armed as a gladiator and in procession from the gladiators' barracks. The offense to public decency was enormous. Marcia and her associates had him strangled during the night of Dec. 31, 192, and a grateful senate proclaimed Pertinax emperor before the imperial guards woke at dawn. (Jn. R. M.)

COMMON LAW, the body of customary law, based upon judicial decisions and embodied in reports of decided cases, which has been administered by the common-law courts of England since the middle ages. From this has evolved the type of legal system now found also in the United States and in most of the member states of the Commonwealth of Nations. Common law stands in bold contrast to the rules developed by the separate courts of equity (*q.v.*), to statute law, *i.e.,* the acts of legislative bodies such as parliament, and to the legal system derived from civil or Roman law now widespread in western Europe and elsewhere. In certain contexts common law can mean law which is applicable to a whole country and therefore not merely local or particular in its authority. The history of the English common law reveals the origin of these various meanings of the term.

Development of English Common Law During the Middle Ages.—In early medieval England law was a local and particular phenomenon. There was no national law applicable to the whole country, although some of the elements of such a law were present in the broad basis of Germanic custom which had persisted from the period of the Anglo-Saxon settlement. However, the various tribes of invaders retained a number of individual characteristics. It was only with the achievement of political unity toward the end of the Anglo-Saxon age that there came into existence a body of law applying to the whole land, with one king to enforce it. Even at the beginning of the 12th century, the *Leges Henrici primi* ("Laws of Henry I," written *c.* 1113–18) could refer to a threefold division of English law, following the old political boundaries: the law of Wessex, the law of Mercia and the Dane law. This division must have been rapidly fading by that time, for under the strong rule of the Norman kings the power of the central government was increasing; by the time of Henry II (1154–89) it was clear that there was going to be a "common" law throughout England, administered by the new royal judges of the king's court (*curia regis*). Owing to the relative strength and efficiency of royal justice, the common law gradually swallowed up its early rivals, the old local customary laws.

Influence of Roman and Canon Law.—The nature of the new common law was at first much influenced by the principles of Roman law, but later it developed more and more along independent lines. The Normans had introduced into England many of the new collections of the church's canon law; many of the early royal judges were themselves clerics, and as canon law was largely based on Roman law (*qq.v.*) England was brought for a time into the Roman-law atmosphere. Roman law supplied the early English lawyers with the necessary framework of legal concepts within which to develop their own system. The earliest rules of the common law were thus based partly on an amalgamation of local customs, partly on Roman law and partly on the policy of the central government.

Importance of the Inns of Court.—As the law became not only "common" but also more complex, there grew up a body of professional lawyers who gave expert advice to their clients and also supervised the professional education of those who aspired to follow them. These common lawyers had to decide how legal professional education was to be organized in the future. The canonists and the civilians (as Roman lawyers were called) looked to the universities to teach and train new entrants to the profession. While common lawyers were themselves mostly clerics there was a strong temptation for them to follow this course. But the clerical element declined, and by *c.* 1300 English common lawyers had ceased to frequent the universities and had undertaken their own education in their "inns of court" (*see* Inns of Court and Chancery). The result of this was to make the common lawyers still more conscious of the peculiarities of their own developing system, which had now taken on a life of its own. They became more critical of the theories of the Romanists and canonists. A popular exposition of this attitude was the tract *De laudibus legum Angliae* ("Praises of the Laws of England"), an early example of comparative law written *c.* 1470–71 by Chief Justice Sir John Fortescue.

The separatism of the common law was fostered by the way it was administered in the independent "common-law courts," of which there were, by the end of the 13th century, three: the court of common pleas, the exchequer (*qq.v.*) and the king's bench (*see* also Queen's Bench, Court of). The bench and bar of these courts were staffed by practitioners bred in the inns of court and nourished in the traditions of the common law. The principal subject matter of that law in the middle ages was land law and criminal law, in both of which the crown was deeply interested. A series of new procedures was evolved for each, in which the principal role was played by the jury, a new form of an institution which had its roots in Anglo-Saxon and Frankish law. However, although the common law expanded rapidly between the 12th and 15th centuries, many other quite separate legal systems and jurisdictions coexisted with it. The laws of the church governed marriage and succession, and the clerics had their own internal discipline with many privileges and immunities which often put them beyond the reach of the common law. The Jewish community was governed by a special sort of mixed court. The merchants had their own separate courts, which administered speedy justice under the mercantile law. The law of ships and the sea was administered from at least the mid-14th century by the courts of admiralty, held in the name of the lord high admiral; and there were several special jurisdictions assumed by royal officials such as the steward. Over the centuries, the common law either restricted or annexed many of these rival fields of law.

The Rise of Chancery.—By the end of the 14th century the common-law courts were firmly established as the principal organs of royal justice. In earlier days they had exercised a wide jurisdiction in framing and applying the rules of the common law. Now their most creative period was over; the common law was much less able to meet the needs of justice by supplying new remedies for new cases. A large body of rules, many of which were highly technical and artificial, had come into existence, and the common law was increasingly rigid and inflexible. Inevitably, this resulted in many failures to do justice, for in their insistence on the letter of the law the courts often failed to do "equity" between the parties. Another cause of dissatisfaction was that, with the growing political chaos of the 15th century, "over-mighty subjects" could frustrate the ends of justice by bribing or intimidating juries and defying court orders.

Origin and Nature of the Chancellor's Jurisdiction.—It had always been possible, in cases where the law could not or would not do justice, to petition the king to exercise his extraordinary legal powers as the "fountain of justice." The fact that he had established the common-law courts to administer the law on his behalf did not mean that he had exhausted his judicial powers, which were theoretically limitless. It was the practice to refer such petitions to the lord chancellor, who, as "keeper of the king's conscience," was the appropriate officer for this duty. During the 15th century the chancellor built up his own court in the chancery for dealing with these cases where the common law was inadequate. Unlike the common-law judges, the chancellor was concerned primarily with the moral concept of "equity" rather than with strict legal rights, the more so because, until the 16th century, chancellors

were almost invariably clerics. In the exercise of his equitable jurisdiction the chancellor was not bound by precedent, as the common lawyers were. He had very wide powers to do justice as he thought fit, and he exercised them with a minimum of procedural formality. The chancery was relatively cheap, efficient and just; during the 15th and 16th centuries it developed spectacularly at the expense of the common-law courts. Equity, as it came to be called, was a fertile source of new remedies and legal concepts. Perhaps the most important of these was the use or trust (*q.v.*), which was an obligation to hold property on behalf of another. The common law would not enforce this obligation, but equity would. For this reason, equity captured for itself a large part of the subject of real property.

The Struggle With the Prerogative Courts.—Most European countries during the 16th century were experiencing the rediscovery and "reception" of Roman law, and this influence extended to England. The strong and relatively secure rule of the Tudors was favourable to the establishment of a whole new range of courts, of which the chancery was only one (though the greatest), which for one reason or another owed little to the common-law heritage. An example of these prerogative courts was the court of requests, a poor man's court, which dealt with small claims. Another was the famous and later notorious star chamber (*q.v.*), which dealt primarily with offenses against public order. The common-law courts lost a good deal of business to the chancery and the other new courts, and bitterly opposed the extension of their jurisdiction. One of the principal defenders of the common law was Sir Edward Coke (*q.v.*), perhaps the greatest of all common lawyers. He was a voluminous writer with an immense knowledge of the law. As chief justice of the common pleas (1606–13) and, later, chief justice of the king's bench (1613–16), he waged ceaseless war, first on the chancery court and then against the royal power of James I. He was finally dismissed from the bench in 1616 for his "turbulent carriage," after which he went into parliament and joined the antiroyalist faction. The new courts, indeed, were particularly associated with the royal prerogative, which during the 16th and early 17th centuries was more and more frequently asserted. The common-law courts, on the other hand, were already thoroughly institutionalized and had nothing to gain from changes in the political structure, especially changes which brought new and rival courts with them. Thus, in the 17th-century struggles between king and parliament, the chancery and the prerogative courts were ranged on the side of the king, while the common lawyers on the whole allied themselves with parliament. It was at this period that the tradition of the common law as a bulwark against the arbitrary power of the crown first appeared. The victory of parliament saw the end of the prerogative courts, and the unpopular chancery court only barely survived.

Influence of Common Law Upon Equity.—This position was unchanged by the Restoration (1660). However, by that time equity had already received a strong infusion of common-law principles and methods. After the appointment of Sir Thomas More in 1529, chancellors had increasingly been laymen drawn from the ranks of the common lawyers. Gradually the office of chancellor had become more judicial in its character, though it still carried with it great political power. This tendency increased after the Restoration. Only professional lawyers were appointed, and they bent themselves to the task of making equity into a logical and consistent body of rules which would supplement the common law rather than conflict with it. Heneage Finch, later earl of Nottingham, lord chancellor from 1675 to 1682, who has been called the father of modern equity, was instrumental in removing the arbitrary element from equity and emphasized the importance of precedent in chancery decisions. The introduction of equity doubtless enriched the English legal system and in some ways stimulated the growth of the common law; but it created the serious disadvantage of having two different systems—law and equity—administered in separate courts and often impeding each other with such weapons as writs of prohibition and common injunctions. The common law never succeeded in swallowing up equity, but it gradually subsumed most of the other separate jurisdictions. In the 18th century it absorbed most of the mercantile law. Since the great fusion of jurisdictions by the Judicature act of 1873, common law and equity have been administered in the same courts; but they are still separate bodies of rules, each with its own characteristic methods and remedies.

Common Law and Statute Law.—Legislation is another source of law to which the common law had to adapt itself. Although to medieval philosophers it was a difficult question whether man could "make" law *ab initio* instead of declaring existing law, legislation was used in practice by English kings after the Norman conquest. It was, however, relatively rare; and legal development in the middle ages was mostly left to the common lawyers. Early forms of legislation can only be surmised, but from *c.* 1100 the royal charter became the usual medium, until it was slowly replaced by the statute, cast in forms evolved by the newer institution of parliament. The volume of legislation has steadily increased until, in the 19th and 20th centuries, it has become a vast flood. It was by no means clear at first whether a statute could override a rule of the common law. This was determined at the Reformation, when Henry VIII's use of parliament to effect a fundamental alteration in the position of the church finally exalted the power of parliament over all other English institutions. Although as late as the 17th century common-law judges occasionally claimed that where a statute was contrary to reason or natural justice, it would be void at common law, it has long been clear that in England the courts can do nothing with an act of parliament except apply it. In England always, and normally throughout the common-law world, legislation is superior in strength to common law.

Distinctions Between Common Law and Civil (Roman) Law Systems.—The common law has been exported into most of the countries where the English have settled or governed. As subjects of the crown, English settlers carried it with them wherever they went. The end of British rule has not usually involved the abandonment of the common law, though of course it has developed independently thereafter. Today a large portion of the world is governed by one branch or another of the common law. The United Kingdom and its colonies, the United States, Canada, Australia, New Zealand, Ghana, Nigeria and India are all common-law countries in this sense. Though individual rules of law may differ, their legal systems have in common the characteristic hallmarks of the common law. Prominent among these are the institution of the jury, the right to speedy trial and the tradition of a powerful and independent judiciary. Such common-law countries are to be compared with civil-law (*q.v.*) countries such as France, Germany and Italy, which derive their legal systems mainly from Roman law. Perhaps the feature of the civil-law system which is most different from that of the common law is that in civil-law countries the main rules are normally embodied in a legislative code. The common-law judge, however, is normally guided not by a code but by the principles declared in the reports of previous decisions by his predecessors in similar or analogous cases. This system of precedent, fundamental to the common-law method, results in a continuous process of legal evolution which makes for both stability and flexibility, qualities which are essential in any legal system.

See ENGLISH LAW; AMERICAN LAW; *see* also references under "Common Law" in the Index volume.

See T. F. T. Plucknett, *A Concise History of the Common Law*, 5th ed. (1956). (T. F. T. P.; T. S. Le.)

COMMON MARKET: *see* ECONOMIC UNION.

COMMON ORDER, BOOK OF, sometimes called the Order of Geneva or Knox's Liturgy, a manual of public worship in the Reformed Church in Scotland. The name is still used in some Reformed churches for their service books. A book of "common order," as contrasted with a book of "common prayer," aims at securing a common pattern of worship without making specific verbal forms compulsory, and the prayers are almost entirely put into the mouth of the minister, in accordance with a practice introduced by Calvin, who thought that I Cor. xiv, 16, demanded this procedure apart from congregational amens.

In 1557 the Scottish reforming lords prescribed the use of the

English Book of Common Prayer in place of the Roman missal. Meanwhile, at Frankfurt a controversy had arisen among British refugees between upholders of the English liturgy and others who, under the leadership of John Knox, desired a form of worship like Calvin's. The latter party drew up a liturgy based on Calvin's *La Forme des prières*, but its use was denied and Knox was banished from the city. In 1556, after some revision, the book was put into use in Geneva when Knox became minister of the English congregation there. It is notable as being the first Reformed rite in English and as providing a liturgy ready to hand for the Scottish Reformers, who adopted it after the Reformation in 1560. The norm of public worship followed in the book is the ancient service of word and sacrament.

The policy of the Stuart kings was to adapt Scottish church life to English ways. Their efforts were directed particularly toward introducing bishops into the Presbyterian system and imposing English liturgical forms. An attempt made by Charles I in 1637 to introduce a liturgy prepared by Archbishop William Laud and some Scottish bishops on the basis of the English book brought Scottish resistance to a head. The resulting uprising of the Covenanters (*q.v.*) was inspired less by resistance to episcopacy and prayer books as such than by resistance to royal interference with the freedom of the church. But it led both to a hardening of attitude against bishops, who were regarded as agents of the king, and to greater sympathy with those Puritans who desired books to be less prominent in worship. Up to this time Scottish sentiment was against the extremer forms of Puritanism, and the Book of Common Order had retained the use of the Creed, the Gloria and the Lord's Prayer. In 1645 the Scottish general assembly accepted the Directory of Public Worship, which had been prepared by the Westminster assembly in pursuance of its purpose to unify the church life of England, Scotland and Ireland along Puritan lines. Though the Directory contained full prescriptions as to the content and order of the prayers, it did not pretend to be a liturgy, and required that each minister be careful "to furnish his heart and tongue with further and other materials of prayer and exhortation, as shall be needful upon all occasions."

The subsequent period in Great Britain was one of decline in the manner of worship, not only among Presbyterians. A newer day dawned in Scotland in 1865 with the formation of the Church Service society, which in 1867 produced an influential service book, Euchologion. Since that time, most Reformed churches have undergone a revived interest in liturgy and have published books that have largely superseded the Westminster Directory. The Church of Scotland has a scholarly Book of Common Order (1940) that carries further the achievements of several previous books, and the Book of Common Worship (1946) of the United Presbyterian Church in the U.S.A. is notable for its much-extended element of common prayer (*i.e.*, prayer voiced by the people).

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COMMON PLEAS, COURT OF, an English court of law that originated from Henry II's assignment in 1178 of five members of his council to entertain pleas involving contests between individuals, as distinguished from litigation to which the crown was a party. This group of councilors did not immediately emerge as a body distinct and separate from the *curia regis*, or "king's court." It remained a part of the court and traveled with it until art. 17 of Magna Carta (*q.v.*) required that this jurisdiction be assigned to a body to be convened at a designated place, at which time it settled in Westminster hall, London. In 1223, on the majority of Henry III, the court began to maintain separate rolls and in 1272 it was given its own chief justice. Its identity is usually dated from that time.

During the middle ages, common pleas was the busiest though not the highest of the common-law courts; it included within its jurisdiction not only almost all civil litigation but supervision of local and manorial courts as well. Its judgments, however, were subject to review by the court of king's bench (*see* QUEEN'S BENCH, COURT OF). Beginning in the 15th century, common pleas engaged in a contest with the court of king's bench and the court of the exchequer for common-law business. The result was an accumulation of complicated and overlapping jurisdictional rules. By the 19th century the multiple forms of writs and competing jurisdictions had become unbearable and the Judicature act of 1873 resulted in a replacement of the three common-law courts, as well as the assumption of equity jurisdiction, by the supreme court of judicature, a single integrated court that remains today as the court of general jurisdiction in England and Wales. *See* also COURT. (P. B. K.)

COMMON PRAYER, BOOK OF, contains the liturgy appointed by law for use in the Church of England. It is a product of the English Reformation and its successive revisions reflect the phases through which that Reformation has passed.

Before the Reformation the services of the English church were in Latin and followed the local "uses" or modifications of the Roman rite, the pattern liturgy for the greater part of Western Christendom. The chief English uses were those of Hereford, York and Salisbury, or Sarum, the last being the best known and the most widely followed on the eve of the Reformation. Although the uses differed neither from each other nor from the Roman rite in type, they exhibited considerable differences in detail, with the consequence that there was no uniformity of liturgical observance within the single area of the kingdom.

Each use had its own set of service books. A number of these was necessary for the performance of the services and was provided, according to law, at the expense of the parish. The minimum requirement was a *Directorium* (sometimes called *Ordinal* and to be distinguished from the book of ordination rites later attached to the Prayer Book) which indicated the service to be recited on any Sunday or festival in accordance with the variations of the ecclesiastical year (the *Directorium* was also commonly termed the *Pica* or *Pie*, *i.e.* "magpie," because it was printed in black and had no rubric, or red, type); a missal, which contained everything necessary for the celebration of Mass, the principal act of worship; a processional, in which were to be found the psalms, anthems and hymns to be sung in the procession before Mass and after evensong on Sundays and festivals; a breviary, which contained the priest's daily canonical office; and a manual, in which were collected the "occasional offices" or services of baptism, marriage, burial, etc. The services performed by the bishop, *i.e.*, confirmation, ordination, etc., were collected into his pontifical. Mention must also be made of a quasi-liturgical and vernacular prayer book used by educated lay people and known as the primer. This consisted of the Offices of the Dead and of the Blessed Virgin Mary, derived from the breviary with the litany and other devotions in the vernacular from the 14th century onward, which lay people recited either privately at home or in groups in church during the celebration of the Latin service by the priest and choir. The primer played some part in preparing the way for the Prayer Book.

The introduction of vernacular liturgy and the simplification or reform of church services were among the early changes effected by the Reformation on the continent. In England the approach to liturgical change was slower and gradual. Thomas Cranmer, shortly before becoming archbishop of Canterbury in 1533, had had experience of Lutheran vernacular worship in Germany. More than a decade passed before he had an opportunity of experimenting at home. In 1544 he was authorized by Henry VIII to compile an English litany for use as a "common prayer of procession." The main sources of Cranmer's litany are the litanies in the Sarum processional and manual and Luther's Latin litany of 1529, some phrases and the final prayer being derived from the Greek liturgy of St. John Chrysostom. Cranmer's first essay at liturgical composition for public use exhibits the same dignity of English style and the same felicitous handling of older material which distinguish his prayer books. With some changes, Cranmer's litany has remained in use to the present day. It was designed to be the first installment of an English processional, which, however, was never completed, Henry VIII being disinclined for further liturgical experiment. In fact the litany of 1544 was the first install-

ment of the Book of Common Prayer.

The second installment followed four years later when, on account of Edward VI's minority, the government of the kingdom was in the hands of a protector and council resolved on reform and Cranmer, himself a member of the council, was no longer restrained by royal conservatism. The order of the Communion, issued in 1548, was a move in the direction of an English Mass. It consisted of devotions in English to be said at the administration of Holy Communion in the course of the Latin Mass; it also ordained the ancient practice, revived in the Reformed churches of the continent of Europe, of delivering to the communicants the cup as well as the bread. The contents of the order—viz., exhortations, invitation to communicate, confession and absolution, "comfortable words," "prayer of humble access" and sentences of delivery—were to reappear in the Prayer Book. With the exception of the prayer of humble access (which may be attributed to Cranmer) the order owes its inspiration to a German church order compiled in 1543 to forward the Reformation in the diocese of Cologne.

First Prayer Book (1549).—The royal proclamation promulgating the order of the Communion gave warning of "the other order" to come. The "other order" was the first Prayer Book enacted by the first Act of Uniformity in 1549. By ordaining that "all common and open prayer" should be conducted "in such order and form as is mentioned in the said book, and none other or otherwise," the act suppressed the local uses and their Latin service books. Henceforward the realm would have but one use, and the Prayer Book would be its service book. The comprehensive character of the book is demonstrated by its table of contents, which with some rearrangement has passed to its successors. The services have been collected from the several Latin service books into a single volume comparable with such Lutheran Church orders as the *Agenda* of Saxony and the *Kirchenordnung* of electoral Brandenburg, both issued in 1540. The preface of the Prayer Book—although primarily concerned with matins and evensong, the substitute for the breviary (and largely paraphrased from Cardinal Francisco de Quiñones' Latin preface to his revised Roman breviary of 1535)—expresses the principles which motivate the book as a whole. The fundamental principle is intelligibility. Services must therefore be in English and must be so simplified that there shall be no need of the complicated rules of the *Directorium* or *Pie*. Further, psalms and lessons must be read in sequence without frequent interruption by "proper" psalms and lessons appointed for festivals, as in the Latin office. Similarly, the sequence of psalms and lesson in a service must no more be broken by antiphons to the psalms and responds after the lessons; and the psalms were in fact issued separately, as *The Psalter or Psalms of David*, in Aug. 1549. Again, only "the very pure worde of God, the holy scriptures," and the books of the Apocrypha may be read; the lives of the saints hitherto read on their festivals and other nonbiblical writings were jettisoned. The resultant jejune order is described as "muche agreeable to the mynde and purpose of the olde fathers" who instituted daily service.

The first Prayer Book preserves much of traditional liturgical form and usage. The principal rite, "commonly called the Masse," is modeled on the Latin Mass. The canon, or central prayer in which the elements are consecrated and Christ's passion, resurrection and ascension commemorated, is reminiscent of the Latin canon, partly in form and partly in content. The sentences of delivery (which are the first half of those now in use) refer to Christ's body and blood. The traditional vestments and wafer bread are retained. At baptism the water is blessed; and the infant is exorcised before, and anointed with chrism and clothed with the white robe (chrisom) after, being baptized. At confirmation the bishop marks the child's forehead with the sign of the cross. At the visitation of the sick, the sick person may be anointed with oil, and Holy Communion be brought to him from the church, if he so wish. The traditionalism of the book is of a Lutheran type, however, and is offset by Reformed elements which are equally characteristic of the book. The primary title of the Mass is "the Supper of the Lorde, and the Holy Communion." The celebrant, at his choice, may wear a cope instead of a chasuble. There may be no celebration of the service, "except there be some to communicate with the priest." This restriction, together with the title and the ample devotions of the order of 1548, implies that the rite is of no significance apart from Communion. In the absence of communicants the priest is to follow Lutheran usage and to read only the ante-Communion part of the service. A non-Lutheran Reformed feature is the prohibition on elevating wafer and chalice after their consecration. In regard to the controversial matters of the real presence of Christ's body and blood and of the conception of the Mass as a propitiatory sacrifice for living and dead, the service of 1549 is equivocal. Cranmer (whose authorship of the service, and of most of the book, is indisputable) declared its meaning to be Protestant. His conservative opponent, Stephen Gardiner, bishop of Winchester, argued that the phraseology of the canon and the inclusion within the canon of prayer for the dead justified a Catholic interpretation.

Second Prayer Book (1552).—In 1552 a second Act of Uniformity substituted the second Prayer Book for the first. The second book is a radical revision of its predecessor, designed to align English worship with the more extreme Reformed position to which Cranmer now adhered. Almost all the traditional usages of the first book are jettisoned. Alb, chasuble and cope are forbidden; bishops are to wear rochets, other ministers surplices only. The altar is replaced by a movable Communion table. The Communion service has been so rearranged that it no longer follows the order of the Mass, and the word "Mass" is no longer applied to it. The canon has been broken up; the commemoration of Christ's passion, etc., and the prayer for the dead have been discarded; and the remaining parts have been inserted at new positions in the service, thus rendering it insusceptible of Gardiner's interpretation. The idea and term of "consecration" of the elements is avoided. The present "prayer of consecration" made its first appearance in the second Prayer Book; but in 1552 it lacked a title and also the directions to take bread and cup, etc. The bread used may be domestic instead of wafer. The new sentences of delivery (which are the second half of those now in use) exclude reference to Christ's body and blood; and the phraseology of the prayers of humble access and of thanksgiving (after reception) has been so revised as to avoid implying that the elements are the means of conveying Christ's body and blood to the communicant. The total effect of these changes is to transform the liturgical action into eating of bread and drinking of wine in thankful remembrance of Christ's death. The declaration on kneeling, or "black rubric," which was attached to the Communion service by order of the council after parliament had enacted the second Prayer Book, affirms that kneeling at reception does not imply that any adoration is done either to the sacramental elements, or to any supposed "reall and essenciall presence there beeying of Chrystes naturall fleshe and bloude," which are stated to be "in heaven and not here."

The service of baptism has been as drastically revised as that of the Communion, although without a corresponding change in its meaning. The exorcism, the blessing of the wafer, the anointing with chrism and the robing with the chrisom are discarded. The central portion of the service has been redrafted so as to present a parallel with the equivalent portion of the Communion service; *i.e.*, recalling of the institution (Matt. xxviii, 19), administration of the sacrament, the Lord's Prayer and the prayer of thanksgiving. The infant is now to be marked with the sign of the cross immediately after being baptized. The book allows no other use of the sign of the cross.

The second Prayer Book had been in force for little more than six months, when the accession of Mary in 1553 brought back the Latin rite. The Prayer Book was used, however, in the churches of English Protestants who migrated to the continent in Mary's reign. There is some evidence to suggest that when Elizabeth succeeded Mary in 1558 there was a project to restore the first Prayer Book. In the issue, less conservative influences prevailed; and the Prayer Book actually restored was the Prayer Book of 1552, exclusive of the "black rubric." With additions and alterations, important if generally slight, the second Prayer Book has remained in force since its restoration by the third Act of Uniformity in 1559.

The same act made the first of the important additions: it provided that, in the Communion service, the sentences of delivery of 1549 should be added to those of 1552, the former taking first place. The doctrinal implication of the addition is significant; reception of Christ's body and blood was again associated with reception of the sacramental elements. When the book was published it was found to contain an important change in the ornaments rubric, or direction concerning the vesture of the ministers. The altered form of the rubric directed the minister "at the time of the communion" to use the ornaments which "wer in vse by aucthoritie of parliament in the second yere of the revgne of King Edward the VI" and thus legalized the vestments of 1549. The alteration was not covered by the Act of Uniformity, but was presumably authorized by the queen. The Mass vestments were discontinued; but copes were worn over rochets and surplices in most cathedrals and in the queen's chapel, where the Communion table, dressed altarwise, stood unmoved at the east end, and where, also, wafer bread was retained.

Controversy with both papists and Puritans over the Communion service led to the reassertion of the idea and practice of consecration. There being no direction in the Prayer Book, the court of high commission in 1573 ruled that a second supply of bread and wine, before being distributed in Communion, must be "consecrated" by Christ's words repeated over it in a second recital of the liturgical institution-narrative.

The trend of return to the standard of 1549, noticeable in the official interpretation of the service of 1559, was confirmed by the teaching about the Lord's Supper contained in the questions and answers concerning the sacraments added to the catechism, by authority of James I, in 1604. The same trend is observable in the ill-fated Scottish Prayer Book of 1637. This book, often wrongly styled "Laud's liturgy," was a revision of the English book undertaken by Scottish bishops in the hope of reconciling Scottish Presbyterians to the use of the Prayer Book. The Scottish was the first Prayer Book to introduce the description "the prayer of consecration" into the Communion service. The description, and the Scottish directions both for an additional consecration and also for the reverent treatment of any consecrated bread and wine remaining after the distribution, were to be adopted by the English revisers in 1661.

Revisions of the Prayer Book.—The English Prayer Book, which had been the object of Puritan attack for three-quarters of a century, was "abolished" by parliament in 1645. On the restoration of Charles II in 1660, the Prayer Book was also restored and in the year following a conference between bishops and Presbyterian divines was held at the Savoy palace in London to consider Presbyterian wishes for revision. The conference failed and the work of revision was committed to the convocations. The result was conservative. The substance of the old book remained unchanged. The principles of the revision, as expressed in the new preface, were the "better direction of them that are to officiate"; removal of archaisms; clarification of ambiguities; and the addition of new prayers required by new circumstances. Some of the new features met the wishes of the Presbyterians; *e.g.*, the use of the Authorized Version for all lessons and biblical quotations, the attachment of the doxology to the Lord's Prayer on several occasions, the restoration of the black rubric in slightly amended form and the reintroduction of a blessing of the water at baptism. The revised book was enacted by the fourth Act of Uniformity in 1662. "Sealed books" (*i.e.*, copies of the new book printed exactly from the manuscript annexed to the act, and authenticated by the great seal) were sent to the cathedrals of England and Wales to ensure preservation of the standard text.

A further revision, aiming at a reconciliation between the established church and nonconformists, was moved in 1689, but came to nothing. Again, in 1906, following upon the "ritual" disputes of the previous half-century, the convocations were authorized to revise the book in such a way (according to the royal letters of business) as "to secure the greater elasticity which a reasonable recognition of the comprehensiveness of the Church of England and of its present needs seems to demand." Ill-conceived features and unacceptable regulations for reservation of the sacrament, purporting to satisfy the desires of the Anglo-Catholic party, provoked opposition from Anglo-Catholics and Protestants alike. The convocations and the church assembly passed the revised book in 1927. In parliament, however, though passed by the house of lords, it was rejected by the house of commons. Modified in regard to the reservation regulations, it was again presented to parliament in 1928, and again rejected by the commons. The official liturgy of the Church of England retains the form given to it in 1662; but considerable latitude in the use of the book everywhere obtains. (*See* also ENGLAND, CHURCH OF: *20th-Century History and Development: Prayer Book Revision.*)

Ordinal.—The book containing the rites for consecrating bishops and ordaining priests and deacons was not counted a part of the Prayer Book until 1662. It preserves something of the pattern of the Latin rites, but its content has been influenced by the German reformer Martin Bucer. Ordination to each order consists in the laying on of the ordaining bishop's hands accompanied by a formula. The formulas for bishops and priests begin with the words, "Receive the Holy Ghost," retained from medieval usage. From the same usage the formula for priests also retains the clause, "whose sins thou dost forgive, they are forgiven," etc. The act of ordination both of bishops and priests is preceded by prayers which are almost identical and are derived from Bucer's ordination prayer. The first ordinal, issued soon after the first Prayer Book, retained the medieval *porrectio instrumentorum* in the form of delivering to priests a chalice and a paten with bread, as instruments symbolical not of offering sacrifice, as in the Latin rite, but of ministering the sacraments. The delivery of a pastoral staff to bishops, in symbolism of their function as shepherds "to the flock of Christ," was also retained. The first ordinal introduced the delivery of the New Testament to deacons and of the Bible to priests and bishops as instruments of the preaching ministry. The revised ordinal of 1552 discontinued the delivery of chalice and paten and of the staff, retaining only the scriptural instruments. A further change was made in 1661. The ordination formulas of both bishop and priest had neglected to specify the order being conferred. In order to meet papist criticism of the omission and to silence the Presbyterian argument that the prayers and formulas of the ordinal witnessed to the fundamental parity of the two orders, the revisers of 1661 redrafted the two formulas, in each case specifying the order conferred and so asserting a distinction between bishop and priest.

Related Prayer Books.—Most churches of the Anglican Communion now possess their own variants of the English Prayer Book. The Scottish book of 1637 was not reintroduced at the Restoration, but its Communion office was used in some Episcopalian congregations and private chapels. Under Nonjuring influence, during the first half of the 18th century, it became the practice to rearrange the several parts of the office in accordance with the Eastern pattern; *i.e.*, the invocation in the consecration prayer was removed from its position before the institution narrative to a subsequent point of the prayer, and the general prayer for the church was placed after the consecration prayer. This arrangement received the approval of the Scottish bishops in 1764. The "Scottish liturgy" or Communion office of the present Scottish Prayer Book (1929) retains the Eastern pattern.

The Scottish Communion office of 1764 is also associated with the beginnings of the Prayer Book of the Protestant Episcopal Church of the United States of America. At the time of his consecration by Scottish bishops in 1784, Samuel Seabury, the first American bishop, undertook to promote the use of the office among American Episcopalians. In 1789, however, the general convention, which determined the form of the first American Prayer Book, while retaining the Scottish consecration prayer with some modification, left the general prayer for the church in the English position. The Communion office contained in the American Prayer Book of 1928 preserves this compromise, but in certain other respects has reverted to Scottish usage.

In 1954 the Church of the Province of South Africa issued a revised Prayer Book of which the distinctive feature is the Communion service drawn up about 30 years earlier as an alternative to the English service. In the main this service follows the Scottish

pattern of 1637; but the consecration prayer adopts ancient Roman phraseology for expressing the eucharistic offering, and at the same time introduces an invocation of the Holy Spirit, in accordance with Eastern usage, after the offering.

In 1959 the Anglican Church of Canada issued *A Draft Prayer Book* for experimental use over a period of years. The consecration prayer of the draft Communion service may be described as a modification, under slight South African influence, of the Scottish prayer of 1637.

The variant Prayer Books referred to here and including the Irish (1927) and the Indian (1957), although providing for new needs and local requirements, exhibit a clear continuity with the English book of 1662. Nevertheless it will have been observed that in the matter of the Communion service (with the exception of the Irish book, which preserves the English service unchanged) the variants prefer Cranmer's first service, in some Scottish modification, to his second.

The fine diction of the Prayer Book, and the beauty of expression which marks its prayers, have led to the adoption of many of its prayers into the liturgies of English-speaking churches outside the Anglican Communion (*e.g.*, into the Book of Common Order of the Church of Scotland and that of the United Church of Canada).

See also references under "Common Prayer, Book of" in the Index volume.

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COMMONS, JOHN ROGERS (1862–1945), U.S. economist, authority on labour and author of reform legislation in Wisconsin, was born at Hollandsburg, Darke county, O., on Oct. 13, 1862. He studied at Oberlin college and at Johns Hopkins university, and joined the faculty of the University of Wisconsin in 1904. Commons first achieved a reputation as the foremost authority on U.S. labour. With the collaboration of disciples, he published *A Documentary History of American Industrial Society* (10 vol., 1910–11) and *History of Labour in the United States* (4 vol., 1918–35). Although subject to considerable controversy, Commons' theory of the evolution of the American labour movement in terms of changes in the market structure became the leading theory.

After World War I he broadened his reputation with *Legal Foundations of Capitalism* (1924) and its sequel, *Institutional Economics* (1934). These studies stressed the importance of group controls or rules as the bases for the orderly expansion of individual action. He especially emphasized the role of the U.S. supreme court as the "supreme faculty of political economy."

Commons drafted much of the reform legislation that made Wisconsin the laboratory for other states and the federal government, notably legislation on civil service, public utilities, workmen's accident compensation and unemployment insurance. These activities made him as influential a factor in economic practice as in theory. He died May 11, 1945.

For Commons' bibliography, *see* his *Economics of Collective Action* (1950), and Joseph Dorfman, *The Economic Mind in American Civilization,* vol. 3, ch. 8 (1949) and vol. 4, ch. 13 (1959); for biographical material *see* Commons' autobiography, *Myself* (1934). (J. DN.)

COMMONS, a word used to describe the rights of persons to enjoy a profit a prendre in common and, more generally, to describe the land over which those rights are enjoyed.

By the common law, a profit a prendre (or, more shortly, a profit) is the right to take from the land of another either part of the soil or its produce, or the wild animals existing on it. Thus a right to "hawk, hunt, fish and fowl" may exist as a profit, and so may the right to take grass, herbs or minerals. A profit enjoyed by one person to the exclusion of others is called a several profit, whereas a profit enjoyed in common with others is called a profit in common, or simply a common.

England.—Commons originated in the medieval system of cultivation of lands in England. Each vill or township was surrounded by the arable land, cultivated in strips by each householder, by meadows and pastures, and by the waste. From this waste each householder was entitled to take wood for repairs and fuel. When the fields were under crops and the meadows laid up for hay, the waste was used to support the horses and oxen needed for the plow, and the cows and sheep, who contributed their manure. Each householder then had the right to turn out his beasts to graze on the waste; and in the developed terminology of the law, these rights were profits in common, exercisable over the waste, or common.

Types.—Any type of profit may be held in common. There are five main categories. A common of pasture is perhaps the most frequent; it confers the right to take away the grass and herbage by the mouths of cattle. Often the cattle are limited to the number levant and couchant on the land of the commoners; *i.e.,* the number which their other land is capable of maintaining during the winter. The common may, however, be *sans nombre* ("without stint"), though even here the number is limited to the amount the common is capable of maintaining. A common of turbary gives the right to take peat or turf for use as fuel in the commoners' houses. A common of estovers entitles the commoners to take wood as housebote, for repairing their houses or burning in it; as plowbote, for agricultural implements; and as haybote, for repairing fences. Commons of piscary or other sporting rights entitle the commoners to take fish, game and fowl; and a common in the soil gives the right to take sand, gravel or minerals. In general each type of common may exist as appurtenant, appendant or in gross. A common appurtenant is granted for the benefit of nearby land of the commoner, and passes with that land. A common appendant is similar, except that it can only exist in land forming part of ancient manors. A common in gross is held independently of any other land. Commons may arise under statute, by operation of law, by express or implied grant or by long enjoyment.

Approvement.—After the Norman conquest it became established that title to the waste was vested in the lord of the manor, subject to the commons owned by the householders. This soon gave rise to conflicts of interest which took six centuries to resolve. The Statute of Merton, 1235, and the second Statute of Westminster, 1285, confirmed the lord's right to "approve" (*i.e.,* take for his separate use) any of the waste, provided he left enough for all the animals that the commoners were entitled to turn out upon the common; the onus of proving sufficiency lay on the lord. Approvement was by no means always against the public interest, for it often resulted in the cultivation of land that otherwise would have lain derelict; but sometimes the right was merely used to give the lord a new deer park or the like. With the decay of the old system of agriculture, and the great increase in population in the 19th century, approvement was subjected to control by the Commons act, 1876. Under this act a person seeking to approve a common otherwise than under the act must advertise his intention in the local press on three successive occasions. The Law of Commons Amendment act, 1893, prohibited approvement except with the consent of the minister of agriculture, fisheries and food, given after holding a local inquiry.

Enclosure.—Enclosure differs from approvement in that the whole of the waste is discharged from all rights of common, whereas approvement discharges only part of the waste, and then only from commons of pasture. In 1709, the first enclosure act was passed, and by the second half of the century more than 40 enclosure acts were being passed each year, each act authorizing the enclosure of specified areas of land, ostensibly for encouraging the more efficient production of food. The Inclosure (Consolidation) act, 1801, facilitated enclosures by enacting a series of common-form clauses which could be incorporated in individual enclosure acts, leaving only the general question of enclosure or not to be debated; and in 1801 no fewer than 119 enclosure acts were passed, enclosing over 300,000 ac. The Inclosure act, 1845 (as amended by a series of later acts), further aided enclosures

by laying down a procedure under which it became unnecessary to obtain individual acts of parliament. But public opinion was becoming aroused by the disappearance of open spaces, especially in and near London and the larger cities, and the Inclosure act, 1852, prevented any further enclosures being made without the express consent of parliament. The Commons act, 1876, established the modern procedure. An application must be made to the minister of agriculture, fisheries and food. If a prima-facie case is made out, regard being had to the benefit of the neighbourhood, a local inquiry is held. If this establishes the case for an enclosure, a provisional order is submitted to parliament for confirmation.

The Public.—The difference between legal theory and popular assumption became especially marked in the case of commons. In law a common was land which was owned by the lord, subject only to the limited rights of the commoners; and only the lord and commoners had any rights over it. In common practice, the rights of the lord and of the commoners kept the land open and accessible to all; and with fewer commoners exercising their rights as the years passed, the public's assumption that a common was so called because it was common to all became more firmly established. Until the Law of Property act, 1925, came into force at the beginning of 1926, the law had given little enough support for this view, though under various statutory powers to make provisions for the regulation of commons, bylaws could be made regarding the use of commons for recreation. However, s. 193 of the act of 1925 gave the public "rights of access for air and exercise" to urban commons, subject to certain limitations. Section 194 extended the restrictions on enclosures to the erection of buildings or fences or any other works which impede access to any common.

The Modern Position.—It is difficult to say how much land was enclosed during the century and a half that enclosures were in full spate; one estimate puts it at as much as one acre in every seven in England. Nevertheless, the process was halted just in time; and much of the credit for this must go to a small group of men who afterward formed the Commons Preservation society. The most prominent were George Shaw-Lefevre (afterward Lord Eversley), Henry Fawcett and Sir Charles Dilke. There remain something between 1,500,000 and 2,000,000 ac. of common land in England and Wales. It is capriciously distributed. Thus there is little in the Midlands, whereas in Surrey nearly every parish has its common, and there are large areas of heath and moorland. In some cases, there are still commoners who exercise their rights to pasture their beasts; but gradually these rights are falling into desuetude. In general practice as well as in public estimation, commons are more and more becoming places of recreation for the public, and less and less places where commoners exercise their profits a prendre in common. Enclosures and approvement alike are almost things of the past. The danger that commons might prove attractive targets for land-hungry local authorities with powers of compulsory acquisition has been met by subjecting all such acquisitions to a special parliamentary procedure which requires the proposal to be referred to each house of parliament: see, *e.g.,* Acquisition of Land (Authorisation) Procedure act, 1946, s. 1 (2). In broad terms, commons may be said to have nearly completed their transition and to have attained stability as an institution for the public benefit.

See also Enclosure. (R. E. My.)

United States.—During the colonial period of American history, commons were prevalent in the New England area. The English manor system of landholding, however, was never a part of the colonial settlements. In Massachusetts, for example, all titles were presumed to be freeholds based upon grants from the crown and free from the feudal incidents of allegiance and duties to the lord of the manor; indeed, there was no manor. Moreover, in the early days land was plentiful in the colonies. In one village 60 families were granted about 64 sq.mi. for their individual and common use. Each family had about one square mile of land, and the families were grouped in the centre of the area for protection against the Indians. The village community enjoyed the use of a large area of common land belonging to the proprietors, who had a right to sell their individual interests in such land, and it was inherited by the heirs of the owners. While common land was devoted to common use, the settlers had the privilege of pasturage, cutting wood and using other products of the land. It is said that in the Newbury area there were cow commons, ox commons, calf commons and sheep commons.

Perhaps the best known of the New England commons is the Boston common. Its origin is somewhat obscure, but it appears that in 1634 a Rev. William Blaxton (Blackstone) sold a tract of approximately 45 ac. to the town of Boston for £30. Later a royal grant and deeds of purchase from Indian tribes established clear title to this tract. Town records of 1640 show a vote not to sell any part of this land, but to use part of the tract for streets. In its early history Boston common was used to pasture cattle and sheep. In the course of its development from an unimproved parcel of land it became a drill field for local militia. It was used also for training British troops, and colonial soldiers used it in 1775 for encampment on their march to Bunker hill. Other uses included a location for executions, dueling and religious meetings. In the 20th century Boston common is important as a recreation centre where the public may enjoy the usual pleasures of a large park. In 1908 George F. Parkman bequeathed $5,000,000 to the city of Boston to maintain and improve the area.

(J. J. Hn.)

Bibliography.—C. I. Elton, *A Treatise on Commons and Waste Lands* (1868); G. Shaw-Lefevre, *English Commons and Forests* (1894); Sir W. Hunter, *The Preservation of Open Spaces* (1896); M. A. De Wolfe Howe, *Boston Common* (1921).

COMMON SENSE is intelligence of the degree conventionally expected of adult persons in practical affairs. In the history of philosophy, however, the term has had other connotations.

Aristotle, in his *De anima,* book ii, 6, divides the objects of sense between "special objects" (that is, objects discernible to one sense only, as colour is to sight) and "common sensibles" (objects discernible to more than one sense), the latter group comprising movement, rest, number, figure and magnitude; and in book iii, 1, after denying that there is any sixth sense or sense organ to be added to the five natural ones for the perception of common sensibles, he concedes that there is a "general sensibility" that enables us to perceive them directly. With this reference common sense, which later Aristotelians also called inner sense, means the co-ordinating faculty of the mind.

For other technical uses of the term *see* Common Sense, Philosophy Of.

COMMON SENSE, PHILOSOPHY OF, the usual designation of the Scottish philosophy of the school of Thomas Reid (1710–96), Adam Ferguson (1723–1816), Dugald Stewart (1753–1828) (*qq.v.*) and others.

This trend of thought was a reaction or revolt against the skepticism of Hume and the subjective idealism of Berkeley, both of which were regarded as the consequences of a false start, namely an excessive stress on ideas, and as reductions to absurdity of the premisses from which they started. For the false start Descartes and Locke were held to be chiefly responsible inasmuch as they gave to ideas an importance that inevitably made everything else succumb to them.

> Ideas [says Reid] seem to have something in their nature unfriendly to other existences . . . they have by degrees supplanted their constituents, and undermined the existence of everything but themselves. First, they discarded all secondary qualities of bodies; and it was found out by their means that fire is not hot, nor snow cold, nor honey sweet; and, in a word, that heat and cold, sound, colour, taste and smell, are nothing but ideas or impressions. Bishop Berkeley advanced them a step higher, and found out, by just reasoning from the same principles, that extension, solidity, space, figure and body, are ideas, and that there is nothing in nature but ideas and spirits. But the triumph of ideas was completed by the *Treatise on Human Nature,* which discards spirits also, and leaves ideas and impressions as the sole existences in the universe (*Works,* i, p. 109).

In the actual perception of the normal unsophisticated man, sensations are not mere ideas or subjective impressions but carry with them the belief in corresponding qualities as belonging to external objects. Such beliefs, Reid insists, "belong to the common sense and reason of mankind," and in matters of common

sense "the learned and the unlearned, the philosopher and the day-labourer, are upon a level."

Kant, who was too much under the influence of idealism to respect the philosophy of common sense, the natural enemy of idealism, spoke contemptuously of common sense as "one of the subtlest inventions of modern times, by which the emptiest talker may coolly confront the profoundest thinker, and hold out against him" (*Prolegomena*, Introduction). That, however, did not kill all forms of the philosophy of common sense.

From 1816 to 1870 the Scottish doctrine was adopted as the official philosophy of France; and in the 20th century G. E. Moore's teaching (in particular his "Defence of Common Sense," *Contemporary British Philosophy*, 1925) convinced many British and U.S. philosophers that it was not their business to call in question the common certainties but rather to analyze them.

(A. Wo.; X.)

COMMONWEALTH is the term that was often employed by 17th-century writers (*e.g.*, Thomas Hobbes and John Locke) to signify the concept of the organized political community. For them it meant much the same as either *civitas* or *respublica* did for the Romans, or as "the state" means in the 20th century. Specifically, also, commonwealth served as the label of the Cromwellian regime in Great Britain (1649–60). Modern usage has further extended the term. Thus, the Australian colonies were federated as states in 1900 under the official title of the Commonwealth of Australia. Then, as various British colonies evolved from a status subordinate to the United Kingdom into a free association of equal partners, the new relationship was named a commonwealth, especially after the declaration on status approved by the 1926 Imperial conference.

After India became a republic and chose to remain inside the commonwealth, the phrase "head of the Commonwealth" was substituted for "emperor of India" in the royal title, and Queen Elizabeth II was so crowned in 1953. (*See* COMMONWEALTH OF NATIONS.)

In the United States, commonwealth has continued to be the official description of four states (Kentucky, Massachusetts, Pennsylvania and Virginia).

The same term also was applied to the island of Puerto Rico after the act of congress of 1950 and adoption of the constitution of 1952.

(L. LIP.)

COMMONWEALTH OF NATIONS, formerly described as the British Commonwealth or British empire, is the name given collectively to all those territories which give allegiance to the British crown or acknowledge the British monarch as the symbol of their free association and as such the head of the commonwealth. They comprise 21 sovereign states: the United Kingdom, Canada, Australia, New Zealand, India, Pakistan, Ceylon, Ghana, Malaysia, Nigeria, Cyprus, Sierra Leone, Tanzania (Tanganyika and Zanzibar), Jamaica, Trinidad and Tobago, Uganda, Kenya, Malawi (Nyasaland), Malta, Zambia (Northern Rhodesia) and Gambia, and also the territories still administered by the U.K., besides the protected states, protectorates and trust (formerly mandated) territories over which the United Kingdom or one of its independent partners exercises more or less control. Sometimes the term "British Commonwealth" is used to describe only the independent member nations but technically is all-embracing.

The commonwealth is not a federation, for there is no central government or constitution, defense force or judiciary, and no rigid obligations or commitments. Nor is it comparable with a contractual alliance such as the United Nations. Members have a broad community of interest arising in part from the fact that each was at one time the responsibility of the United Kingdom. They speak a common political language and, in spite of diversities of race and tradition, possess a broadly similar pattern of institutions, whether legislative, executive or judicial. Her Majesty Queen Elizabeth II, broadcasting from Auckland, N.Z., in 1953, described the commonwealth as "an entirely new conception—built on the highest qualities of the spirit of man: friendship, loyalty and the desire for freedom and peace." A notable role in the relations between commonwealth peoples is also played by sport. (*See* BRITISH EMPIRE AND COMMONWEALTH GAMES.)

This article contains the following sections and subsections:

I. Area, Population and Status
II. Evolution
  A. Self-Governing Countries
    1. World War I
    2. Problems of Status and Responsibility
    3. Statute of Westminster, 1931
    4. Abdication of King Edward VIII
    5. International Affairs, 1931–39
    6. World War II
    7. Co-ordination After World War II
    8. Asian Members of the Commonwealth
    9. British Nationality Act
    10. Secession of Ireland (Eire)
    11. Regional Security
    12. Changing Commonwealth
    13. Special Territories
  B. Nonself-Governing Territories
    1. Colonial Policy
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III. Co-operation and Consultation
    1. Colonial Office and Commonwealth Relations Office
    2. High Commissioners
    3. Prime Ministers' Meetings
    4. Governors General
    5. Organizations and Standing Committees
    6. Economic Co-operation
    7. Scientific Co-operation
    8. Educational Co-operation
    9. Nationality and Citizenship
    10. Judicial Committee of the Privy Council
    11. Social Security Reciprocity
    12. Defense
IV. Production and Trade
    1. Production
    2. Economic Development
    3. Trade
V. Finance
    1. Sterling Area
    2. Banking
    3. Investment
VI. Communications
    1. Shipping
    2. Air Communication
    3. Railways and Roads
    4. Telecommunications
    5. Postal Services

Insofar as the history of the commonwealth is that of its several parts, it may be studied in the articles on the individual countries and territories listed in Tables I and II. Further aspects of the commonwealth's origin and development are to be found, however, in supplementary articles as follows:

For the participation of the British in the voyages of exploration that followed the discovery of the new world at the end of the 15th century, *see* GEOGRAPHY; for the motive and effect of this participation, *see* COMMERCE, HISTORY OF and also COLONY. The end of the 16th century saw the foundation of the East India company (*q.v.*). The beginnings of English settlement on the American continent are part of the history of the United States of America (*q.v.*) and the separate articles on the original 13 states of the union may also be referred to. Of more enduring importance for the commonwealth, however, was the formation of the Hudson's Bay company (*q.v.*) in 1670.

The progress made in the 18th century and in the early part of the 19th was largely the result of the so-called Second Hundred Years' War between England and France (*see* articles dealing with the War of the Spanish Succession, the Seven Years' War, the French Revolutionary Wars, and the Napoleonic Wars which were all terminated by treaties assigning overseas possessions to the United Kingdom; *see* also UTRECHT, TREATY OF; PARIS, TREATIES OF); even the treaty of Aix-la-Chapelle at the end of the War of the Austrian Succession contained provisions that assured a certain British expansion abroad.

The 19th century was that of the penetration and partition of Africa (*q.v.*); *see* also EGYPT; SUDAN, REPUBLIC OF THE and SOUTH AFRICAN WAR. The major gains of the 20th century came from the partition of the German colonies and of the Ottoman provinces under the mandate system sponsored by the League of

Nations (*see* MANDATE). For commonwealth flags *see* FLAG.

For further information *see* the biographical articles on the great pioneers, navigators, merchants, governors, viceroys, generals and administrators.

I. AREA, POPULATION AND STATUS

The areas and populations of the territories of the commonwealth are shown in Tables I and II. The dates given against the names indicate in some cases when colonies were first organized or claimed as British, in other cases treaties recognizing either British possession, protecting status or mandatory power. This is an attempt to indicate the chronology of British expansion overseas from the 17th century to the end of World War I and its changing relationship in the modern world.

At mid-20th century the forms of government in the commonwealth were diverse—they ranged from independent parliaments of the fully self-governing member states to colonial forms of administration over which the United Kingdom parliament exercised

TABLE I.—*Independent Members of the Commonwealth and Their Dependencies (Excluding U.K. Dependencies), May 1965*

Country	Area (land and inland water, sq.mi.)	Population*
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND	94,211	52,709,031
England (excluding Monmouthshire)	50,332	43,460,525
Wales (including Monmouthshire)	8,016	2,664,023
Scotland	30,411	5,179,441
Northern Ireland	5,452	1,425,042
Isle of Man (not part of U.K.)	227	48,150
Channel Islands (not part of U.K.)	75	110,608
CANADA	3,851,809	18,238,247
Provinces: Manitoba (1670), Saskatchewan (1670), Alberta (1670, 1795), Nova Scotia (1713), New Brunswick (1713), Quebec (1763), Ontario (1763), Prince Edward Island (1763), British Columbia (1849), Newfoundland (1623) with Labrador (1759)		
Territories: Yukon (1898), Northwest Territories (Keewatin, Franklin, Mackenzie, 1903)		
AUSTRALIA, COMMONWEALTH OF	2,967,741	10,508,186†
States: New South Wales (colony, 1788), Victoria (1836), Western Australia (1829), Queensland (1824), South Australia (1836), Tasmania (1803)		
Mainland territories: Northern Territory (1824), Capital Territory		
Trust territories:		
Nauru (Austr., U.K. and N.Z.; administered by Austr.)	8.2	4,539
New Guinea (with the Bismarck archipelago and N.E. Solomon Islands)	93,000	1,448,919‡
External territories: Papua (with D'Entrecasteaux Islands, Louisiade Islands, Woodlark Islands and Trobriand Islands)	Papua-New Guinea jointly administered 90,540	523,442‡
Norfolk Island	13.3	844
Cocos (Keeling) Islands	5	606
Christmas Island (1888; to Austr. 1958)	55	3,099
Heard and McDonald Islands	113	—
Antarctic territory (claimed)	2,472,000§	...
NEW ZEALAND	103,736	2,414,984
New Zealand proper: North Island, South Island, Stewart Island and Chatham Islands with Auckland Islands, Campbell Island, Antipodes Islands and other minor islands (1840–42, etc.); also Kermadec Islands (1887)		
Island territories: Niue, Cook (internally self-governing, 1962) and Northern Islands (1901), Tokelau Islands (British 1892, N.Z. administration 1926)	193	25,107
Ross dependency (Antarctic territory, claimed)	160,000§	198
INDIA, REPUBLIC OF (BHARAT)	1,262,275	439,072,893
States: Andhra Pradesh (from Madras, 1953), Assam (protectorate, 1826), Bihar (attached to Bengal, 1765), Gujarat (formed 1960 from part of Bombay [factory at Surat, 1616]), Kerala (created 1956 from Travancore, treaty 1923, Cochin, treaties 1791, 1809, and Madras), Madhya Pradesh (Nagpur annexed, 1853), Madras (settlement, 1639), Maharashtra (formed 1960 from part of Bombay), Mysore (1831 *et seq.*), Orissa (annexed 1803), Punjab (1849), Rajasthan, Uttar Pradesh (annexations, 1775–1856), West Bengal (factories, 1633), Jammu and Kashmir (treaty 1846; inclusion disputed by Pakistan)		

Country	Area (land and inland water, sq.mi.)	Population*
Centrally administered territories: Andaman (1789 *et seq.*) and Nicobar (1869) Islands; Delhi (protectorate, 1803); Himachal Pradesh; Laccadive, Minicoy and Amindivi Islands (from Travancore-Cochin, 1956); Manipur (treaty, 1762); Tripura (1765); Pondicherry (former French, *de facto* administration 1954, *de jure* 1962); Nagaland (from Assam, 1961); North East Frontier Agency (from Assam, 1961); Goa and other former Portuguese enclaves (*de facto* administration 1961)		
Protected states:		
Bhutan (treaties, 1774 *et seq.*)	19,305	680,000§
Sikkim (treaties, 1816 *et seq.*)	2,828	161,080
PAKISTAN, REPUBLIC OF	365,529	93,831,982
Provinces: West Pakistan (1832 *et seq.*) East Pakistan (1633 *et seq.*)		
CEYLON (1795)	25,332	10,624,507‖
GHANA, REPUBLIC OF	92,100	6,726,815¶
Union of four historically separate units: Gold Coast colony (1821) Ashanti confederacy (1896) Northern Territories protectorate (1897) Togoland (British sphere, mandated 1922)		
MALAYSIA	128,693	10,853,000◊
States of Malaya: Settlements: Penang (1786), Malacca (1795, 1824)		
Protected sultanates: Perak (1874), Selangor (1874), Negri Sembilan (1874), Pahang (1888), Kedah (1909), Kelantan (1909), Perlis (1909), Trengganu (1909), Johore (1914)		
Singapore (Settlement, 1819; colony 1867)		
Sabah (North Borneo) (Colony, 1946; Labuan settlement, 1846)		
Sarawak (Colony, 1946; protectorate, 1888)		
NIGERIA, FEDERAL REPUBLIC OF	356,669	55,620,268‖
Lagos (federal capital) (colony, 1861) Northern Nigeria Western Nigeria Eastern Nigeria Mid-West Nigeria (Protectorate, sphere of influence, 1885) (Former northern zone of Cameroons, mandated 1922)		
CYPRUS, REPUBLIC OF	3,572	577,615¶
Possession [treaty] 1878; colony (1925)		
SIERRA LEONE	27,925	2,450,000§
(Colony 1788; protectorate 1896)		
TANZANIA, UNITED REPUBLIC OF	362,821	10,118,000δ
Tanganyika (mandated 1922, trust territory, 1946) Zanzibar (protected sultanate, 1890)		
JAMAICA	4,413	1,613,880¶
(Colony 1655)		
TRINIDAD AND TOBAGO	1,980	827,957¶
(Colony—Trinidad 1802, Tobago 1763, 1814)		
UGANDA	91,134	6,536,616Ω
(Buganda 1894, protectorate)		
KENYA	224,960	8,636,263°
(Colony, 1890; protectorate, 1895)		
MALAWI (NYASALAND)	45,747	2,982,300§
(Protectorate, 1891)		
MALTA	122	328,116Ω
(Colony [1814] with Gozo, Comino and islets)		
ZAMBIA (NORTHERN RHODESIA)	290,587	3,493,590**
(Protectorate, 1924)		
GAMBIA	4,003	315,486‖
(Colony [1618, 1816] including Kombo St. Mary, Protectorate [1894])		

*1961 census, unless otherwise indicated. †Excludes aboriginal population, 40,081. ‡1961 estimate, census of non-indigenous. §Estimate. ‖1963 census. ¶1960 census. ΩΩ1964 estimate. δ1963 estimate. °1959 census. Ω1962 census. **1961/63 census.

TABLE II.—*United Kingdom Dependencies, May 1965*

Territory	Status	Area (land and inland water, sq.mi.)	Population*
MEDITERRANEAN			
Gibraltar	Colony (1704)	2.25	24,502†
CARIBBEAN			
Antigua	Colony (1632) with Barbuda and Redonda	170	54,060
Barbados	Colony (1627), self-governing	166	232,333
British Guiana	Colony (1814), self-governing	83,000	560,406
British Honduras	Colony (1638), including cays	8,867	90,121
British Virgin Islands	Colony (1666) with Sombrero	59	7,340
Cayman Islands	Colony (1670)	100	8,511
Dominica	Colony (1763, 1783)	290	59,916
Grenada	Colony (1763, 1783) with Carriacou	133	88,677
Montserrat	Colony (1632)	32	12,108
St. Kitts (St. Christopher)-Nevis, Anguilla	Colony (1623, 1628)	138	56,693
St. Lucia	Colony (1814)	238	86,108
St. Vincent	Colony (1763, 1783) with Grenadines other than Carriacou	150	79,948
Turks and Caicos Islands	Colony (1799)	166	5,668
ATLANTIC OCEAN			
Bahama Islands	Colony (1649)	4,404	130,721‡
Bermuda	Colony (1612)	20.59	42,640
British Antarctic Territory	Colony (1962)		
	South Orkneys (1821)	239	
	South Shetlands (1819)	1,800	
	Antarctic Peninsula	about 473,000‖	85§
Falkland Islands	Colony (1765, 1833)	4,700	2,172¶
	Dependencies:		
	South Georgia (1775)	1,450	92§
	South Sandwich	120	. . §
St. Helena	Colony (1659)	47	4,613♀
	Dependencies:		
	Ascension (1815)	34	336δ
	Tristan da Cunha (1816), with Nightingale and Inaccessible Islands	75	264δ
	and Gough Island		—
FAR EAST			
Brunei	Protected sultanate (1888)	2,226	83,877
Hong Kong	Colony: Hong Kong Island (1841), with Kowloon ceded territory and islets (1860) and leased New Territories including islands (1898)	398	3,133,131†
AFRICA			
Former High Commission Territories:			
Basutoland (Lesotho)	Colony (1868)	11,716	708,000□
Bechuanaland	Protectorate (1885)	220,000	543,105°
Swaziland	Protectorate (1906)	6,705	287,900**
Southern Rhodesia	Self-governing colony (1923) (Matabele concessions, 1888)	150,333	3,857,470††
ARABIA AND INDIAN OCEAN‡‡			
South Arabia			
Aden Colony	Colony (1839)	75	250,000**
Protectorate of South Arabia	Protectorate (1959) includes Socotra Island	112,000‖	1,220,000**
Federatio of South Arabia	Includes certain member states of Protectorate and Aden State (1962)	(60,000‖)	(712,000**)
Perim Island	Possession (1857)	5	280δ
Kuria Muria Islands	Possession (1854)	28	300‖
Kamaran Island	Possession (1915)	22	2,220**
Maldive Islands	Protected sultanate	115	94,257
Mauritius	Colony (1810, 1814) with Rodrigues and lesser dependencies, including Diego Garcia	720	681,619¶
		84.5	20,000δ
Seychelles	Colony, including the Seychelles proper (1814), the Amirante archipelago, Providence, Farquhar, Cosmoledo and Aldabra Islands, Assumption, Astove and Coetivy (92 islands and islets in all)	156	41,425
WESTERN PACIFIC			
Western Pacific High Commission:			
British Solomon Islands	Protectorate (1893) with the Santa Cruz and other islands (1898–99)	11,500	124,076§§
Gilbert and Ellice Islands	Protectorate (1892), colony (1915–16) with Phoenix Islands (1889, 1900), Northern Line Islands (1888) and Ocean Island (1900)	338	48,780‡
New Hebrides	Anglo-French condominium (1887, 1906) with Banks Islands and Torres Islands	5,700	61,476□
Central and Southern Line Islands	Possessions (5 islands)	36	—
Canton and Enderbury Islands	Anglo-U.S. condominium (1939)	27	391♀
Fiji	Colony (1874) with Rotuma (1881) (about 322 islands).	7,055	441,301**
Pitcairn	Colony (1790) with Henderson, Ducie and Oeno (1902) dependencies	2	89°
Tonga	Protected kingdom (1900) comprising Tongatabu, Vavau and Haapai groups of islands	17	—
		270	69,495**

*1960 census, unless otherwise indicated. †1961 census. ‡1963 census. §Fluctuates according to season. ‖Estimate. ¶1962 census. ♀1964 estimate. δ1961 estimate. □1962 estimate. °1964 census. **1963 estimate. ††1961/63 census. ‡‡Excludes states under special treaty with the U.K.: Bahrain, Muscat and Oman, Qatar, Trucial states. §§1959 census.

ultimate control. Most colonial governments enjoyed a large measure of autonomy, the broad aim of British colonial policy being to guide the peoples of the territories through internal to self-government to independence within the commonwealth of nations.

The independent member states are either monarchies or republics and have adopted democratic constitutions; the legislative pattern is common to all members and, with the exception of Pakistan, there exists in each a parliament comparable in form and procedure with the British parliament at Westminster with a cabinet responsible to it.

Each is a sovereign state, framing its own laws, maintaining its own armed forces and controlling its own internal and external affairs. At the same time, each is a freely co-operating member of an association which is linked by common ideals, purposes and interests. In those member states of the commonwealth which are monarchies, the monarch is represented by a governor general. The latter acts only on the advice given to him by the ministers of the county to which he is appointed (see *Governors General*, below).

The prime minister of the United Kingdom communicates directly with the prime ministers of the other member countries, as they do with him. The United Kingdom appoints high commissioners, corresponding to ambassadors, to other member states, which, in turn, appoint high commissioners to the United Kingdom and to one another (see *High Commissioners*, below). Members of the commonwealth have their own representatives in the United Nations.

During the ten years of its existence (1953–63) the status of the Federation of Rhodesia and Nyasaland, though in some ways similar to that of independent members of the commonwealth, did not amount to full membership. While the federation enjoyed responsible government in accordance with its constitution, the United Kingdom government was generally responsible for the federation in the international sphere. However, extensive entrustments in the field of external affairs were made to the federal government.

Territories that have not reached fully self-governing status are collectively called dependencies and include colonies, protectorates and protected states. They pay no taxes or tribute of any kind to the British government, except that a few which have bases defended by British armed forces make small maintenance contributions.

COLONIES: Some dependencies, *e.g.*, Barbados, are self-governing internally but the United Kingdom government is responsible for their defense and foreign policy. In others, the administration is carried on by a governor with the help of a legislature partly elected, partly nominated. In some of the more advanced terri-

tories, for example in British Guiana, a ministerial system has been introduced. Their peoples are citizens of the United Kingdom and colonies.

PROTECTORATES: These—Swaziland, for example—are territories not formally annexed but under the protection of the United Kingdom, which controls their government in varying degrees as it does those of colonies. Their peoples are British-protected persons.

PROTECTED STATES: These are states under a ruler, such as the kingdom of Tonga, which, while retaining their own sovereignty, have entered into treaties giving the British government certain rights and responsibilities. Their peoples are British-protected persons.

TRUST TERRITORIES: These were former enemy territories, administered under a trusteeship agreement with the United Nations. Examples were Tanganyika, administered by Great Britain until attainment of independence in Dec. 1961; and Western Samoa, administered by New Zealand prior to becoming an independent state in Jan. 1962. The Territory of New Guinea is still under Australian trusteeship.

CONDOMINIUMS: These are territories where responsibilities are shared by two administering powers; *e.g.,* the New Hebrides (Anglo-French condominium).

LEASED TERRITORY: This term now applies only to the mainland of China and adjacent islands known as the New Territories which were leased to Great Britain in 1898 for 99 years and administered from Hong Kong. Membership status is discussed more fully in *Evolution,* below.

II. EVOLUTION

It may be useful to discuss initially those overseas territories which were once for considerable periods of time controlled to a greater or lesser degree by Great Britain but which by the middle of the 20th century were outside the commonwealth. The European territories that the Norman and Angevin kings of England held at various times as dukes of Normandy, counts of Anjou or dukes of Aquitaine were all, except the Channel Islands, *de facto* lost before the union of the English and Scottish kingdoms (1707) and so do not fall within this definition; and the same applies to Surinam, ceded to the Netherlands in 1667, and to Tangier, which was English from 1662 to 1684. Nor can territories subjugated in the course of military operations but evacuated or retroceded on the conclusion of peace treaties be enumerated here.

The most serious territorial loss that the British empire had to sustain was that of the 13 North American colonies that revolted to form the United States of America. Before this, St. Pierre and Miquelon, captured in 1702, had in 1763 been restored to France. Minorca in the Balearic Islands, which had been a British possession *de jure* since 1713, was ceded to Spain in 1802. In the century following 1814, during which so much was being acquired and consolidated (*see* Tables I and II), comparatively little was lost: Bengkulen (Benkoelen; 1685) and other Sumatran factories of the East India company, however, were given to the Dutch in 1824 in exchange for Malacca and their settlements on the Coromandel coast (though British claims to the exclusive protection of Achin [Atjeh, Indon.] were not to be formally abandoned until 1871); the protectorate over the Ionian Islands, Greece (1815), was terminated in 1864; Heligoland (1814) was ceded to Germany in 1890 as the price of acquiescence to the British protectorate over Zanzibar; Palmyra (1889), one of the Line Islands, was incorporated among the Hawaiian Islands by the U.S. in 1898; and the Los Islands (1818), now in the Republic of Guinea, were ceded to France in 1904. After World Wars I and II the ratio of diminution and acquisition changed: Egypt, which had been occupied since 1882 and a protectorate since 1914, was declared an independent kingdom in 1922; the Hankow concession fell to the Chinese nationalists in 1926, and Wei-hai-wei, leased in 1898, was given back to China in 1930; the mandate over Iraq (1922) was terminated in 1932; Jarvis, one of the Line Islands, was tacitly relinquished to the United States in 1935; Kuling passed back to the Chinese in 1936; in the Pacific, Canton and Enderbury Islands, of the Phoenix group, became an Anglo-U.S. condominium in 1939; the concessions in Shanghai and in Amoy were abandoned in 1943; the mandates over Transjordan and over Palestine were terminated in 1946 and in 1948, respectively; and Burma seceded from the commonwealth in 1948, the Republic of Ireland in 1949, the Sudan in 1956, British Somaliland which amalgamated with the former Italian Somaliland to form the Somali Republic in 1960, and South Africa in 1961.

Meaning of Commonwealth.—Historians are agreed that the first British empire came to an end in 1776 but thereafter there is no unanimity about the great watersheds in its history. Some have endorsed the opinion of Sir Alfred Zimmern, who in *The Third British Empire* (1926) recorded that the second British empire reached the culmination of its power in World War I and then expired to be succeeded by a third British empire, "new in its form, new in the conditions which it has to face within and without its borders, new even in its name." But even where this argument was accepted, the designation was not generally used, for to many "empire" seemed no longer an appropriate description.

The term "British Commonwealth of Nations" was first used by Lord Rosebery on a visit to Adelaide, Austr., in 1884. It was revived by Lionel Curtis and given wider publicity by Gen. J. C. Smuts in 1917. In that same year a resolution of the imperial war conference spoke of a full recognition of the dominions as "autonomous nations of an Imperial Commonwealth." The term "British Commonwealth of Nations" first received statutory recognition in article iv of the Anglo-Irish treaty of 1921, but even thereafter there was no finality about its phrasing or precise meaning. To some "British Commonwealth of Nations" was synonymous with "British empire"; to others it had a more restricted meaning, being applied only to the United Kingdom and the self-governing dominions. The famous report of the Inter-Imperial Relations committee of the 1926 imperial conference, generally known as the Balfour report, referred to the dominions as "autonomous communities within the British Empire" which were "freely associated as members of the British Commonwealth of Nations." The use of both descriptions was deliberate, the term "British empire" being used in the words of L. S. Amery, the first secretary of state for dominion affairs, to describe the British political organism as a whole, and the designation "British commonwealth" to denote within that wider whole the smaller group of fully self-governing communities which were enumerated in article i of the Statute of Westminster in 1931 as the United Kingdom of Great Britain and Northern Ireland, the dominion of Canada, the commonwealth of Australia, the dominion of New Zealand, the Union of South Africa, the Irish Free State and Newfoundland. In 1947 India and Pakistan and in 1948 Ceylon were added to the number of the dominions; in 1949 Newfoundland was absorbed as the tenth province in the Canadian confederation; in 1949 also the Irish Free State, known after the enactment of the constitution of 1937 as Eire, seceded. In 1957 Ghana and Malaya, and in 1960 Nigeria and Cyprus became full members of the commonwealth. They were followed by Sierra Leone and Tanganyika (1961); Jamaica, Trinidad and Tobago and Uganda (1962); Malaysia, Zanzibar and Kenya (1963); Malawi, Malta and Zambia (1964); and Gambia (1965).

The term "British Commonwealth of Nations" was not itself unaffected by changes in the character and outlook of its members. In May 1949 the British prime minister C. R. Attlee revealed that after deliberation there had been no agreement on the part of his majesty's governments to adopt or exclude the designations "commonwealth," "British Commonwealth of Nations" or "British empire" to describe the community of peoples to which they belonged. Nonetheless by the middle of the 20th century "commonwealth" was the most generally accepted description of the community as a whole while "member nations" or "realms" was replacing "dominions" as the description of its self-governing units. In 1947 the dominions office was renamed commonwealth relations office. In the field of citizenship, however, "British subject" still held its own against the newer designation of "commonwealth citizen" (introduced in the British Nationality act, 1948).

The shift in emphasis from "empire" to "commonwealth" was a matter not so much of constitutional form as of political reality.

It denoted the principle which had guided the development of this group of nations in the first half of the 20th century by reflecting the emphasis placed throughout on decentralization. "It is the policy of decentralization," said Gen. Louis Botha in 1911, "which has made the British empire." It was the decisive influence in the refashioning of the empire after World War I; and with the increase in the stature of the older dominions during, and the addition of the new Asian members to their number after, World War II it gathered renewed momentum. By 1943 General Smuts could say that the British group of self-governing nations had "become wholly decentralized as sovereign states." Yet he saw there evidence not of impending disintegration but of the fuller realization of the ideal of commonwealth. Indeed his principal misgiving was lest the continued centralization of government in the British colonial empire should create problems which might impair the success of a great experiment. In 1949, with the acceptance of India as a full member, the commonwealth reached a climax in this phase of its development by the abandonment, in respect of India, of allegiance to the crown, the traditional symbol of constitutional unity.

The development of the relationships between the units of the commonwealth is further dealt with in the section on *Co-operation and Consultation*, below.

A. Self-Governing Countries

The political development of the dominions is best described as a process of assimilation by which British citizens in the overseas territories occupied by the dominions acquired in course of time, stage by stage, the same political status as British citizens in the mother country.

The isolation of the first colonists on the North American coast made it difficult for these pioneers to be represented in the English parliament. In each colony, however, soon after its foundation, a representative assembly was established, on the model of the house of commons, which enacted legislation for the colony, including taxation to meet the cost of its administration. But the executive was independent of the legislature: the governor and other officials were responsible in most colonies only to the crown or the minister who advised the crown.

Externally, however, the colonists were quite subordinate to the British government. Their trade was controlled by a system of navigation acts and other legislation, enacted by the British parliament as part of a commercial system applied to the whole empire. This system was bound to become objectionable as soon as anything occurred to emphasize the inequality of status that it involved; and when the British government attempted to raise money for the cost of maintaining troops in America, partly by direct taxation and partly by stiffening up the administration of the trade laws, the colonists revolted and the system collapsed.

Fifty years after the American Revolution, British statesmen were confronted with a similar crisis in those colonies in North America which had survived the schism or had been established since. Except for the decision never again to tax the colonies for revenue, the new political system was much the same as the old. The colonies possessed local representative government and nothing more, and in 1837 a period of increasing tension in Upper and Lower Canada culminated in rebellions. Lord Durham, sent from England to investigate, declared in his famous report (*see* Durham, John George Lambton, 1st Earl of) that the only cure was to give the colonists the same kind of self-government in all their internal affairs as that enjoyed by Englishmen at home. The result was that responsible government was established in the North American colonies in 1846–49 and in Australia and New Zealand a few years later. Once it had been conceded that the people of a colony had the same right as the people of the mother country entirely to control their local affairs, it was difficult to refuse their claim for a wider measure of equality. In 1859, after a brief controversy, the demand of the province of Canada to be free to set up protective tariffs not only against foreign goods but also against British was conceded.

The most important stage in this advance was the change from colonies into dominions; *i.e.*, the unification of contiguous groups of colonies into national entities. By this means colonies, which in their separate existence had been small and weak, attained a size and strength which made them at least potentially comparable with the mother country. Unification also made possible the steady growth of a distinctive national spirit. In 1867 the four chief North American provinces, on their own initiative but with full consent in Great Britain, constituted themselves a federation under the title of the Dominion of Canada; the other provinces, existing or created later, all joined the federation in due course. Newfoundland chose to remain separate.

For various local reasons the other groups of colonies were slow to follow Canada's lead. The commonwealth of Australia was not to be proclaimed till 1901 and the Union of South Africa (from 1961 the Republic of South Africa) did not become a reality till 1910. New Zealand, which had never been divided into separate colonies, obtained a unitary constitution in 1870, but did not receive the official designation of "dominion" till 1907.

1. World War I.—At the imperial conference of 1911, H. H. Asquith recognized the guiding principle of decentralization in imperial affairs: "We each of us are, and we each of us intend to remain, masters in our own house." But responsibility for foreign policy, he said, could never be shared and must remain solely the province of the imperial government in London. Yet even when he spoke this limitation had no absolute validity. Already the government of Cape colony had expressed strong views about the German acquisition of South West Africa; the Australian colonies had pressed for expansionist policies in the Pacific so as to forestall other powers; and in 1911–12 Robert Borden defined the Canadian contribution toward naval defense in the light of German naval construction. For the most part, however, the views expressed by colonial or dominion governments related not to the broad issues of foreign policy but to questions of local or regional concern. Yet, even this much was important in that it suggested that Asquith's conception of a foreign policy that remained the exclusive preserve of the imperial government could not even in normal circumstances be indefinitely sustained. The coming of World War I and the wholehearted participation of the dominions from the outset altogether outdated it, for their services in the field at least entitled them to a voice in the shaping of the world that was to emerge with the victory of Allied arms.

Imperial War Cabinet.—Dominion participation in shaping foreign policy came almost incidentally out of the exacting responsibilities and demands of war. In March 1917 the imperial war cabinet was created, as a means whereby dominion leaders might be more effectively associated with the prosecution of the war. Its creation meant that in 1917–18 there were two cabinets sitting in London, that of the United Kingdom concerned with its own affairs and the imperial war cabinet dealing with those wider issues which affected the empire as a whole. The prime minister of the United Kingdom presided over both; but in the imperial war cabinet all met as equals and the United Kingdom prime minister was *primus inter pares* ("first among equals").

As victory approached, the members of this imperial war cabinet became progressively more preoccupied with questions of peacemaking and foreign policy, and at its third plenary session in Nov. 1918 the dominions, under Canadian leadership, claimed the right as autonomous states and effective belligerents to representation at the peace conference. Their claim was recognized by the United Kingdom, and the empire was represented at Versailles not by a United Kingdom but by a British empire delegation. From there it was a short step to dominion membership of the League of Nations and to the recognition of the dominions as full members of the international community.

If, however, the creation of the imperial war cabinet marked the decisive stage in the extension of dominion autonomy from internal to external affairs it did little to resolve the essential problem which had led Asquith to conclude that responsibility for foreign policy could not be shared. That problem arose from the apparent difficulty of devising any system acceptable to dominion opinion that would reconcile the separate responsibility of five governments in the making of policy with continuing imperial unity. It is true that at one time it seemed as though the imperial

war cabinet itself might provide the answer. It acquired much prestige from its character, from its distinguished membership and from its achievements. But it suffered from one inherent weakness: it was not in any accepted sense of the word a cabinet at all, because it was collectively responsible to no single legislature, dominion ministers being separately responsible to their own parliaments and peoples. Moreover, when victory was assured the strength of imperial sentiment waned. The majority of the dominions became more and more concerned with the exercise of their new powers and anxious lest continuing centralized wartime expedients should fetter their peacetime freedom of action. For this reason they emphasized their separate responsibility in matters of policy and resolved to secure recognition of their new status in the international field.

2. Problems of Status and Responsibility.—In 1919 the dominions were not recognized by foreign powers as independent nations, and at the Versailles peace conference the British empire delegation was accepted as representing not sovereign states but only "belligerent powers with special interests" having a right to a voice in the making of peace. In fact dominion influence at Versailles, though considerable, was indirect, being exercised through the United Kingdom delegation and particularly through David Lloyd George as one of the "Big Three." Moreover, it did not reflect any uniformity of view: while the Australian prime minister, W. M. Hughes, advocated a Carthaginian peace, the South Africans Botha and Smuts pleaded persistently for more generous terms for the vanquished. In the signing of the treaty, however, the status of the dominions was significantly advanced. Their delegates received from the crown the power to sign separately on behalf of their respective governments, and while the United Kingdom delegates signed for the British empire as a whole the dominion delegates signed each for his dominion. The dominions also insisted that the treaty should not be ratified until approved by their own parliaments.

The same procedure was followed in the negotiation and ratification of the Washington treaties of 1921–22 on naval disarmament and Pacific security. By 1945 the dominions' signatures to international agreements were customarily to appear in their correct alphabetical order in the list of the signatory nations; but in 1919 for the Versailles treaty they were grouped together under the general heading "British Empire." The effect of League of Nations membership was to confer on the dominions and India, which though nonself-governing was for this purpose numbered with them, an international status which was enhanced by the direct responsibility given to Australia, to New Zealand and to South Africa for the administration of mandated territories.

The climate of opinion in the years after World War I at once encouraged and assisted the dominions' desire for full international recognition; if the new international machinery of the League had banished war, close imperial cohesion for defense was now of secondary importance. At the same time concentration of interest on that international machinery encouraged the belief that it was not as members of an imperial grouping but as separate and independent nations that the dominions could make their best contribution to world affairs. For them, and more particularly for the nationally self-conscious dominions of Canada, South Africa and, after 1921, the Irish Free State, the League provided a training ground in international affairs and the means whereby their status might be at once asserted and further advanced. Yet it would be unwise to assume that dominion membership in the League conflicted in the long run with the cohesion of the commonwealth; later experience was to suggest that the League, so long as it was in effective existence, could contribute much to commonwealth solidarity by uniting all its members in support of causes which transcended exclusively commonwealth interests.

The implications of the trend of dominion opinion toward separate responsibility was not for some time assessed correctly. As late as Dec. 1921, in the debate on the Anglo-Irish treaty, Lloyd George told the house of commons that the foreign policy of Great Britain would henceforward be the joint foreign policy of the British empire; while the foreign office would, in his view, inevitably remain the instrument of that policy, all the dominions would be associated in its control. But the dominions had very different views, which were elicited by the crisis at Chanak (Canakkale), Turk., in Sept. 1922, which threatened to involve Great Britain in war over the control of the Dardanelles. When it seemed that the aims of British policy in the near east could be achieved only by armed intervention, Lloyd George dramatically appealed to dominion governments for support and, if need be, military assistance. The response varied, but the decisive reply came from the Canadian prime minister, W. L. Mackenzie King. He stated in friendly but emphatic terms that the Canadian government had no prior knowledge of the impending crisis, that it would require full information before making any decision and that in any event Canadian participation in any conflict could be decided only by the Canadian government and parliament. This principle of reference to parliament, endorsed at the time by the South African government and later implicitly accepted by all dominion governments, precluded in practice a common imperial foreign policy.

In the Locarno treaty of 1925 dominion assumption of joint responsibility with the United Kingdom was not pressed but it was left open to dominion governments to say whether or not they wished to underwrite the obligations which Great Britain thereby undertook in the hope of maintaining peace in western Europe. In fact none of them, nor India, did so. Dominion inaction acquired added significance from the fact that they warmly approved and welcomed this departure in Great Britain's policy and frankly recognized that they would almost certainly be involved in its consequences. Their reserve was attributable in the first place to a feeling that, as extra-European states with regional interests of their own, direct participation on their part in European affairs was inappropriate; and in the second to a deep-seated mistrust of specific commitments which might be beyond their capacity to fulfill. Mistrust of specific commitments, whether to the empire or to the League, was to remain a dominant feature of dominion policy up to the outbreak of World War II.

Dominion Status.—Despite the new role and aspirations of the dominions in international affairs the imperial conference of 1921 declared itself satisfied that no reconstruction of imperial relations was desirable. Emphasis was placed upon the value of the imperial conference itself as a means of reconciling differences of view and thereby securing unity of policy; and here the conference of 1921 itself gave practical illustration of how this might be done by an agreement, after the expression of conflicting views, to allow the Japanese alliance to lapse and to replace it by regional agreements on the lines favoured by the United States government and embodied in the four- and nine-power Washington treaties of 1921–22. Whether the decision to do so was wise is a matter about which grave doubts were later expressed, especially in Australia, but at least it represented an agreed imperial decision reached after a debate on the issue involved. Later in the same year, however, the addition of the Irish Free State to the number of the self-governing dominions raised again more fundamental questions about the ordering of imperial relations and the defining of dominion status.

Irish Free State.—The Irish settlement of 1921 rested on the grant of dominion status to 26 of the 32 counties of Ireland. The Irish Free State was to have the same constitutional status in the British Commonwealth of Nations as "the Dominion of Canada, the Commonwealth of Australia, the Dominion of New Zealand, and the Union of South Africa; with a Parliament having powers to make laws for the peace, order and good government of Ireland and an Executive responsible to that Parliament." More particularly the status of Ireland was defined as being that of the dominion of Canada, the senior dominion, and "the law, practice and constitutional usage governing the relationship of the Crown . . . and the Imperial Parliament to the Dominion of Canada shall govern their relationship to the Irish Free State." The definition of the status of the new dominion was thus imprecise and by analogy. This was unsatisfying to the Irish; but both the United Kingdom and the dominion governments, other than that of South Africa, were reluctant to have any rigid definition of dominion

status and indeed felt that the association of the status of the Irish Free State with that of the dominions was both a reinsurance and a guarantee of future development. Thus Lloyd George, after dwelling on the dangers of limiting the constitution by too many "finalities," went on to emphasize that this imprecision was, in fact, of great advantage to the Irish Free State, since any attempt at "encroaching" upon its rights would make every dominion "feel that its own position is put in jeopardy."

Certain provisions in the treaty introduced from the outset differences between the status of the Irish Free State and that of the older dominions. The oath of allegiance imposed by the treaty aroused resentment in the Irish Free State, although its wording indicated that the allegiance of the members of the parliament of the Irish Free State, as distinct from those of the overseas dominions, was owed first to the constitution and only secondarily to the crown. More important in the long run was the partial maintenance of British naval control over Irish coastal defenses. In times of peace the government of the Irish Free State agreed to afford to the British forces certain harbour and other facilities, while in time of war or strained relations these facilities might be extended to anything required for defense purposes by the British government. These concessions, if fully utilized, would almost certainly have precluded an independent Irish foreign policy.

There was one inevitable distinction between the position of the Irish Free State and the overseas dominions which was of general commonwealth interest. Ireland was one of the historic nations of Europe; it had a treasured cultural tradition of its own and was itself not a country of settlement but a mother country. For these reasons its political development and aspirations were very different from those of the overseas dominions. While for Ireland dominion status represented a remarkable political advance, it was not an advance along the road which the Irish nationalists had hoped to travel. In 1916 republicanism had for them become the symbol of independence. In 1921 their leaders had conceived of Ireland as forming a republic constitutionally outside the commonwealth but, because of a community of interests in trade, foreign affairs and defense, externally associated with it and therefore recognizing the king not as king of, and in, Ireland but simply as head of the association. To this idea the Irish republican leaders, and notably Eamon de Valera who had conceived it, remained faithful, viewing it always as an alternative to dominion status. Its importance in the history of Anglo-Irish relations was therefore considerable, and for the commonwealth as a whole it had far-reaching implications. In 1917 responsible self-government had been marked out by E. S. Montagu in a momentous declaration as the goal of British rule in India. But India, too, was a mother country with an ancient civilization and political traditions that might not easily be reconciled with the accepted forms of dominion status.

Irish experience strongly reinforced the arguments of those who maintained that the old imperial legal structure must be brought more into conformity with political realities. General Smuts submitted a closely argued memorandum to this effect, urging that delay involved many and grave dangers. At the imperial conference of 1923, at which the Irish Free State was represented for the first time, some changes in conventional practice were recognized. It was accepted that treaties thenceforward should normally be negotiated and signed by the representatives of those parts of the empire which were affected and that it should be the duty of the government primarily concerned to ensure that any other government whose interests were in any way involved should be invited to take part in the negotiations at the earliest stage. Two years later a further step was taken with the creation of a dominions office presided over by a secretary of state for dominion affairs, to which all matters relating to the dominions were transferred from the colonial office. "A Foreign Office with a family feeling" was how Walter Runciman described the new department, whose first secretary of state was L. S. Amery.

Imperial Conferences of 1926 and 1930.—The most memorable step in the defining of "the position and mutual relation" of Great Britain and the dominions was taken at the imperial conference of 1926. In the report prepared by Lord Balfour's Inter-Imperial Relations committee the dominions were described as "autonomous communities within the British Empire, equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown, and freely associated as members of the British Commonwealth of Nations." In conformity with this description of a community of coequal states the right of the United Kingdom government to advise the crown on the "disallowance" or "reservation" of dominion legislation, which had already fallen into abeyance, was recognized to be inconsistent with the newer convention that in respect of dominion affairs the monarch would be advised only by the government of the dominion concerned. Yet the report recognized, too, that equality in status did not mean equality in stature and that for some time to come at least there must be diversity in functional responsibility, for the very practical reason that in the conduct of foreign affairs the dominions still relied largely on the machinery of the foreign office and in defense upon the Royal Navy. In all this, therefore, the Balfour report marked not so much a new departure as formal recognition of changes that had taken or were taking place.

The imperial conference of 1930 adopted the report of a committee, set up after the conference of 1926, to study proposals for giving legal effect to the decision to remove limitations on the freedom of the dominions and so paved the way for the enactment of the Statute of Westminster. The conference of 1930 also resolved that thenceforward governors general should be appointed by the crown on the advice of and in consultation with dominion governments.

3. Statute of Westminster, 1931.—The equal status of the dominions within the Commonwealth of Nations, as expressed in 1926 and approved in the legislative draft of 1930, was formally ratified by parliament in the Statute of Westminster, 1931. The purpose of the statute was to state some of the conventions governing relations within the commonwealth and thereby to give them the force of law. Thus it provided that no act of the imperial parliament could extend to a dominion except with its own consent, and the dominions were severally empowered to make laws with extraterritorial effect. The preamble, which had not the force of law, conveniently summarized the new pattern of the commonwealth and the essentials of dominion status.

> And whereas it is meet and proper to set out by way of Preamble to this Act that, inasmuch as the Crown is the symbol of the free association of the members of the British Commonwealth of Nations, and as they are united by a common allegiance to the Crown, it would be in accord with the established constitutional position of all the members of the Commonwealth in relation to one another that any alteration in the law touching the Succession to the Throne or the Royal Style and Titles shall hereafter require the assent as well of the Parliaments of all the Dominions as of the Parliament of the United Kingdom:
>
> And whereas it is in accord with the established constitutional position that no law hereafter made by the Parliament of the United Kingdom shall extend to any of the said Dominions as part of the law of that Dominion otherwise than at the request and with the consent of that Dominion. . .

The Statute of Westminster did not resolve overnight all those problems of status that had preoccupied the more nationalist dominions since 1919, but at least it placed within their grasp the power to resolve them for themselves. South Africa under the fusion government of J. B. M. Hertzog and Smuts embodied the principal provisions of the statute in South African law in the Status of the Union act, 1934; but while majority opinion was thereby satisfied the more extreme nationalists under Daniel Malan's leadership nonetheless continued to express concern about the right of the dominions to remain neutral in a war in which the United Kingdom was involved and to secede from the commonwealth. De Valera between 1932 and 1937 carried through a constitutional revolution which removed first the oath, then the office of governor general and finally the crown from the constitution of the Irish Free State, without (in the opinion of the judicial committee of the privy council as expressed in its judgment in the case of *Moore and Others* v. *Attorney General*) exceeding the powers conferred upon a dominion by the statute. In Australia and New Zealand on the other hand there was no such nationalist

reforming zeal. On the contrary the governments of both countries declined to ratify the relevant provisions of the statute until circumstances arising in World War II demonstrated the inconvenience of their not doing so. With reference to the possible adoption of the statute by Australia in 1937 R. G. Menzies, the attorney general, expressed something of their point of view in remarking: "My criticism is criticism of the whole 1926–1931 process, and begins and has its roots in what I would have thought was a misguided attempt in 1926 to reduce to written terms something which was a matter of the spirit and not of the letter. . ." But the majority within the commonwealth welcomed the continuing process of decentralization and definition; and it is to be noted that the weight of opinion in Canada, the senior dominion, was strongly in favour of every advance toward recognition of equality of status.

The progress of the dominions toward full equality of status led to a decline in the importance and prestige of imperial institutions. In the 20 years following the enactment of the Statute of Westminster, Canada, the Irish Free State and South Africa, as well as India and Pakistan, which were added to the number of the dominions in 1947, all abolished appeals to the judicial committee of the privy council. The imperial conference itself did not wholly escape suspicion, and before 1939 Hertzog and the Canadian prime minister Mackenzie King were careful to underline its purely advisory function. Though the exigencies of cooperation in World War II were the occasion for superseding the imperial conference with less formal meetings of commonwealth prime ministers, that was in some measure adventitious. It was already widely felt that the imperial conference had outlived its usefulness and that informal intimate discussions between ministers should take its place. At the same time intracommonwealth consultation at every level was increasingly emphasized as the means for co-ordinating policies.

4. Abdication of King Edward VIII.—It was awareness of the decline or disappearance of formal bonds of imperial unity that led Stanley Baldwin in the abdication crisis of 1936 to lay so much emphasis on the crown as the one remaining link of empire. The Statute of Westminster made the succession to the crown the responsibility of all the dominion governments, it being presumed that in the highly unlikely event of any dispute about the succession to the crown or other crisis affecting it the governments of the commonwealth would agree upon a common course of action. In this the drafters of the statute were justified in Dec. 1936. Difficult and controversial though the circumstances of King Edward's abdication were, no government within the commonwealth dissented from the course sponsored by Baldwin. In the early stages of the crisis responsibility was necessarily confined to the prime minister and later the cabinet of the United Kingdom, and it was only when the king put forward the proposal of a morganatic marriage with Mrs. Wallis Simpson that dominion prime ministers were at his request formally consulted.

The formal action taken by the dominions following the abdication varied partly for reasons of law and partly for reasons of policy. The South African government took the opportunity to reaffirm its view that the king was the king of South Africa by virtue of South African law. In the Irish Free State the government, while taking the steps necessary to ensure that appropriate action could be taken by the commonwealth to end the abdication crisis, also took the opportunity to enact the External Relations bill. Originally it had been intended that this should come after the new constitution (which was to be published early in 1937 and ratified by the people in a plebiscite later that year), but the king's abdication compelled De Valera to introduce it before. The External Relations act and the new Irish constitution, which was republican in form though not in name, together left Eire associated with the commonwealth rather than a full member of it.

At the coronation of the new king, George VI, the coronation oath mentioned the dominions by name for the first time in order to indicate their new relationship with the crown. The oath, as Mackenzie King said at the imperial conference of 1937, thus recognized that "the relationships of the several peoples under the Crown, one with another, as well as with foreign states, have become interpenetrated by the ancient principles of freedom and the rule of law. . . .It may be said that the new Oath preserving the old and finding place for the new, embodies in simple fashion our political faith, and mirrors the stature of this group of free, equal and autonomous states, known as the British Commonwealth of Nations."

5. International Affairs, 1931–39.—In 1931 the authority of the League of Nations was openly challenged by a great power in the far east. Japanese aggression in that year, therefore, shattered the belief entertained by so many within the commonwealth since 1919 that the existence of an international organization would free them from direct responsibilities for the maintenance of world security. This lesson was brought home yet more sharply four years later when the Italian armies invaded Ethiopia. Throughout the crisis that ensued dominion opinion was much divided about the right policy to pursue. All welcomed early evidence of a strong United Kingdom stand in support of League principles, but when in Dec. 1935 the terms of the contemplated Hoare-Laval agreement were made public the reaction was varied. While majority opinion strongly condemned the pact, there was anxiety, particularly in Canada and Australia, lest they should be drawn farther than they desired into international policies over whose course they had little control. In South Africa and in New Zealand, on the other hand, there was unwavering support for League principles not only in Dec. 1935 but even in the summer of 1936 when the western powers had in fact decided to accept the *fait accompli* of the Italian conquest.

The decline in the authority of the League had great importance for the commonwealth in two respects. In the first place it underlined the need for effective defense co-operation. After the publication of the United Kingdom White Paper on defense in 1935 and a tour of the commonwealth countries by Sir Maurice (later Baron) Hankey, secretary of the committee of imperial defense, steps were taken in every dominion to strengthen defenses. But dominion defenses at that time were almost nonexistent, so that it was clear that a considerable number of years would elapse before the dominions could assume with any assurance responsibility even for their local defense. The second consequence of the failure of the League in Ethiopia was political. So long as the League existed as an apparently effective instrument for the maintenance of world security all the members of the commonwealth could be united in its support. The Union of South Africa was the foremost champion of the League in the Abyssinian crisis, and throughout its duration the Irish Free State also supported the authority of the League and imposed sanctions against Italy. With the failure of the League, however, these two dominions, strongly nationalist in outlook, found no convenient or congenial system of security in which they could wholeheartedly participate. South Africa remained thereafter within the imperial defense system but with reservations about unrestricted co-operation; and the government of Eire made it clear that it would thenceforward adopt a policy of neutrality. The strategic provisions of the Anglo-Irish agreements of 1938, under which the treaty ports were restored to Irish control on the advice of the chiefs of staff but in the face of outspoken criticism by Winston Churchill, thereby acquired enhanced importance and were the cause of bitter controversy during World War II.

The imperial conference of 1937 met to consider a rapidly deteriorating international situation. The overriding concern of all those represented was to avoid war and to see the differences that might arise between nations settled by negotiation. Yet their faith in conciliation had been diminished, and they felt bound to "adopt such measures of defence as they may deem essential for their security as well as for the fulfilment of such international obligations they may respectively have assumed." While they agreed to continue closest consultations among themselves in the conviction that the cause of peace was likely to be promoted by their using their influence in the same direction, they also agreed that the latter should be toward international appeasement. At the time their pronouncement elicited a favourable response, and it is important to remember that it was only later that the word "appeasement" fell into discredit. Nonetheless their conclusion

indicated both the predominant dominion desire to avoid war and a continuing dominion resolve to keep free, so far as possible, from compromising entanglements in Europe. Particularly significant were the references to League obligations, which were noncommittal in form and meant that the dominions other than New Zealand no longer regarded the League's authority as binding.

6. World War II.—The drafters of the Balfour report had expressed in 1926 their conviction that the separate control of foreign policy by each of the member nations of the commonwealth would not imperil the common cause. Not all either within or without the commonwealth shared their confidence but at the least it was notably vindicated in Sept. 1939, when none of the dominions, unlike the United Kingdom, was formally committed to war in the event of German aggression against Poland. Their hands were free, and it was with full freedom of choice before them that the dominions took their decision. Australia and New Zealand, the most "British" in extraction, proclaiming their allegiance to "one king, one cause, one flag," declared themselves to be at war from the moment the mother country was at war. Canada declared war on Germany independently six days later, and with the explicit sanction of its own duly summoned parliament. In South Africa the coming of war split the fusion government in which Hertzog was prime minister and Smuts his deputy. When in the house of assembly Hertzog moved that South Africa should not participate in the war, Smuts submitted an amendment recommending that South Africa should take its place with the commonwealth partners at Great Britain's side in resistance to aggression. There followed a tense, dramatic debate in which the house, not because of any sense of formal obligation but because of South Africa's own interests, which in common with those of the rest of the commonwealth were felt to be directly involved, decided by the narrow majority of 13 votes to go to war. Here was the most conclusive evidence of the independence of the dominions in foreign policy, for there could be no question of South Africa's full membership of the commonwealth, while Eire, though it remained a dominion in name, was not, in the opinion of its own government, a dominion after the enactment of the 1937 constitution but a state externally associated with the commonwealth. Nonetheless the almost unanimous Irish decision to remain aloof was also instructive in that the other members of the commonwealth, in respecting its desire to remain neutral, did not suggest that in so doing it modified or terminated a membership which they continued to regard as still being in existence.

There were proposals at the outset of World War II that an imperial war cabinet should be reconstituted, but they were not adopted. Yet there were frequent visits throughout the war years by prime ministers and ministers from all the overseas dominions to London, some for general and some for specialized and technical discussion. Visiting prime ministers were invited to attend sessions of the United Kingdom war cabinet and did so; and the Australian government, when confronted with the immediate danger of Japanese attack, appointed first Sir Earle Page and then Stanley (later Lord) Bruce as special envoy to the war cabinet.

The contribution of the commonwealth to the victory of the United Nations is part of the history of World War II. In 1939 Canada had become the headquarters of the British Commonwealth Air Training plan by which the countries of the commonwealth, including Great Britain, were enabled to train their airmen under favourable Canadian conditions and secure from enemy air attack. By early 1944 the plan had sent out a total of more than 86,000 air crew cadets. In the dark days that followed the fall of France messages were received from all dominion prime ministers endorsing Great Britain's decision to continue the war. There was also evidence of growing co-operation between a belligerent commonwealth and a nonbelligerent United States with the U.K.-U.S. destroyers-bases deal and the Canadian-U.S. defense agreement, both negotiated in the summer of 1940. During the fateful year when the commonwealth stood alone, Canadian troops manned the shores of Great Britain against invasion; Australian, New Zealand and Indian troops fought a second time to protect the middle eastern artery of the empire, while the South African forces played a major part in the victorious east African campaigns before joining the British armies in north Africa.

With the irruption of the Japanese into southeast Asia and their threat of invasion to Australia, a large-scale redistribution of all too slender imperial resources in materials and manpower was imperative. After a correspondence that was at times acrimonious, the Australian divisions were withdrawn from the middle east to protect Australia from possible invasion; and when that danger had passed they were engaged in the bitter fighting in the southwestern Pacific. In order to meet the Australian demand for a voice in the higher strategy of the Pacific, a Pacific War council was formed in 1941, with headquarters first in London, then later in London and Washington, D.C. The dominions as well as the United Kingdom participated in "mutual aid" agreements with the U.S., both Australia and New Zealand signing the "master agreements" on the principles applying to mutual aid in 1942. These agreements foreshadowed still closer co-operation between the commonwealth and the U.S., extending with the passage of time from the military and economic to the political field. The strength and casualties of commonwealth armed forces during World War II are shown in Table III. Decorations for valour are discussed in MEDALS AND DECORATIONS.

TABLE III.—*Commonwealth Forces, Sept. 3, 1939, to Aug. 14, 1945*

Country	Strength	Killed	Missing	Wounded	Prisoners of war
United Kingdom*	5,896,000	357,116	46,079	369,267	178,332
Canada	724,023	37,476	1,843	53,174	9,045
Australia	938,277†	23,365	6,030	39,803	26,363
New Zealand	205,000‡	10,033	2,129	19,314	8,453
South Africa	200,000§	6,840	1,841	14,363	14,589
India‖	2,500,000¶	24,338	11,754	64,354	79,489?
U.K. dependencies	473,250	6,877	14,208	6,972	8,115

*Cmd. 6832. †Net full-time service, June 1945. ‡Includes women. §Approximate figure. ‖Now India and Pakistan. ¶1945 figure. ?Includes 20,147 officers and other ranks missing but presumed prisoners of war.

7. Co-ordination After World War II.—When it was apparent in 1943 that however exacting the task might prove both Germany and Japan would suffer total defeat, commonwealth statesmen displayed renewed concern with the working of the commonwealth and its contribution to the postwar world. In September of that year John Curtin, the Australian prime minister, with the problems of the Pacific area foremost in his mind proposed the formation of a commonwealth consultative council to be served by a commonwealth secretariat. Both were intended to bring about a closer co-ordination of commonwealth foreign and defense policies. In November, Smuts, in a speech to the Empire Parliamentary association in London, advocated a grouping of the commonwealth countries with the like-minded democratic states of the western European seaboard so as to form in association a power equal to the U.S.S.R. and the United States and capable of holding the balance between them. In Jan. 1944 Lord Halifax, then British ambassador in Washington, D.C., spoke in Toronto of the need for greater unity in commonwealth policies. But the response to these speculations was, generally, unfavourable. The commonwealth peoples wished neither for formal unity in policy nor for centralized machinery to bring it about. They thought that for them it would be "a step along the road to yesterday," and also that peace could best be preserved not by the revival of a balance of power on a world scale but by the creation of an effective international organization supported by all peace-loving states. Mackenzie King on Jan. 30, 1944, told the Canadian house of commons:

> It is indeed true beyond question that the peace of the world depends on preserving on the side of peace a large superiority of power, so that those who wish to disturb the peace can have no chance of success. But I must ask whether the best way of attaining this is to seek a balance of strength between three or four Great Powers. Should we not, indeed must we not, aim at attaining the necessary superiority of power by creating an effective international system inside which the co-operation of all peace-loving countries is freely sought and given?

This view prevailed. The conference of commonwealth prime ministers in London in the spring of 1944 discountenanced any suggestion that new machinery for the co-ordination of commonwealth policies was required and explicitly reaffirmed the faith of the prime ministers in the existing independence in policy coupled with active informal consultation. The praise which the Canadian

prime minister bestowed in London upon a system which made possible "a continuous conference of cabinets" was echoed by his commonwealth colleagues, other than Curtin, who continued to feel that while good as far as it went the system did not go far enough.

The Balfour report had drawn a distinction between status and function, but in suggesting that there must be continuing inequality in functional responsibility it had not implied that this was to be more than a protracted transitional phase. World War II, by thrusting responsibilities upon dominion governments, shortened the period of transition. The disposition of dominion forces in the field remained throughout the ultimate responsibility of the respective dominion governments; and if the dominions were not themselves represented in the supreme Allied war councils, they played their part in the regional organizations such as the Pacific War council, the Eastern Group Supply council (with its headquarters in Delhi) and the Commonwealth Supply council. Canada, as a major source of supply both for war materials and for food, had an especially important contribution to make to the over-all resources of the United Nations, and its government requested a voice in the making of United Nations policies proportionate to this functional contribution.

"Consultation and consultation only" had seemed to New Zealanders in the 1920s an unstable foundation for imperial cooperation. But as the system developed its appropriateness to the character of the commonwealth became more apparent. It allowed of full individual responsibility for policy while fostering the sense of commonwealth unity, and it possessed the supreme merit of flexibility. Its purpose was, and remained, to keep all members of the commonwealth fully informed about their respective policies. "Every day," remarked Lord Cranborne, secretary of state for dominion affairs in 1945, "sheaves of telegrams go out from the dominions office on all and every subject of mutual interest—foreign affairs, economic developments, military co-operation, even domestic issues here which are likely to interest our partners." Foreign office telegrams received from and sent to diplomatic posts abroad constituted the raw material of the information on international affairs sent out to dominion governments. The number of telegrams alone handled by the dominions office in 1946 was more than 23,000. Speed in transmission was a matter of cardinal importance. Lord Cranborne admitted that in the hectic conditions of wartime it was not always adequate, and inevitably the greater the urgency, the greater normally was the issue at stake. On more than one occasion during the war a dominion government felt that it had been committed implicitly to a course of action in a matter of vital concern to it without any adequate opportunity of expressing a considered opinion. Even in peacetime there were occasions when the apparent need for an immediate decision made consultation with the dominions difficult or impossible; *e.g.*, when guarantees were given to Poland and Rumania in 1939.

The allocation of responsibility for decisions on any issue made after discussion among the member states of the commonwealth was well illustrated in the debate in the house of commons in May 1946 on the withdrawal of British troops from Egypt. On May 24 Ernest Bevin, then secretary of state for foreign affairs, recalled that none of the dominion governments had committed themselves to the Anglo-Egyptian treaty of 1936. They had been consulted, they had raised no objections, but they had not endorsed the terms of the treaty. When the United Kingdom government had felt that it was time to negotiate a new treaty, "almost every document" that was relevant had been sent to the dominion governments and they had been asked for their opinions. Discussion had followed but no decision. In no instance, remarked Bevin, could he remember any specific case of a treaty, or the termination of a treaty, or a change in a treaty, in which a formal decision had been recorded by the dominions. What was asked for was an opinion, and having heard it the United Kingdom government came to a decision on its own responsibility.

A detailed account of the procedure adopted in 1946 was given by the prime minister, C. R. Attlee. As he later confessed, he was "led away in the course of debate" on the revision of the treaty into saying that the dominions had "agreed" that the government's method of approach to this question was best. In withdrawing this statement he said:

> It is our practice and duty as members of the British Commonwealth to keep other members of the Commonwealth fully and continuously informed of all matters which we are called upon to decide, that may affect Commonwealth interests. The object is to give them the opportunity of expressing their views if they so desire. These views are taken fully into account but the decision must be ours, and other governments are not asked, and would not wish, to share the responsibility for it. Dominion governments follow the same practice.

Attlee added that in the circumstances it was obviously not possible for him to disclose the opinions expressed by the dominion governments. It was made clear, however, in a comment by Mackenzie King, that Canada not only was not a party to the decision that had been taken, but had in fact offered no advice on any aspect of the Anglo-Egyptian negotiations.

The first meeting of dominion prime ministers, as distinct from the more formal imperial conferences of the past, was held in London in the spring of 1944; the second was in the spring of 1946, after victory had been won; and a further conference was held in Canberra, Austr., in 1947 for the purpose of considering the terms of the Japanese peace treaty and the settlement in the far east generally. For the meeting in 1946 Bevin returned on two occasions from the Paris peace conference to inform dominion representatives of discussions there and to learn himself what they thought about the postwar settlement in Europe. In the communique issued at its conclusion the meeting was described as an "informal exchange of views," and throughout its proceedings emphasis was placed on the need to avoid any impression that its purpose was to make "decisions" or to reach "agreement." The talks were said to "have contributed greatly to the elucidation of many problems" and to a "mutual understanding of the issues involved." Among the subjects on which views were exchanged were the draft treaties with the satellite powers in Europe; the treaty with Germany; co-operation in the South Pacific and southeast Asia; and "security responsibilities and arrangements for liaison on military affairs between British Commonwealth governments." There followed reiteration of faith in the system of consultation: "The existing methods of consultation . . . are peculiarly appropriate to the character of the British Commonwealth . . . While all are prepared to consider and adopt practical proposals for developing the existing system, it is agreed that the methods now practised are preferable to any centralized machinery."

8. Asian Members of the Commonwealth.—The emerging informal pattern of commonwealth relations had an importance in a wider context: it facilitated the association of new members of non-European stock and tradition with the old. In 1917 responsible self-government was proclaimed to be the goal of British rule in India. The Government of India act, 1919, with the declared intention of leading up by gradual stages to responsible government, introduced a constitutional system known as dyarchy, by which the field of government in the provinces was divided into "reserved" and "transferred" subjects, the former to be controlled by the governor of a province and by a nominated executive council, the latter by the governor acting with Indian ministers responsible to elected legislative councils. At the same time a mainly elected legislature was created for all British India; but the all-India executive (the governor general and council), while acting as far as possible in harmony with this legislature, was not to be responsible to it but only to the British government and parliament.

In 1927, two years before it was required by the act of 1919, a statutory commission (under Sir John Simon) was appointed to report on what further progress could be made. Following its recommendation in 1930 that dyarchy and "gradualness" should be abandoned, three round-table conferences of Indian representatives met in London to discuss further legislation. A new constitution was embodied in the Government of India act, 1935, separating Burma from India and giving full responsible government to the provinces of British India (then increased from 9 to 11). Also, for the first time provision was made (with the reservation of de-

fense and foreign affairs) for a federal government of India responsible to a federal legislature composed of representatives of both British India and the Indian states. These federal provisions were disliked by the All-India National Congress (or Congress party), which, though noncommunal in principle, was increasingly Hindu in composition. It favoured unitary government and moreover disliked the entrenchment of "reaction" in the federation in the form of the princely states. The Muslims, on the other hand, feared that their community of about 70,000,000 persons would become a permanent minority if all seats were open to the election of any candidate, whatever his creed, and sought security first in a weak centre and later in the creation of a Muslim state, named Pakistan. The coming into existence of this federation was, however, made dependent upon acceptance by a majority of the princes and that was not forthcoming. The provincial, as distinct from the federal, provisions of the act came into force in 1937 and elections were held in all provinces. They resulted in a significant and overwhelming victory for the Congress party, which in eight provinces, and after some hesitation, took office. Experience of Hindu rule in the provinces finally convinced the Muslims that only in a separate and independent state could their way of life be preserved. Hindus and Muslims, declared the Muslim leader Mohammed Ali Jinnah, belonged to two separate civilizations, members of which "neither intermarried nor interdined." When in 1939 the Congress ministers resigned because of the failure of the British government to consult India's political leaders about India's participation in the war, Jinnah proclaimed for Muslims a day of national rejoicing. Thereafter it was probable that unity would not survive the ending of the British raj.

In 1942 Sir Stafford Cripps, lord privy seal, visited New Delhi to discuss with leaders of the main parties and interests proposals for co-operation in war and the postwar transfer of power to Indian hands. He proposed that immediately after the war there should be created, through a constitution-making body elected by provincial assemblies and containing also representatives of the Indian states, a new Indian union which would constitute a dominion equal in every respect to the United Kingdom and other dominions. The British government would stipulate only that: (1) any province that did not accept the new constitution might remain outside the union; and (2) a treaty should be negotiated between the British government and the constitution-making body covering all matters arising out of the complete transfer of responsibility from British to Indian hands (in particular the protection of minorities) but not restricting the power of the union "to decide its relationship" to the rest of the British empire (*i.e.*, to secede if it wished). He also proposed that meanwhile provision be made for "immediate and effective participation of the leaders of the principal sections of the Indian people" in the government of India, for the organizing to the full of the resources of India for India's defense and for the continuation, for the period of the war only, of "control and direction of the defense of India." These proposals were not found acceptable by the various Indian groups and were withdrawn by the British government, but the latter subsequently stated that it would continue to stand by the broad intention of its offer.

Despite efforts made by some Indian politicians to discourage enlistment, the Indian war effort was impressive. The strength of the military forces was increased from less than 200,000 to more than 2,000,000 men by voluntary enlistment. The army was increasingly officered by Indians, and except for technical instructors the air force, greatly expanded, was almost wholly composed of Indian personnel. In the economic field, besides supplying nine-tenths of the military equipment needed at home, India sent to the commonwealth forces in Africa and the middle east a large proportion of their war materials and supplies, while Indian technicians were trained in Great Britain for work in India's expanded munition factories. The Eastern Group Supply council, set up in Delhi in 1941, comprised representatives of the United Kingdom, Australia, New Zealand and South Africa as well as of India. After the rejection of the Cripps offer, however, the Congress party, not seeing its way open to entering a national government for the prosecution of the war, resolved in 1942 to start "a mass struggle on nonviolent lines on the widest possible scale" for independence. The government acted resolutely; but the internment of the Congress leaders, including Mohandas K. Gandhi, lessened the prospects of an agreed political settlement at least while the war lasted.

Partition of India.—In the last two decades of British rule in India the attitude of the three principal forces on the subcontinent underwent little change. The Congress, claiming to be the one representative national organization, demanded the immediate transfer of power to an Indian constituent assembly, which would have exclusive responsibility for drafting the future constitution of India in accordance with the wishes of the people; the Muslims, conscious of being the minority community, insisted ever more strongly on the need for substantial safeguards against Hindu majority rule, even to the extent of demanding after 1940 the recognition of a separate Pakistan; and finally the princes, while prepared in theory to enter an all-India federation, showed in practice extreme reluctance to do so, believing that in a federation their position, however adequately safeguarded on paper, would be undermined by the Congress leaders. It was this internal conflict that presented Attlee's Labour administration, resolved upon an early transfer of power, with its greatest problem. The cabinet mission sent out in 1946 suggested an elaborate and ingenious solution based upon the assumption that, in however loose a form, the unity of India would survive the passing of British rule. But it was not to be. On Feb. 20, 1947, the British government announced its "definite intention to take the necessary steps to effect the transference of power into Indian hands by a date not later than June 1948" and the appointment of Lord Louis (later Earl) Mountbatten as viceroy. Implicit in the declaration was the assumption that India would be partitioned and that power would be transferred to two successor states. Any attempt to maintain Indian unity on the basis of majority Hindu rule would lead, so Jinnah warned the new viceroy, to the bloodiest civil war in the history of Asia. Communal tension and outrage gave ample evidence that this warning could not be lightly disregarded, and in fact by early June even the Congress leaders reluctantly agreed to a settlement which involved the creation of two successor states to which power was transferred on Aug. 15, 1947, almost a year earlier than had been contemplated in the declaration of Feb. 20. Both were to have dominion status, but it was made abundantly clear that the final decision about membership of the British Commonwealth was for them and for them alone to take. With the ending of paramountcy the princes were left free either to accede to one or other of the new dominions or to retain an independent status.

Partition was accompanied by communal massacres on a terrible scale in the Punjab, and the two new states were confronted with the problem of restoring order and housing countless refugees. Relations between them rapidly deteriorated, and disputes about the future of certain princely states, Hyderabad, Junagadh and finally Kashmir, culminated in open war in Kashmir.

"Strong winds are blowing all over Asia," declared Jawaharlal Nehru at the opening of the Inter-Asian conference at New Delhi, and in 1947 there were many who believed that the ending of western imperialism should also bring to an end intimate relations with the west. "Asia for the Asians" to them meant exclusive continentalism. Talk of an Asian bloc was fashionable, and hopes were expressed that at least southeast and south Asia might become a neutralized region. Yet, however attractive such proposals might seem to peoples long subjected to alien rule, a closer inspection of them brought to view rivalries within Asia which cast serious doubts upon their practicability, as well as the probability of reactions which could be only unhelpful to both west and east. Fundamentally it was the long-term maritime interests of the countries of south and southeast Asia which seemed to preclude such isolationism. The Indian leaders' anxiety, lest permanent membership of the hitherto predominantly European commonwealth should loosen the new ties with neighbours in Asia, was gradually modified by appreciation of the unexclusive nature of the commonwealth relationship and by the practical experience afforded

by the New Delhi conferences on Indonesia, where the attitude of the Pacific dominions made it clear that moderate nationalist forces in Asia could count on support from non-Asian members of the commonwealth; but it was not wholly removed. The psychological difficulties which its existence created were reinforced by more concrete considerations. The principal aims of Indian and of Pakistani external policy were national freedom for colonial peoples and the ending of racial discrimination, which implied antagonism to European imperialism. And however clearly Asia might distinguish between liberal policies of Great Britain (as applied in India and Burma and as epitomized in Attlee's assertion that the commonwealth desired to have no unwilling members) and the attitudes of the "reactionary imperialism" of the Netherlands and France, it could not be overlooked that Great Britain's vast colonial empire in Africa had not reached the goal of self-government or that South Africa, a member of the commonwealth, was enforcing racial discrimination as a matter of political principle. Indeed, in 1947 the fact that South Africa was a member of the commonwealth seemed to many Congress leaders sufficient reason why India should not be, and if easy justification for negative policies had been wanted, it lay there ready to hand.

In late 1947 and in 1948 there was a gradual trend in Indian opinion away from isolationism and toward the maintenance of friendly associations that would not commit India to explicit policies but would enhance its influence in world affairs and contribute to international understanding in a wider field. It was increasingly felt that friendly association with the commonwealth might act as a steadying influence at a time when revolntionary forces within and without were challenging established authority. In Feb. 1949 Nehru spoke of the policy of the Communist party in India as one "of open hostility bordering on open revolt." And, however firmly resolved the Indian government might be to remain aloof from the grouping of the powers, events in southeast Asia and the advance of communism in China suggested that the commonwealth connection might prove to be at the least a valuable reinsurance. But recent history was a barrier which could be surmounted only by imaginative understanding and, above all, by magnanimity in outlook. These qualities were tested to the full by the problem with which India now confronted the commonwealth.

While the older dominions were largely British and almost wholly European in origin and outlook, India was a mother country with memories and traditions that went back to the dawn of history and with a cultural influence that had at one time or another spread over much of Asia. Could this India, never more mindful of the glories of its past, find a satisfying sense of fulfillment in the membership of a commonwealth formally united by a symbolism alien to much of Indian history? Dominion status as a practical expedient by which a threatened deadlock over the transfer of power in 1947 might be resolved was one thing, as a permanent element in India's constitution it was quite another. Here was a problem that required both study and reflection on the part of India's leaders; for in their hands lay full freedom to decide. To some the constituent assembly's resolution of Jan. 22, 1947, declaring that India would become a sovereign, independent republic, seemed to dispose of it. Most Indians felt that republicanism was the only form of government appropriate to their circumstances. It was also the only form of government which seemed to them to make clear beyond all manner of doubt that India was a wholly independent nation. It was argued that dominion status, too, conferred full autonomy; but such arguments carried only partial conviction in Asia in the light of prewar discussions about the right of a dominion to secede or to remain neutral in a war in which the United Kingdom was engaged.

Ceylon.—The secession of Burma from the commonwealth in 1948 (*see* BURMA) was paralleled by the steady progress of Ceylon toward dominion status. Since 1931 the island had enjoyed representative, though not responsible, cabinet government under the Donoughmore constitution. During World War II its great strategic importance was underlined, and its people, influenced by the rising tide of nationalism in Asia, pressed for self-government. The response in London, at first somewhat hesitant, had become more forthcoming by 1945, when the United Kingdom government declared its willingness to co-operate with the Ceylonese in their advance to self-government. Under the Soulbury constitution of 1946, which was based largely on the recommendations of the commission of which Lord Soulbury had been chairman, the island attained full self-government in all matters of internal administration. Then in June 1947 the colonial secretary, Arthur Creech Jones, stated in the house of commons that the United Kingdom government was preparing to negotiate with the government of Ceylon for the amendment of the Soulbury constitution so as to give to Ceylon full self-government in external as well as in internal affairs. The Ceylon Independence bill, introduced in parliament in Nov. 1947, came into force on Feb. 4, 1948. It was supplemented by agreements on defense and external affairs that had been signed on Nov. 11, 1947. The former provided that the two governments should give one another "such military assistance for the security of their territories, for defense against external aggression and for the protection of essential communications as may be in their mutual interest to provide" and also permitted the United Kingdom to base naval and air forces and to maintain such land forces in Ceylon as might be mutually agreed as being necessary for the island's security; in the latter the government of Ceylon undertook to adopt and follow the resolutions of past imperial conferences and to observe the accepted principles and practice of commonwealth consultation, while the United Kingdom government undertook to support Ceylon's application for membership in the United Nations.

The general significance of Ceylon's advance from colonial to dominion status was far-reaching. "This is the first occasion in our history," said Lord Addison, introducing the second reading of the Ceylon Independence bill in the house of lords on Dec. 4, 1947, "in which a colony, developing this system of government of its own accord, has deliberately sought to become a Dominion State in our Commonwealth . . . but we hope and expect it will not be the last." Encouraging though the implications of Ceylonese membership might be, however, it was on the decision of India and of Pakistan that the future of the commonwealth in Asia ultimately depended.

Commonwealth Membership.—But was not the question of Indian membership by implication already decided? Between 1926 and 1931 the three conventional characteristics of dominion status were defined as free association, equality and common allegiance to the crown. Did not the third of these qualifications exclude an India about to become a republic? Or could it be so qualified that a republic might remain a member of the commonwealth if it so wished and other existing members agreed?

These delicate questions were not approached in a hasty, still less in a theorizing or legalistic, spirit. Commonwealth statesmen long continued almost to ignore them. At the conference of commonwealth prime ministers in London in Oct. 1948, where for the first time the three new dominions of Asia were represented, the form of their membership or relationship was not discussed in full session at all. On the contrary, this conference concerned itself with severely practical questions of defense, security and economic development and, though discussions about the Irish repeal of the External Relations act erupted on to the stage while it was meeting, the conference left constitutional questions affecting the Asian dominions on one side. These Fabian tactics enabled the prime ministers of the Asian dominions to see at first hand how the commonwealth worked before taking any final decisions about their own position. Since India, Pakistan and Ceylon "have come into the Commonwealth," said Liaquat Ali Khan, the prime minister of Pakistan, after the conference, "its complexion has changed—now it is a Commonwealth of free nations who believe in the same way of life and in the same democracy. To my mind, these ideas are even stronger than racial ties." There was also evidence of a similar and more favourable reaction in India which was reflected in a resolution of the Congress meeting on Dec. 18, 1948, at Jaipur, which implicitly posed the problem with which commonwealth statesmen were squarely confronted in April 1949. It was a republican India that contemplated continued association with the commonwealth. There was no suggestion from any quarter that India could or should renounce republicanism for mem-

bership. The question was, could the two be reconciled?

The commonwealth prime ministers, including those of the three new dominions in Asia, met again in London in April 1949 to settle the issue. Agreement was reached in the short period of six days. Though allowance be made for the preliminary work done by emissaries sent from Downing street to the dominion capitals, this was a remarkable achievement. The declaration issued at the conclusion of the meeting was as follows:

The Governments of the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Pakistan and Ceylon, whose countries are united as Members of the British Commonwealth of Nations and owe a common allegiance to the Crown, which is also the symbol of their free association, have considered the impending constitutional changes in India.

The Government of India have informed the other Governments of the Commonwealth of the intention of the Indian people that under the new constitution which is about to be adopted India shall become a sovereign independent republic. The Government of India have, however, declared and affirmed India's desire to continue her full membership of the Commonwealth of Nations and her acceptance of The King as the symbol of the free association of its independent member nations, and as such the Head of the Commonwealth.

The Governments of the other countries of the Commonwealth, the basis of whose membership of the Commonwealth is not hereby changed, accept and recognise India's continuing membership in accordance with the terms of this declaration.

Accordingly the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Pakistan and Ceylon hereby declare that they remain united as free and equal members of the Commonwealth of Nations, freely co-operating in the pursuit of peace, liberty and progress.

The settlement reached, it will be noted, was specific, not general, in application. There was no decision that a republic, as such, could be a full member of the commonwealth. The conference simply recorded that when India, under its new constitution, became a sovereign, independent republic, it would remain, in accordance with its own wishes, a full member of the commonwealth and would acknowledge the king as a symbol of the free association of its independent member nations and, as such, the head of the commonwealth. As the Indian republic owed no allegiance to the crown, and as the king had no place in its government, this settlement involved a notable departure from the doctrine embodied in the preamble to the Statute of Westminster. Republicanism, which had been regarded both in Ireland and in South Africa as synonymous with secession, was now accepted as compatible with full membership.

The Indian constitutional settlement went a long way toward reconciling constitutional forms with political realities. In the dominions and particularly in the older dominions, which are predominantly British in extraction, loyalty to the crown had been a unifying force of transcendent value. For them all, the constitutional position remained unchanged. But India's adoption of a different symbolism was accepted with the agreement of all its partners as compatible with membership of the commonwealth. The commonwealth thus became an international democracy in a fuller sense than before, and the successful outcome of this historic conference suggested that the association of Asian peoples with the older dominions, predominantly European in stock, was to be not an episode but a continuing factor in its history.

In India the constituent assembly endorsed the settlement reached in London with only one dissentient voice. No doubt this did not fairly reflect the balance of opinion within India, for the settlement was severely criticized by Socialists as well as by Communists both then and later when India's first general election was held in 1951–52. Yet the general satisfaction with the solution reached was unmistakable. By any criterion by which it may be judged, this welcome was striking evidence of the continuing vitality of the commonwealth idea. "We joined the Commonwealth," Nehru told the constituent assembly, "obviously because we think it is beneficial to us and to certain causes in the world that we wish to advance. . . . The other countries of the Commonwealth wish us to remain there because they think it is beneficial to them. In the world today, where there are so many disruptive forces at work, where we are often at the verge of war, I think it is not a safe thing to encourage the break-up of any association that one has . . . it is better to keep a co-operative association going which may do good in this world rather than break it." He admitted that he was "a bad bargainer," that he was not used "to the ways of the market place" and that he had thought it, in London, "far more precious to come to a decision in friendship and good will rather than to gain a word here or there at the cost of ill will."

Pakistan, unlike India, inherited no established administrative system and few trained administrators, and the telescoping of the period originally contemplated for the transfer of power allowed it only three or four months in which to plan its organization. Thereafter Pakistan was confronted by such terrible problems that relations with the commonwealth aroused only intermittent public interest. Moreover, in Karachi it was generally assumed in 1947 and even in 1948 that Pakistan would remain within the commonwealth. In the past understanding had been easier between Muslim and Briton than between Hindu and Briton, and the traditional friendship of the United Kingdom for the Muslim world reinforced the presumption of close association with what was now to be the largest Muslim state. Also commonwealth membership seemed to hold out advantages to a state lying in an exposed position geographically and beset by dangers and difficulties.

It was not till the closing months of 1948 that the cordiality of Pakistan's relations with the older commonwealth members and particularly with the United Kingdom began to decline perceptibly. It is true that the continued, intimate association of Lord Mountbatten with India as its governor general evoked from the outset hostile comment from Pakistan. But that in itself was a symptom of a growing feeling that Pakistan was not receiving from its commonwealth partners the sympathetic consideration that its circumstances warranted. This feeling became more pronounced when the commonwealth governments felt themselves compelled to return a negative response to the appeal from Pakistan to arbitrate in Kashmir (though many Pakistanis admitted that commonwealth arbitration in a dispute between two dominions was practicable only when both agreed to such arbitration).

Under the terms of the transfer of power the Indian princely states were left free, with the lapse of paramountcy, to accede either to India or to Pakistan or to remain independent of both. The vast majority acceded to one or other of the two dominions, but controversy arose about the future of three of them, Hyderabad, Junagadh and Kashmir. In all cases the decision about accession rested in the hands of the ruler, and in Hyderabad the vast majority of the inhabitants were Hindus and the nizam a Muslim, while in Kashmir the situation was almost exactly reversed, a Hindu ruler governing a predominantly Muslim population. This produced first inaction and then crisis. In Hyderabad, a state wholly surrounded by Indian territory, the Indian government decided on armed intervention; and in Junagadh, a small state with no land communications with Pakistan to which its ruler acceded, they applied pressure to secure its incorporation in India. In Kashmir an irruption of tribesmen in 1947 from the frontier and across Pakistani territory was checked after the maharaja had formally acceded to India and by the dispatch of Indian armed forces. There followed a period of open warfare on the Kashmir frontier between the Indian and Pakistani units. The United Nations dispatched first a not very well-informed commission, then after a cease-fire had been arranged on Jan. 1, 1949, appointed as its representative Sir Owen Dixon, a member of the Australian high court, in April 1950. Commendable though his report was for fairness and exactitude, he failed to bring about agreement. The efforts of later UN representatives proved equally unsuccessful. Both parties allowed that the wishes of the inhabitants should be respected, but no proposals made for a plebiscite proved satisfactory to India. Confronted with seemingly deliberate procrastination on the part of India, opinion in Pakistan remained inflamed, for to government and people it seemed that Kashmir was vital to the state. As a result it was by reference to the Kashmir dispute that Pakistan's attitude to the United Nations, to international affairs and to the commonwealth was increasingly determined.

The reaction in Pakistan to the London declaration of 1949 was

tepid. It was thought that India had gained too much too easily and had come, by being difficult, to occupy an unduly prominent position in the commonwealth. Nonetheless, partly from force of example but chiefly from a sense of what was most appropriate, Pakistan also decided to adopt a republican constitution and to seek continued membership of the commonwealth. The prime ministers of the commonwealth welcomed Pakistan's continuing membership on this basis in 1955 and after many years' debate, culminating in a constitutional crisis, the constitution was enacted and the Islamic republic of Pakistan inaugurated in March 1956. Later in the same year the prime ministers' meeting in London agreed that Ceylon should also remain a member when it realized its intention of adopting a republican constitution. Malaya attained its independence in 1957 and decided to remain a member of the commonwealth. It did not, however, adopt a republican constitution, but decided to become an elective monarchy, the head of state being elected by the Malay rulers. The state acknowledged the queen as head of the commonwealth. The republican precedent, well established in Asia, was followed in Africa when in 1960 Ghana, with the consent of other commonwealth members, also became a republic within the commonwealth. (*See* also *Changing Commonwealth*, below.)

9. British Nationality Act.—A timely conference of experts on nationality and citizenship and representative of most commonwealth countries, including Ireland, was held in London in Feb. 1947.

In Sept. 1945 Canada advised the United Kingdom and the other members of the commonwealth that it found it desirable to introduce legislation laying down the conditions for the acquisition and loss of Canadian citizenship, and in 1946 it passed the Canadian Citizenship act. The provisions of the act were in certain important respects at variance with the traditional concepts of the status of British subjects. It had long been regarded as a fundamental law of the commonwealth that there should be a common nationality, and in the past the common law rule, which was given statutory effect in the general provisions of the British Nationality and Status of Aliens act of 1914, had been that all persons born within the king's dominions (together with some further special categories) were British subjects. But if this status was common to all who owed allegiance to the crown, the privileges that it gave to each were conditioned in practice by the policies of individual members of the commonwealth. The concept of common status in fact derived from a more spacious past and no longer conferred the right to move about, still less to settle in any of the king's dominions at will. That indeed was a fact which lay at the very root of the long-standing dispute between India and South Africa. If, therefore, for the most part, immigration laws within the commonwealth took the fact of common status into account, they were not determined by its existence. Yet common status retained a symbolic and a certain practical value which none wished to lose. Wherever a British subject traveled throughout the commonwealth (including Eire, where he was an exempted alien, which for all normal purposes amounted to the same thing) he was not a foreigner. In the United Kingdom, moreover, any British subject wherever born found by virtue of his subjecthood that the door was open to him for employment in the public services and the professions. There was anxiety lest this open door should be even partly closed by new nationality legislation.

The principal problem, which the British Nationality act, 1948, sought to solve, was that of reconciling local or national citizenship laws with the common status of British subject. The imperial conferences of 1930 and 1937 had specifically contemplated dominion nationality legislation, and the Canadian Citizenship act of 1946 made more urgent the need for it. The Canadian act defined who were Canadian citizens and provided that all Canadian citizens were British subjects. But they were British subjects because they were Canadian citizens, and British subjecthood was therefore no longer fundamental in Canadian law. The emphasis had shifted from a fundamental common nationality to a fundamental dominion citizenship from which the common nationality was derived.

The British Nationality act, drafted after consultation with representatives of the other dominions and with their concurrence, brought United Kingdom practice, to speak broadly, into conformity with Canadian. It established a local citizenship, that of the United Kingdom and colonies, which was distinct from that of the British subject status common to the whole of the empire. Section i (1) of the act read: "Every person who under this Act is a citizen of the United Kingdom and Colonies or who under any enactment for the time being in force in any country mentioned in sub-section (3) of this section is a citizen of that country shall by virtue of that citizenship have the status of a British subject." The countries listed in (3) were: Canada, Australia, New Zealand, South Africa, Newfoundland, India, Pakistan, Southern Rhodesia and Ceylon. The new term "citizen of the United Kingdom and Colonies" was scarcely calculated to arouse general enthusiasm and indeed was criticized in the house of lords on the dual ground that it contemplated something that was politically unreal and that its terminology was uncongenial, citizen being a word with republican associations. The former objection was substantial since there was lacking the degree of homogeneity between the widely scattered colonial peoples and the inhabitants of the United Kingdom to justify so comprehensive a description. The lord chancellor, indeed, defended the designation not on its merits but on the ground that, since the dominions insisted that the generic term "British subject" should not be used to describe the local citizenship of one or more parts of the commonwealth, some new designation had to be found embracing the United Kingdom and the colonial empire for whose government it remained responsible.

In respect of common status the British Nationality act further provided, as the result of an amendment in the bill introduced by the government, that a "British subject" might thenceforward be known as a "commonwealth citizen," the two expressions having the same meaning. To some colonial peoples, to most Indians, to the Afrikaners in South Africa and to the French in Canada, the words "British subject" continued to imply subjection to Great Britain or to the British crown.

The British Nationality act contemplated that each commonwealth country would enact corresponding nationality legislation. Australia, New Zealand and Ceylon did so in 1948, South Africa and Southern Rhodesia in 1949, Pakistan in 1951, India in 1955, Rhodesia and Nyasaland in 1957, and Ghana in 1957. This legislation was not altogether uniform, the South African act especially showing some significant variation; but the general pattern was in conformity with the principles of the British Nationality act in making, with some minor exceptions, local citizenship the basis of British, or commonwealth, nationality.

Eire was not among the countries listed in section i (3) of the British Nationality act. This was in accordance with Irish wishes. Under the Irish Nationality act of 1935 an Irish citizen could not assume dual nationality; therefore he could not, in Irish law, be an Irish citizen and become a British subject. This was not recognized by the British government at the time, which continued to regard Irish citizens as British subjects. "An impertinence" was how De Valera was wont to describe the practice. The new Nationality act, worked out in collaboration with the Irish government, recognized the principle of reciprocal as against common citizenship, giving to Irish citizens in the United Kingdom the privileges, but not the status, of British subjects and to United Kingdom citizens similar privileges in Eire. Provision was also made for any Irish citizen who wished for reasons of sentiment or occupation to remain a British subject. (*See* also *Nationality and Citizenship*, below.)

10. Secession of Ireland (Eire).—The citizenship arrangements embodied in the British Nationality act implicitly recognized that Eire was not a member of the commonwealth but a state externally associated with it. That indeed was the view long entertained by De Valera. In the last analysis Eire's relations with the commonwealth were determined by the overriding aim of reuniting Ireland. When neither dominion status nor external association seemed likely to advance that aim they were in turn discarded.

De Valera's long period of office ended early in 1948 when an interparty government took office under J. A. Costello. The predominance of the conservative and hitherto procommonwealth

Fine Gael party in the coalition was generally believed to preclude a change in Eire's relations with the commonwealth, for if it had always been critical of the External Relations act it had attacked it from the point of view of a commonwealth party. Great therefore was the surprise when in Sept. 1948 Costello on a visit to Canada announced the intention of his government to repeal the External Relations act, arguing that the removal of the last vestige of the detested authority of the crown would help to improve relations with Great Britain, friendship with which must depend not on archaic forms but on principles of free association.

Eire was not invited to attend the meeting of the commonwealth prime ministers in Oct. 1948, but in October and November Irish ministers had talks at Chequers and in Paris with United Kingdom and with Canadian, Australian and New Zealand ministers as representing the three overseas dominions with a considerable Irish population. The dominion ministers contributed much to the discussions and pressed for arrangements under which trade preferences and reciprocal citizenship rights should be left virtually unimpaired.

In Dublin the Republic of Ireland bill was introduced in November. Its purpose was to repeal the External Relations act, to declare that the description of the state should thenceforward be the Republic of Ireland and to enable the president to exercise executive power in connection with the external relations of the state. Costello predicted that thenceforth the relations of Eire with Great Britain would be far closer and far better because a cause of friction was removed. While not a member of the commonwealth, Eire recognized and confirmed "the existence of a special, close relationship, arising not only from ties of friendship, but from tradition and long-established association and trade relations based on common interest with the nations that form the British Commonwealth." Commenting on statements that the bill would end forever hopes of achieving national unity, Costello said that the External Relations act had been on the statute book for 11 years without the government of Northern Ireland making a single gesture of friendliness. Even had the act remained on the statute book, overtures from this government or any other government in Dublin would still "be opposed by the same cascade of scorn and derision as that directed by the Northern ruling class towards every suggestion for ending partition."

At midnight on April 17–18, 1949, Eire formally left the British commonwealth and cut the last constitutional link with Great Britain. The description of the state from that moment became the Republic of Ireland. King George VI sent his sincere good wishes to the president, and the president in his reply spoke of the many ties and the very special relations that Ireland had with Great Britain.

In May Attlee laid the text of the Ireland bill before the house of commons. The bill recognized that the Republic of Ireland was no longer part of the commonwealth. It declared, however, "that Northern Ireland remains part of His Majesty's Dominions and of the United Kingdom," and ". . . that in no event will Northern Ireland or any part thereof cease to be part of His Majesty's Dominions and the United Kingdom without the consent of the Parliament of Northern Ireland." This provoked a storm of protest in Dublin. The bill also provided that the Republic of Ireland was not to be regarded as a foreign country in the United Kingdom and that its citizens were not to be aliens for the purposes of any law in force in the United Kingdom or its colonial territories, thus sanctioning without substantial modification the provisions embodied in the British Nationality act. The Irish government for its part declared its intention of introducing parallel measures to give reciprocal rights to citizens of the United Kingdom resident in the republic. These reciprocal arrangements were later extended by a series of agreements to other member nations of the commonwealth, so that the republic assumed in respect of the commonwealth an intermediate status between membership and foreignness. Imperial preference (*q.v.*) also continued (to the material advantage of Great Britain and of the republic) to apply to their trading relations. New Zealand's Republic of Ireland act, 1950, went so far as to say:

> All existing law . . . shall, until provision to the contrary is made by the authority having power to alter that law, have the same operation in relation to the Republic of Ireland, and to persons and things in any way belonging to or connected with the Republic of Ireland, as it would have had if the Republic of Ireland had remained part of His Majesty's dominions.

11. Regional Security.—J. C. Smuts wrote the draft on which the preamble to the United Nations charter was based, after discussions with his commonwealth partners in London in April 1945. Yet in the framing of the charter the interests of the United Kingdom, as one of the great powers, and those of the dominions, which were to be numbered among the foremost of the middle powers, by no means always coincided; Australia and New Zealand in particular expressed deep misgivings about the wisdom of the insertion in the charter of the great-power veto. The United Kingdom and the Pacific dominions made considerable contributions in the setting up and in the definition of the work of the Trusteeship council, while Canada secured the insertion in the charter of article 44, which provided for the admission to Security council discussions of members whose armed contingents the council had called upon and intended to use. In succeeding years, despite a disappointing record in many fields, the allegiance of the commonwealth countries to the principles of the charter was not qualified in principle. This was at least as true in the newer Asian as in the older and predominantly European dominions. India, through Nehru, its prime minister, stated on many occasions that it had no intention of aligning itself with either the Soviet or the non-Soviet groupings which divided the world after the war, partly because India believed that it could make a greater contribution to peace through remaining aloof from both and bound only by the obligations it had assumed as a member of the UN.

The evident inability of the United Nations to ensure peace in the event of aggression by a major power could not, however, be disregarded, least of all in western Europe. The policies of the Soviet Union persuaded the commonwealth countries that in their own interest and for their own safety they must seek security in regional pacts made within the framework of the charter and designed to fulfill the purposes for which it had been drafted. Because the United Kingdom remained the preponderant power within the commonwealth and because in western Europe the war had left a vacuum in power brought about by the successive defeats of France, Italy and Germany, attention was early concentrated on the ways in which security and stability might best be restored in that part of the world. There the tradition of British foreign policy and the geographical situation of the British Isles were of major importance for the commonwealth as a whole. The tradition of British statesmanship in Europe was pragmatical partly because of a well-established aversion to anything that savoured of a theoretical approach but still more because of geographical considerations. It was the fact that Great Britain was at once an island semidetached from Europe and the heart of an overseas empire that fundamentally determined, as Sir Eyre Crowe contended in his classic memorandum of Jan. 1906, the character of its foreign policy. The invention of new methods of warfare might have changed its strategic position for the worse but did not transform it in essentials. The twin purposes of Great Britain's European policy therefore remained the safeguarding of its position in Europe by ensuring that neither the Low Countries nor France were controlled by an unfriendly power, and the safety and well-being of its overseas empire. In theory and sometimes in practice these twin purposes were not always easy to reconcile; in the postwar world, when the United Kingdom's margin in manpower and resources in relation to responsibilities was so tenuous, the task of reconciliation posed more difficult questions than at any time in the past.

As early as 1943 Smuts had been outlining his ideas of how the commonwealth might through association with the free peoples of the western European seaboard best contribute to European recovery. The line of thought he put forward did, in time and in the face of pressing dangers, produce practical results, but so far as the commonwealth was concerned they were rather different from those he had contemplated. Where he had foreshadowed an association of like-minded western European and commonwealth

states which together might form a third great power balancing between the U.S.S.R. in the east and the United States in the west, the grouping that eventually emerged was regional, thereby automatically excluding the overseas members of the commonwealth from full participation. Yet if they had no place in the western union that came into being in 1947–48 they were nonetheless deeply concerned with its shaping and composition because of the commitments into which Great Britain might enter.

The broad concept of western union had at once an economic and a political background, both of which involved the creation of consultative organizations. In the economic field were the Anglo-French economic committee, set up in Sept. 1946; the Benelux customs union, which came into existence formally in Oct. 1947; the more general agreement for discussion on colonial problems of common interest between the United Kingdom, France, Belgium and Portugal; and finally the Organization for European Economic Cooperation, set up after the 16-nation Paris conference of July-September 1947. The political counterpart to these steps toward economic co-operation consisted of the Anglo-French treaty of March 1947 and of the five-power treaty signed at Brussels in March 1948. The most important provisions of the Brussels treaty were those which provided for the setting up of machinery for consultation on any situation constituting a threat to peace "from whatever quarter" and a more specific commitment to joint defense in the event of aggression in Europe.

The overseas members of the commonwealth welcomed the strategic commitments into which the United Kingdom entered in western Europe, the military security of which they were all concerned to maintain. If the Brussels treaty was not formally underwritten by any of the dominions, neither had been the guarantee extended to Poland in 1939, and their reaction to the invasion of Poland had proved that a reluctance to undertake specific obligations in Europe in no way implied an isolationist attitude. Moreover, Canada in 1948 departed from tradition by joining in the western union defense talks as a member of the permanent military committee in London, thereby giving practical effect to an already declared policy of military assistance to the western powers in the event of aggression. Yet on the political as distinct from the economic side there were misgivings about the possible absorption of Great Britain in a purely European grouping. It was felt, in Australia and New Zealand especially, that the closer Great Britain drew to Europe the further it must draw away from the commonwealth, with the result that any close integration there might deprive it of the margin of uncommitted resources and so of the freedom of action necessary to sustain its position in the world overseas. Attlee, therefore, emphasized in May 1948 that in respect of every development in western Europe the United Kingdom government had kept "in the closest touch with the other commonwealth countries . . . and we take very full account of their views. . . . While I want to get as close as we can with the other nations, we have to bear in mind that we are not solely a European power but a member of a great commonwealth and empire." The conference of commonwealth prime ministers in Oct. 1948 evidently felt that the balance between Britain's European and its overseas interests was being fairly maintained, for the final communiqué recorded its general approval for the steps that Great Britain had taken in western Europe to build up resistance to aggression. It restated, too, the resolve of all countries of the commonwealth to maintain peace by every means in their power. In 1950 the first meeting of the foreign ministers of the commonwealth at Colombo gave yet more specific approval to Britain's policy in western Europe, their communiqué stating that "there was no inconsistency between the policy followed by the United Kingdom in relation to Western Europe and the maintenance of the traditional links between the United Kingdom and the rest of the Commonwealth."

It is against this background that the significance for the commonwealth of the North Atlantic treaty of 1949 may best be judged. While of the commonwealth countries the United Kingdom and Canada alone came within its scope, the close Anglo-American co-operation that it foreshadowed constituted a valuable reinsurance against aggression for the other dominions and went far to resolve tension in external policy to which they might otherwise have been subjected.

Anglo-American accord on the broad issues of foreign policy had long been recognized as a principal aim of Canadian policy. Its extension to other members of the commonwealth and particularly to the Pacific dominions was an important consequence of World War II. To the latter dominions Japanese aggression had demonstrated that their security was thenceforward dependent upon close Anglo-American co-operation. The value of the commonwealth co-operation in defense as in other fields was not in question, but that it was no longer in itself enough. Just as in 1947 Canada had extended its defense agreement of 1940 with the United States into peacetime, so then in 1951 Australia and New Zealand negotiated with the United States a Pacific security agreement to afford them a reinsurance against a revival of Japanese aggression. The successful operation of such agreements depended on the continuing close accord on the essentials of foreign policy between the United States and the United Kingdom, the preponderant commonwealth partner. It was that assurance that the signature of the North Atlantic treaty in 1949 seemed to give. What, therefore, had been a distinctive Canadian approach to the problems of Anglo-American relations became the dominant attitude of the commonwealth as a whole.

The North Atlantic treaty marked a turning in the history of commonwealth foreign policy for another reason. It indicated at least a modification of that general dominion reluctance to assume specific commitments in Europe. Its signing was for Canada a radical departure from the tradition of its external policy. Two things made this possible: first, the joint Anglo-American sponsorship, since, as L. S. St. Laurent said in Toronto in 1947, there was in Canada both loyalty to the commonwealth and a readiness "to accept our responsibility as a North American nation in enterprises which are for the welfare of this continent"; second, the treaty's purpose of creating a bulwark against communist expansion (even isolationist opinion in French Canada had been impressed by the revelations in 1946 of Soviet espionage in Canada) within the framework of the UN. Nor were the lessons of experience overlooked: "We must," said St. Laurent, "at all costs avoid the fatal repetition of the history of the prewar years when the Nazi aggressor picked off his victims one by one."

Australia and New Zealand, who were equally mindful of the lessons of recent history, and who had signed an agreement in 1944 to provide for co-operation in every field of common interest, made their acceptance of the lenient American draft for the peace treaty with Japan in 1951 virtually conditional upon U.S. participation in a Pacific security agreement, which alone, in the words of the New Zealand external affairs minister, F. W. Doidge, could free the Pacific dominions "from the nightmare of a resurgence of Japanese militarism." Yet the agreement, signed in San Francisco, Calif., in Sept. 1951, and the first of this kind entered into by either dominion with a foreign country, while going far to resolve their security problems did not lessen their concern with developments in Asia. In particular they were deeply interested in the outlook of the new commonwealth members in south Asia. They had feared that the very success of the North Atlantic treaty in building a barrier against aggression in the west might divert the pressure of communist expansion to the east, and the aggression of North Korea in the summer of 1950, followed by increased communist pressure in southeast Asia and especially in Indochina, had seemed to justify their worst misgivings. Yet it seemed impossible in practice to bring into being a Pacific pact in the east that, firmly based on the mainland, would broadly correspond to the North Atlantic treaty in the west. Not only did continuing tension over Kashmir preclude the joint participation of India and Pakistan in any such pact, but the existence of a strong sense of continental solidarity among Asian peoples, coupled with mistrust of the western colonial powers and of U.S. dollar imperialism, constituted a seemingly insuperable obstacle to an over-all agreement for defense, for which, in the east as in the west, U.S. participation was a condition of effectiveness. Moreover, Indian and indeed much Asian opinion doubted whether security agreements of this kind afforded the right answer to the communist challenge

in Asia. It might be that defense needs were first in point of time, but unquestionably the raising of the standards of living throughout the whole of south Asia seemed to them first in point of importance. Therein lay the political significance of the Colombo plan, formulated in 1950 to assist the economic development of south and southeast Asia. It was an example of commonwealth co-operation, free from any explicit political commitment, which in the existing conditions of south Asia appeared to hold out much hope for the future even if its contribution to the raising of living standards in countries with a great and rapidly growing population could not be on a scale sufficient to yield quick results.

Co-operation in implementing the Colombo plan could not disguise important differences among commonwealth countries in their approach to political problems in Asia. These differences were underlined in 1954 by the Manila treaty setting up a defense organization for southeast Asia. Pakistan with the United Kingdom, Australia and New Zealand among commonwealth members subscribed to it. India and Ceylon living within the geographical area covered by the treaty did not. The Indian prime minister, Nehru, vigorously denounced both the treaty and the earlier Pakistan decision to accept U.S. military aid as being likely not to lessen but to increase the risks of war in south and southeast Asia. For his part, he reiterated his faith in nonalignment and pursued an active foreign policy based on the five principles (*Panch-Shila*) in which were defined the Indian aim of peaceful coexistence. Though they had general application they were enunciated with particular reference to China. They lost, therefore, much of their practical significance when rigorous Chinese suppression of a revolt in Tibet early in 1959, leading to the flight of the dalai lama to India, strained relations between those two major Asian states; and even more, when later in the same year armed Chinese incursions into Indian territory along the northeast frontier led to formal Indian protests and to widespread popular indignation against communist China. Yet while relations between India and China thus deteriorated sharply, the Indian government again asserted its intention of adhering to its policy of nonalignment.

South Africa, like the Asian dominions, lay outside the scope of the regional security agreements which linked the United States with the United Kingdom, Canada, Australia, New Zealand and Pakistan in a network of alliances covering the Atlantic, the middle east, the southeast Asian and the Pacific areas, but it welcomed these agreements without reservation. Daniel Malan defined South Africa's position as one of unyielding opposition to communist expansion, and promised South Africa's participation in the defense of the middle east. (*See* also *Defense,* below.)

12. Changing Commonwealth.—World War II, whose challenge had elicited from the countries of the commonwealth a unity that astonished the world, left behind it many problems. Great Britain emerged from it with moral prestige higher than ever before but gravely weakened both economically and strategically. It was this weakness that prompted heart searching about commonwealth defense and underlined the need for close association with Europe and still more with the United States in the postwar years. It was therefore a realistic assessment of the increased vulnerability of the commonwealth that led commonwealth statesmen to discard the possibility that the commonwealth should aspire to fulfill the role of a third force in world affairs, whether in association with western Europe or on its own, and, for the most part, to accept the view, strongly urged on grounds of principle as well as of expediency by the Canadian government, that the aim should be to build up a league of free peoples resolved to create a preponderance of force on the side of the peace-loving nations sufficient to deter any aggressor. Within that wider framework the commonwealth as a community of independent states could contribute much to the maintenance of peace. Their response when the authority of the United Nations was challenged in Korea indicated more clearly the nature of this contribution, for in the Korean fighting the forces of the commonwealth countries engaged were linked together in a division serving under the United Nations command.

Yet the process of adjustment to changes in the world balance of power, to the threat of nuclear weapons and the search for some measure of agreement on major issues of international politics among the new multiracial membership, imposed exacting strains on commonwealth ties. Member states associated with the United States in regional defense agreements did not find that such association necessarily made for easy relations and both in Korea and in Indochina commonwealth governments expressed concern lest United States policies should involve them in a major crisis. In almost all commonwealth countries, including Canada in the late 1950s, there was anxiety about United States economic penetration which in Asia was apt to be thought of as "dollar imperialism." One of the principal attractions of closer United Kingdom association with western European countries was that it might serve to ensure greater economic stability and so lessen dependence on the United States. In large measure such reactions reflected the new awareness of United States military predominance in the nuclear age and while their existence precluded complacency about commonwealth-United States relations, they were not thought likely to undermine them.

The far-reaching character of the changes in the composition of the commonwealth after World War II are best appreciated when considered together. Newfoundland, whose financial difficulties had led in 1933 to the replacement of dominion status by government by commission, decided in 1948 by plebiscite to join Canada as the tenth province, thus fulfilling the dream of the fathers of confederation. Burma seceded in 1948; so did the Republic of Ireland in 1949 but without becoming a foreign country. In 1947–48 there were added the three new member states in Asia. The commonwealth's new multiracial character was further underlined with the addition of Ghana and the Federation of Malaya in 1957, the Federation of Nigeria in 1960 and Sierra Leone, Cyprus and Tanganyika in 1961 with the prospect of the principal remaining dependent territories of the British colonial empire following the same course in succeeding years. South Africa, however, withdrew from the commonwealth in 1961 as the result of its refusal to change its internal policy of apartheid (*see* below) under pressure from its fellow members.

The Suez Conflict.—The British-French landings at Port Said, Egy., exposed dramatically the tensions to which the commonwealth was subjected. Commonwealth governments were neither informed nor consulted about the Anglo-French ultimatum to Egypt and Israel of Oct. 30, 1956. While the governments of Australia and New Zealand adopted an understanding view of the British action and at the United Nations generally supported Britain and France in their lonely isolation, there was elsewhere in the commonwealth no such sympathetic reaction. The Indian prime minister denounced "the flagrant violation" of the United Nations charter and found Sir Anthony Eden's reasons for intervention "unconvincing and unsatisfactory," while in Pakistan there was unreserved condemnation by the government and popular demonstrations in many cities. The commonwealth, said Lester Pearson, Canada's minister for external affairs, had been brought "to the verge of dissolution," though in Canada itself the reaction was one of remonstrance and pained surprise at Britain's participation in such an adventure, like finding (to quote the *Economist*) "a beloved uncle arrested for rape." Yet, though resentments smouldered for some time (in the United Kingdom they were especially pronounced against the United States and India), on the longer view the impressive fact was that the commonwealth, having survived the crisis, used it for some realistic reappraisal and a resolve to restore what had been lost. In this respect, Harold Macmillan's visit to Asia in 1958 was important and helpful.

Migration.—The changes within the commonwealth itself were as remarkable as those in its position in relation to the world without. They were hastened or accentuated, though perhaps in no single instance caused, by World War II. Of general importance was the redistribution of population, even though it was on a comparatively modest scale. There was a steady flow of emigrants from the United Kingdom to the commonwealth overseas after the war. Their number, however, was quite insufficient to meet the needs of Canada and, more especially, of Australia for new settlers. In 1951, for example, Australia gained 110,000 persons

by migration, of whom 73,563 in all (whether coming directly or indirectly) had the United Kingdom as their country of origin. The country would have welcomed all British settlers and it was because they were not available in sufficient numbers that Australia looked to western European countries to fill the gap. By the 1960s "new Canadians" and "new Australians" of European origin were a familiar feature in most large cities.

After 1955 there was substantial immigration into the United Kingdom from the West Indies and to a lesser extent from India and Pakistan. In 1962, however, a law was enacted whereby quotas and other restrictions were imposed on commonwealth immigration to Britain. Authorities were also empowered to deport commonwealth citizens convicted of serious crimes.

Effects of Apartheid.—The changes that had taken place or were contemplated in the character of the commonwealth focused ever increasing attention on the South African Nationalist government's policy of racial segregation, known as apartheid (*q.v.*). This policy, which had been a principal plank in the Nationalist party's election manifestos since 1948 and which had received increasing support from the almost wholly white electorate in succeeding elections, was described by its protagonists in terms of "differential development." In 1959 legislation was introduced for implementing the policy of the creation of separate African states under the general designation of Bantustan. The goal was stated to be ultimate independence; the contemporary reality was rigorous dependence, economically and politically, on a basis of racial segregation. Here was something that not only provoked controversy with India and Pakistan about the treatment of South African citizens of Asian descent, and differences with the United Kingdom about the direction of its colonial policy in Africa (symbolized by the South African demand for the transfer of the three high commission territories of Bechuanaland, Basutoland and Swaziland to the jurisdiction of the Union, and Great Britain's insistence that the inhabitants must first be consulted), but also struck at the very roots of the multiracial commonwealth itself. Was it in fact possible for that commonwealth to maintain its cohesion if in colonial territories in Africa the United Kingdom progressively transferred the responsibilities of government to assemblies elected by universal adult suffrage, while south of the Limpopo the Union in the interests of "white civilization" deprived them of what meagre political responsibilities they enjoyed?

In raising the question of the admission of new members to the commonwealth in 1951 Malan brought to the surface the fundamental question: what was to be the character and composition of the commonwealth of the future and who was to determine it? While the South African prime minister was not justified in suggesting that the United Kingdom had admitted India, Pakistan or Ceylon to membership without consultation with the older dominions, he was right in saying that contemporary British pronouncements on the aims of colonial policy implied that in due course commonwealth membership would be open to colonial territories in Africa, thereby largely presuming later commonwealth agreement to their admission. Was this the natural course of commonwealth evolution, or, as Malan contended, the road to disintegration? There was little doubt that most commonwealth governments and peoples either accepted or welcomed the notion of an expanding commonwealth, and in 1956 J. G. Strijdom, Malan's successor as prime minister of the union, indicated that he had no objection in principle to co-operation within the commonwealth with future African members. Four to five years later, however, the question was asked the other way round: how great were the objections of other members of the commonwealth to continued co-operation with South Africa so long as its government enforced a policy of rigid racial discrimination contrary not only to the charter of the United Nations but also, so it was strongly maintained, to the character of the multiracial commonwealth itself? On a tour of Africa in 1960 Harold Macmillan, the prime minister of the United Kingdom, had felt "the wind of change" blowing across the continent and vigorously reasserted in Cape Town Britain's continuing faith in the government of people by themselves, irrespective of race or colour, as the goal of British policy. When later in the year the commonwealth prime ministers met in London their repudiation of the principles underlying South African racial policies was freely expressed. In the meantime, the South African government had decided to submit the quite different question of a republican constitution for South Africa to the electors in the union, who were exclusively Europeans. The referendum, held in Oct. 1960, resulted in a small but sufficient majority for a republic and the prime minister, H. F. Verwoerd, announced his intention of bringing the new republic into being on May 31, 1961, the 51st anniversary of the coming into force of the Act of Union, and at the same time of seeking the consent of his commonwealth partners to South Africa's continued membership of the commonwealth as a republic. The second issue duly came before the prime ministers at their meeting in London in March 1961. While there was no opposition to South Africa's continued republican membership as such, the opportunity was taken by the prime ministers to press home their criticisms of South Africa's racial policies and their sense of its incompatibility with membership of the commonwealth. In view of the criticisms that were made Verwoerd decided to withdraw South Africa's application for continued membership. While there was a widespread regret at the decision of the South African government, there was also a general, though not universal, feeling that the commonwealth as a whole had been strengthened by its assertion of principle.

Commonwealth Adaptability.—There was no disposition within the commonwealth to minimize the gravity of internal tensions but there was a certain confidence, even among the critics of some recent developments, that its flexibility and adaptability, never more strikingly shown than in the postwar years, would enable it to resolve them. That adaptability derived in large measure from a well-established reluctance to taking up a theoretical position or to defining the nature of the ties that bound the commonwealth countries together. "We have never attempted," said St. Laurent, speaking of Canada's position in Toronto in 1947, "to define our relations with the British Commonwealth of Nations. . . . But though they are not precisely defined the principles on which we act . . . may be clearly discerned. We seek to preserve it as an instrument through which we, with others who share our objectives, can co-operate for our common good in peace as in war." Binding commitments were therefore, he maintained, out of place because by defining they restricted the area of co-operation. Formal machinery was out of place because it introduced an element of central control and rigidity. "The more machinery we have," commented Smuts when Lord Bruce submitted proposals for a commonwealth consultative council to the house of lords in 1948, "the more friction there will be." It was free co-operation that continued to be the lifeblood of the commonwealth. The intimate, informal meetings of prime ministers were regarded as wholly in accord with its character and, as the problems with which the commonwealth was confronted became more complex and technical, were supplemented by meetings of foreign ministers, the first of which took place in Colombo in 1950, and by meetings of ministers of finance, defense and supply. In commonwealth capitals representation of other commonwealth members by high commissioners became the general rule and made possible continuous contact on a personal basis. This emphasis on friendly, informal consultation between equals was underlined with the addition of the Asian and African members. Indian co-operation with the commonwealth, Nehru told the Canadian houses of parliament in an address in the autumn of 1949, "will have the greater strength that common endeavour derives from a sense that it is inspired and sustained by the free will of free peoples."

The unity of the commonwealth was thought to owe much to the existence of common political institutions. The Asian members had followed the older dominions in adopting the practices and conventions of British parliamentary government; Liaquat Ali Khan of Pakistan discerned in them a bond of unity whose importance for the future was difficult to exaggerate, and the Indian general elections of 1952, 1957 and 1962, where candidates contested constituencies with up to 750,000 voters, afforded striking evidence of what their extension to the populous Asian states

meant in practice. Military rule in Pakistan and some approaches to autocratic government in Ghana constituted a reminder, however, that their stability and capacity to endure in these very different conditions were not something that could be lightly assumed.

The outstanding characteristic of the commonwealth has been its adaptability. Nowhere has this been more remarkably demonstrated than in the constitutional field. On her accession to the throne in 1952 Queen Elizabeth II was proclaimed in terms which took due account of the constitutional changes that had taken place during the reign of King George VI, and the governments of the commonwealth agreed before her coronation in June 1953 that she should have not one but several titles so as to express more precisely the relationship of the crown to the realms and states comprising the commonwealth. Significantly the new designation "Head of the Commonwealth" was common to all these titles. For in relation to the commonwealth the queen filled two distinct roles. For the newer republican members she was the symbol of the free association of the commonwealth while for the older members she was also the head of the government and society to whom their peoples gave allegiance. (P. N. S. M.)

The various aspects of co-operation between the member nations of the commonwealth, economic, scientific, educational, social and defense, are dealt with in the section on *Co-operation and Consultation*, below.

13. Special Territories.—There are certain territories within the commonwealth which, while preserving full autonomy in most spheres, lack, more particularly in matters of defense and foreign policy, that complete freedom of action possessed by the members of the commonwealth with which the preceding section of this article has dealt.

Southern Rhodesia was fully self-governing from 1923, except that defense, foreign policy and discriminatory legislation affecting native interests were reserved to the secretary of state; and the territory is somewhat paradoxically described as a self-governing colony. The practice grew up of inviting its prime minister to all meetings of commonwealth prime ministers. In the Federation of Rhodesia and Nyasaland the constituent elements retained their status, the federal government having, in those matters which fell within its responsibility, a status comparable with that previously possessed by Southern Rhodesia (*see* RHODESIA, SOUTHERN; RHODESIA AND NYASALAND, FEDERATION OF).

During 1959–63 the state of Singapore enjoyed full internal self-government under a Malayan-born head of state. The United Kingdom, represented by a commissioner, remained responsible for external affairs and defense, but responsibility in certain fields of external affairs was delegated to the Singapore government. In Sept. 1963 Singapore became part of the independent federation of Malaysia.

From 1917 Malta had enjoyed internal self-government under a system of dyarchy, but that constitution was suspended in 1958. A constitution for Malta broadly similar to Singapore's came into force in 1962. The country achieved independence in 1964.

The kingdom of Tonga should also be placed in this category, the relations between it and the United Kingdom being governed by the treaty of friendship of 1900. The United Kingdom is represented by an official known as the British commissioner and consul. Tonga enjoys a very large degree of autonomy in its internal affairs. (X.)

B. Nonself-Governing Territories

The great majority of the commonwealth territories which have not yet become independent are the responsibility of the United Kingdom, and what follows refers to British policy in and toward these territories. It must not, however, be overlooked that other members of the commonwealth of nations are also responsible for dependent territories—Australia, for instance, for New Guinea and Papua.

The differing bases of the United Kingdom connection with its overseas territories are reflected in the varied nomenclature whereby some are termed crown colonies, and others protected states or protectorates. But the formal classification of the territory has, for the most part, only slight relevance to its administration, whose character and rate of development are determined primarily by other factors. The Cameroons, formerly under United Kingdom trusteeship, were until 1960 administered together with Nigeria, and the leased territories on the mainland of China are not differentiated from the colony of Hong Kong for administrative purposes.

All the United Kingdom dependencies are the responsibility of the colonial office, except Southern Rhodesia which is the responsibility of the Commonwealth relations office.

1. Colonial Policy.—The central aim of policy was defined in 1948 by a former secretary of state for the colonies, A. Creech Jones, as being "to guide the colonial territories to responsible self-government within the Commonwealth in conditions that ensure to the people concerned both a fair standard of living and freedom from oppression from any quarter." This has since been reaffirmed by successive governments; and its fulfillment may be seen in recent years in the emergence as sovereign states of Ghana and Malaya (1957), Nigeria (1960), Tanganyika (1961) and Kenya (1963). Other territories too have become self-governing: Togoland, formerly under United Kingdom trusteeship, as part of Ghana, and the British Somaliland protectorate as part of the Somali Republic (Somalia). Cyprus also became an independent republic in 1960, but it falls into a different category, inasmuch as the contemporary problem there was less one of laying the constitutional, educational and economic foundations of independence than of reconciling the interests and aspirations of the Greek and Turkish communities. In the other territories instanced, except to some extent Malaya where a Communist terrorist campaign had to be contended with, progress was not dependent on considerations of international politics and conflicting community interests, but followed the broad pattern common to most of the dependencies.

2. Colonial Administration.—The colonial office (*see* below) does not directly administer the territories with which it deals. Each of these has its own administration and an increasing measure of autonomy. A legislative council, introduced at as early a stage as possible, becomes more important as popular representation widens; its composition is progressively transformed from the point at which the majority of its members are officials or other nominees of the governor, through the stages when elected members sit alongside the nominated element. The proportion of these elected members is gradually increased until at length the council consists wholly of elected members. At the same time, the basis of election is broadened from a limited franchise until ultimately universal adult suffrage is reached. The development of the legislature is paralleled by analogous changes in the way in which executive authority is exercised; a system of ministerial responsibility is progressively introduced. Here also, at first, the basis is nomination by the governor of some members of the legislative council to assume responsibility for particular departments and to join the executive council. Next comes the stage at which ministers are either formally elected to the executive council by the legislative council, or hold office only while they retain the confidence of the latter body. Eventually internal self-government is reached, with a cabinet responsible to an elected assembly. The governor retains certain reserve powers which can be used in an emergency, and defense and external affairs remain the responsibility of the U.K. government. Finally, these powers too are transferred and the territory becomes an independent sovereign state.

Thus in every territory there is a local government which, although not autonomous, is a self-contained unit with its own legislature and its own executive. Members of the overseas civil service are the servants of the local governments, are paid from local revenues, and derive their powers from local legislation. The dependencies are not subject to the direct control of Whitehall in the conduct of their internal affairs; careful attention is paid to local opinion, and where unofficial elected members are in the majority in the legislature, all legislation is subject to their approval save in the unusual event of the governor's making use of his reserve powers.

The approach to government formerly prevailing in British territories, more particularly in Africa, was what had come to be

known as indirect rule. Its essential feature was the full utilization of whatever traditional indigenous authorities and forms of administration could be discovered, insofar as they did not run counter to western ideas of justice and morality. It was assumed that progress toward self-government would be achieved through the supervised evolution of the existing local institutions. But in practice this sometimes tended to have the effect of freezing at a certain stage in their evolution customs and techniques which had previously been frequently adapted to meet the needs of new demands and circumstances. Moreover contact with western ideas and the operation of economic forces were having a disintegrating effect on tribal society generally. In local as in central government, therefore, the years following World War II saw a rapid extension of the elective principle and of the other processes of democratic government as understood in Britain and the older commonwealth countries.

3. Development.—The infrastructure of independence has, of course, an economic as well as a political component, and here also these years saw striking developments in policy. Most of the dependencies are in the tropics and many of them, like other tropical countries, are relatively underdeveloped; their natural resources are, on the whole, neither extensive nor readily exploitable. Nevertheless it was the traditional view that each territory should raise its own revenue for its own needs and should live as best it could within its own means. Some of the poorer territories had to be helped financially with annual grants-in-aid of administration but, although there was no flow of taxation from the colonies to Britain, there was a relatively small flow of direct financial aid from Britain to the colonies. The first attempt to organize systematic financial aid for the colonies, in 1929, was a modest one; but by the time of World War II the needs and opportunities were more fully grasped, and from 1940 a series of Colonial Development and Welfare acts were passed. For the period 1946–64 a sum of £315,000,000 was being made available. Private enterprise also played its part in finding the considerable capital investment necessary before many of these territories could be launched in the international sphere with a viable economy; the flow of overseas private capital into the dependencies during the late 1950s averaged about £90,000,000 a year, of which about half came from the United Kingdom. Another source is the Colonial Development corporation (*q.v.*) which backs schemes that may have too great an element of risk to attract private enterprise, but which offer sufficient long-term prospect of success to warrant the investment of capital. Other sources of finance include the International Bank for Reconstruction and Development and U.S. government assistance. (*See* also *Investment,* below.)

Training in modern techniques is one of the chief needs of the dependencies alike in political, economic and social affairs. The provision of formal educational facilities, at all levels from primary school to university, is essential; hardly less so is practical "on-the-job" training. Since the dependencies have not reached the point at which they can do all this from their own resources, outside help is needed just as much as it is in the provision of capital. Britain sends experts and makes available training places for overseas students. The dependencies also benefit from such international co-operative endeavours as the Colombo plan (*q.v.*) and the Foundation for Mutual Assistance in Africa South of the Sahara, and from the work of the United Nations and its specialized agencies.

To meet the demands placed on it by this policy of economic and social development, the colonial office has been greatly expanded, so that it has come to contain several economic departments, a research department and social service departments. Furthermore, the secretary of state could draw on the advice of professional advisers (covering such diverse subjects as agriculture, co-operation, education, fisheries, forestry, housing, labour and social welfare) and on a number of advisory committees or panels of consultants; in the field of scientific research the advisory committees included some of the most eminent scientists in their several branches. Most of these functions were transferred in 1961 to a new department of technical co-operation.

Research, in fact, played a large part in the new orientation of British colonial policy. Much of the interior of Africa was not explored by Europeans till the end of the 19th century, and in the ensuing half century vast strides were made in opening up the country, in combating its endemic diseases, in surveying its land and in analyzing its agricultural possibilities. But Africa still remained in many ways an undeveloped and an unknown continent, and if this accelerated development was to proceed on sound lines, increased research, as the United Kingdom government was well aware, was essential in all fields.

Now that the main lines of political, economic and social development have been charted, the most serious remaining problem of colonial policy arises from the existence, especially in central Africa, of multiracial societies in which the different races, or at least their most politically minded members, lack confidence in one another's intentions. This problem was apparent in the Federation of Rhodesia and Nyasaland, where endeavours to preserve the benefits of federation (its economic advantages were widely conceded and in the long run the psychological advantages of a successful outcome to its avowed policy of racial partnership might have been immense) ran up against the resolution of a considerable number of the Africans, as expressed by their most articulate representatives, to bring it to an early end. The federation was dismantled at the end of 1963.

4. Federations Within the Commonwealth.—Although the Federation of Rhodesia and Nyasaland never became an independent state, it was usually not classified among the dependent territories; its two northern parts, Northern Rhodesia and Nyasaland, were, however, under U.K. protection and therefore the responsibility of U.K. ministers.

Federation was the way to independence for Malaya and Nigeria (as it was in the 19th century for Canada and Australia), and it was hoped that it would play a similar role in the West Indies, despite decisions by Jamaica and Trinidad and Tobago to achieve independence separately. It provides a convenient means of grouping territories into a unit large enough to stand on its own feet while preserving local interests and traditions to which much importance is often attached, and which may well provide the stuff of local politics. In 1963 Singapore, Sarawak and North Borneo (Sabah) united with Malaya to form Malaysia. There remain a few small and isolated territories for which independence, either alone or as part of a larger grouping, at present appears impracticable; but in those, too, the processes of internal self-government are constantly advancing. (C. Com.)

III. CO-OPERATION AND CONSULTATION

The commonwealth is an association of sovereign states, together with their dependencies, and each member nation of it enjoys complete control over its own policy. It is an anachronism to speak of a "commonwealth" policy; all policies are those of individual governments. This individual responsibility, in international as in domestic politics, has greatly enhanced the importance of the machinery for co-operation and consultation between member nations, because it is on this machinery that they rely for ensuring the greatest possible community of view and action in all matters of common concern. The system of consultation, much elaborated during World War II (see *Evolution,* above), includes not only official correspondence from government to government but meetings of ministers and officials and innumerable personal contacts between representatives of governments. It is a now well-established convention that members of the commonwealth have a duty to inform or consult their partner-nations in advance about any course of action which may affect their interests, and indeed this obligation was written into the agreement on external affairs between the United Kingdom and Ceylon in 1947. It means in practice that the aim of all commonwealth governments should be to take no independent action in a matter of common concern until every effort has been made to achieve a common view, and if that proves impossible, at least to ensure an understanding of why this is so. The failure of the United Kingdom to do so in connection with the Suez conflict in Oct. 1956 was a source of grievance to other commonwealth governments (see *Changing Commonwealth: the Suez Conflict,* above). On a great many occasions

the information passed on foreign affairs from one commonwealth government to another is not thought to require either action or comment but, nonetheless, it helps to fill in the background to developments, problems and tensions throughout the world. Silence is not equivalent to assent; and in every case, whatever the views expressed, unless a commonwealth government wishes explicitly and formally to record its agreement, the policy remains that of the initiating government alone. (On this *see* Attlee's statement quoted in *Co-ordination After World War II*, above.) At the same time when action is called for in international affairs, knowledge of background, supplemented in many cases by preliminary interchange of view, makes it more probable that an agreed conclusion, or an approach to an agreed conclusion, will emerge.

1. Colonial Office and Commonwealth Relations Office.—In London the commonwealth relations office (formerly the dominions office) is the mainspring of the machinery of consultation. Until 1925 the colonial office was responsible for all the overseas territories of the crown, though as early as 1907 it was recognized that there was a distinction between the conduct of relations with dominions which were self-governing in respect of their domestic affairs, and colonies which were administered from London. In that year a special dominions department was set up in the colonial office and in 1925 the dominions office was created as a separate department of state because the existing organization was "inadequate to the extent and variety of the work thrown upon the Colonial office." In 1947 the name dominions office was changed to commonwealth relations office and the minister in charge became known as the secretary of state for commonwealth relations. With the advance in status of the dominions to full independence the work of the commonwealth relations office is principally diplomatic, and indeed the old dominions office was once happily described as "a foreign office with a family feeling." In this respect it is sharply distinguished from the colonial office, which is a department responsible ultimately for the government of the dependent territories of the British crown. These territories are actually administered by their several governments but it is the responsibility of the colonial office through her majesty's overseas civil service (the former colonial service) to see that these governments carry out the declared aims of British colonial policy and to advise and assist the secretary of state for the colonies in everything pertaining to his responsibility for their good government. While therefore the commonwealth relations office is concerned, as its name suggests, with relations, the colonial office is concerned with government. After a former colonial territory as, for example, Ceylon, became a full member of the commonwealth, it no longer dealt officially with the colonial office but with the commonwealth relations office. For this reason the transfer of responsibility from the one department to another is an indication of the acquisition of independent status. It also meant that after 1948 the responsibilities of the colonial office declined, while those of the commonwealth relations office increased. In 1962 the commonwealth relations office and the colonial office were brought under a single minister. However, they were separated in 1964 when a Labour government took office. In Jan. 1965 the overseas representational services of the commonwealth relations office and the foreign office were unified.

The commonwealth relations office is the principal channel through which information is received from and communicated to the departments of external affairs of commonwealth governments overseas. It is the department responsible for maintaining the flow of communications on all matters of mutual interest—foreign affairs, defense, economic and social questions—to other commonwealth members. In respect of foreign policy, this office works closely with the foreign office, on which it is necessarily dependent for the greater part of the information which it communicates overseas. Information and views from other commonwealth members come to the commonwealth relations office, which has the responsibility of conveying them where necessary to other departments of state. The secretary of state for commonwealth relations is a member of the United Kingdom cabinet and, as such, is in a position to bring the views of other commonwealth governments to the attention of his cabinet colleagues. Because of Britain's historic position in the commonwealth and the range of its world interests, the commonwealth relations office fulfills a particular responsibility for the commonwealth as a whole, since it is still the case that the greater part of the communications and consultation between commonwealth members is initiated by the United Kingdom government.

2. High Commissioners.—High commissioners play a most important part in the machinery of consultation. They represent the governments of the commonwealth member countries in the capitals of other member countries, and are normally appointed to governments, though exceptionally in the case of India and the federation of Malaysia they are accredited, like ambassadors, by a head of state to a head of state. High commissioners are equal in status with ambassadors and take precedence according to the date of taking up duty. They have the style of "Excellency." Though practice varies, most communications between commonwealth governments are routed through high commissioners. During World War II the secretary of state for dominion affairs usually met the commonwealth high commissioners daily for a discussion of the war situation, and since that time the practice has been continued of having periodical meetings between the secretary of state for commonwealth relations and the commonwealth high commissioners in London with a foreign office minister in attendance. High commissioners in London have the right of direct access to the secretary of state for foreign affairs and may consult individually with United Kingdom ministers if they desire. The staff of a high commissioner's office is likely to include advisers on trade, finance, labour and the armed services. There is usually close contact at all levels between the staff of high commissioners' offices and officials of the government to whose country they are posted. Representation by high commissioners in other commonwealth member states is now general and it has notably assisted in the strengthening of the commonwealth relationship, not only between the United Kingdom and commonwealth countries overseas, but also between the overseas countries themselves.

3. Prime Ministers' Meetings.—These form the apex of the system of commonwealth consultation. The first of these meetings, in its existing form, was held in 1944 and there have been meetings regularly since that date. As distinct from the imperial conferences which they replaced, the prime ministers' meetings are informal, they have no fixed agenda, and they issue no report of their proceedings but only a final communiqué at their conclusion. Except on such matters as affect the commonwealth relationship as a whole, *e.g.*, the admission of India as a republic to commonwealth membership in 1949, of former colonial territories to membership later, or the enforced withdrawal of South Africa, the prime ministers' meetings do not make decisions. The meetings are private and their principal purpose is to review international and commonwealth questions which are of general interest to them. In 1964, for instance, there were discussions on the world political situation, on the progress of British territories toward independence (including the problem of Southern Rhodesia), and on the means of promoting closer co-operation between the peoples of the commonwealth. The discussions are usually stated to have been frank and informal and the governments represented are in a position to determine their later policies in the light of the views expressed. There is a convention that matters in dispute between two or more commonwealth governments should not be discussed in plenary session. Ministerial meetings with more limited terms of reference are held from time to time and notable among them was the meeting of commonwealth foreign ministers at Colombo in 1950. Since World War II there have also been meetings of finance, defense and supply ministers.

4. Governors General.—The governor general acts as the head of state in the overseas members of the commonwealth that are monarchies. The imperial conference of 1926 defined the position of a governor general as "the representative of the Crown holding in all essential respects the same position in relation to the public administration of public affairs in a dominion as is held by His Majesty the King in Great Britain." Thereafter governors general ceased to be in any way the representatives or agents of the United Kingdom government. The government of the member state con-

cerned alone advises the queen on the choice of governor general. With the more frequent appointment to this post of nationals of the member state concerned its national character was enhanced as its royally representative character declined. (*See* GOVERNOR-GENERAL.) (P. N. S. M.)

5. Organizations and Standing Committees.—All the independent members of the commonwealth participate fully in the United Nations and its specialized agencies and the other functional organizations that have become increasingly important and numerous in the modern world. But their special relationship to one another is illustrated by the fact that for some purposes they have found it desirable to establish their own commonwealth organizations. These include the following:

Agricultural Bureaux.—The executive council of the Commonwealth Agricultural bureaux was set up in 1929 to administer a number of bureaux and institutes already in existence dealing with specialized fields of agricultural science. At various dates other bodies were placed under its control, and the organization now comprises 13 specialized institutions dealing with entomology, mycology, biological control, animal breeding and genetics, animal health, animal nutrition, dairy science and technology, forestry, helminthology, horticulture and plantation crops, pastures and field crops, plant breeding and genetics, and soils. The first of these institutions dates from 1913, the others from the 1920s and 1930s. All except one (biological control, which is in Trinidad) are located in various parts of the United Kingdom, the headquarters of the bureaux being at Farnham Royal, Buckinghamshire. The executive council consists of representatives of the member governments and is financed by those governments.

Scientific Offices.—Commonwealth scientific conferences were held in London in 1936 and 1946 and in Australia (Canberra and Melbourne) in 1952. A commonwealth conference of nuclear scientists was held in the United Kingdom in 1958. In addition to these formal conferences there are periodic meetings of the British Commonwealth Scientific committee which consists of the heads of the national research organizations of the commonwealth countries. At one of these meetings in Canada in 1958 it was decided to abolish full-scale scientific conferences in favour of regular meetings of the committee. The British Commonwealth of Nations Scientific Liaison offices (B.C.S.O.), in London, comprise a group of autonomous national units which after 1948 were located in the same building; they serve as one of the main channels for the communication of scientific ideas and information and are closely associated with the overseas liaison group of the U.K. department of scientific and industrial research. (*See* also *Scientific Co-operation*, below.)

Communications.—The Commonwealth Air Transport council was established in 1945 to keep under review the development of commonwealth civil air communications and to advise on civil aviation matters referred to it by commonwealth governments. It is also a medium for the exchange of information between commonwealth countries on such matters. The Commonwealth Telecommunications board, set up in 1949, makes recommendations to the participating governments on the development and co-ordination of their external telecommunications systems. The members are resident in the United Kingdom and each has an office at the board's headquarters in London. The Commonwealth Shipping committee, of governmental representatives meeting under an independent chairman, established in 1920, is responsible for inquiring into complaints regarding ocean freights and facilities and conditions in commonwealth trade, and for making recommendations for the co-ordination and improvement of maritime transport facilities. (*See* also *Communications*, below.)

Economic.—Until 1958, the principal standing body for commonwealth discussion of economic affairs was the Commonwealth Liaison committee which was set up in London in 1948 with the responsibility for the consideration of financial and economic problems of general interest to the countries of the commonwealth. Representatives of United Kingdom government departments and members of all high commissioners' offices attend its meetings, and the committee serves, in a sense, as a permanent secretariat for the meetings of the commonwealth finance ministers, at which all major questions of sterling area policy are considered.

Commonwealth economic co-operation is also furthered by the work of a number of other organizations and by the Commonwealth Economic committee (established 1925), whose services include reports to governments, commodity surveys and intelligence reports.

At the commonwealth trade and economic conference held in Montreal in 1958, it was decided that existing arrangements should be co-ordinated under a Commonwealth Economic Consultative council, consisting, at the highest level, of the finance and economic ministers of the commonwealth countries. Commonwealth governments subsequently agreed that the council should also be regarded as incorporating the meetings of senior commonwealth economic officials held to prepare for meetings of ministers, the Commonwealth Liaison committee, the Commonwealth Economic committee, and meetings of commonwealth statisticians to consider the balance of payments of the sterling area. The council's first meeting at ministerial level was held in London in Sept. 1959 with the chancellor of the exchequer as chairman. At a meeting in London a year later the decision was taken to set up a special commonwealth African assistance plan. (*See* also *Economic Co-operation* and *Economic Development*, below.)

Parliamentary.—The Commonwealth Parliamentary association, with more than 80 branches in commonwealth legislatures, provides facilities for the exchange of visits and information between its members who are engaged in the actual processes of parliamentary government. It began in 1911 with only six members. At the commonwealth parliamentary conference of 1948 it was decided, in accordance with a resolution of the Canadian branch, to set up a general council, to act as a liaison between the various branches, and perform the co-ordinating functions which up till then had been carried out by the United Kingdom branch. The branches in the parliaments of the independent member countries are represented on the council by two members each, and those of the U.K. dependencies are grouped together and send representatives in rotation. The council's headquarters are in the houses of parliament, Westminster, but its meetings are held each year at a different place. There is a close relationship between the Commonwealth Parliamentary association and the British-American Parliamentary group at Westminster, which works with a similar group in the United States congress. Delegates from congress have attended several conferences of the commonwealth parliamentary association. In 1952 an associated group was formed in the parliament of the Republic of Ireland.

Press.—The objects of the Commonwealth Press union (founded 1909), representing the chief newspapers in most commonwealth countries, include the defense of press freedom, the training, education and exchange of journalists, and the improvement of telecommunications services. The Commonwealth Press union has autonomous sections in Canada, Australia, New Zealand, India, Pakistan, Southern Rhodesia, the federation of Malaysia and the West Indies.

Other Fields.—Most of the organizations mentioned above are concerned mainly (though many of them not exclusively) with the independent members of the commonwealth. But there are others whose primary concern is with the dependent territories, though in certain cases geography dictates that self-governing commonwealth countries and countries outside the commonwealth are also vitally concerned. Such organizations are the Anti-Locust Research centre, administered by the department of technical co-operation as a centre for co-ordinating and disseminating research results; the Tropical Products institute, which investigates the renewable resources of tropical areas; the Royal Commonwealth society, which provides social and residential amenities in London, has a library of about 350,000 books, and maintains an information bureau and a Commonwealth Studies committee. The Community Development clearinghouse, at the London University Institute of Education, is a centre from which those concerned with a wide range of social developments can get information and advice on modern techniques.

There are many bodies active in other fields: in forestry for example, the Empire Forestry association and the standing com-

mittee on British Commonwealth forestry; in work for the handicapped, the Royal Commonwealth Society for the Blind and the Commonwealth Society for the Deaf; in the furtherance of personal friendships and understanding, the Victoria league and the Royal Overseas league; in the academic study of the commonwealth, the Royal Institute of International Affairs, the institutes of commonwealth studies in London and Oxford; on migration, the Oversea Migration board. In Britain the Commonwealth institute promotes, by means of a wide range of information and instructional activities, wider knowledge of the commonwealth and its peoples, and there are many societies concerned with particular regions, such as the Royal India, Pakistan and Ceylon society, the Royal Central Asian society, the Royal Asiatic society and the Royal African society. All these committees and organizations, except where stated, have their headquarters in London.

6. Economic Co-operation.—The sterling area comprises all the members of the commonwealth except Canada, and their dependencies, together with a number of countries outside the commonwealth. Its main feature is that its members finance most of their overseas trade in sterling, keep their reserves largely in sterling, and maintain a fixed relationship between their currencies and sterling. As in the case of other commonwealth arrangements, there are no strict rules laid down centrally. But the commonwealth members confer from time to time and agree among themselves on the general shape of the policies to be followed. There is an opportunity for commonwealth finance ministers to hold discussions annually when they visit Washington, D.C., for the meetings of the International Monetary fund and the International Bank for Reconstruction and Development. They also held special conferences in 1949, 1952, 1954 and 1957. Commonwealth economic conferences were held in 1952 and 1958, and at the latter, in Montreal, Can., it was decided to establish a Commonwealth Economic Consultative council, which subsequently held conferences at ministerial level. The council co-ordinates and to some extent has superseded a variety of *ad hoc* arrangements for consultation on economic affairs. Commonwealth ministers met in Accra, Ghana, in 1961 to discuss the implications of Britain's application to join the European Economic Community. Many regarded this as the most serious problem facing the commonwealth in the early 1960s.

Among the problems that have specially engaged the attention of commonwealth ministers are the advancement of the less developed countries and the widening and freeing of trade both within the commonwealth and in the world at large. A commonwealth initiative in economic development, which has since become widely known, was taken at the meeting of commonwealth foreign ministers at Colombo, Ceylon, in Jan. 1950. At this meeting was born the Colombo Plan for Co-operative Economic Development in South and Southeast Asia. It has since been joined by several countries outside the commonwealth. Each country in the region prepares its own development program, but they co-operate with one another and with outside countries willing to help toward the realization of the programs. External assistance under the plan takes the form both of capital aid (which had reached more than £3,500,000,000 by mid-1961 and of technical assistance whereby about 3,000 experts and 19,500 training places had been provided to countries in the region.

The annual flow of capital from the United Kingdom to the sterling commonwealth exceeds £200,000,000, and to the whole commonwealth (*i.e.*, including Canada) nearer £240,000,000. From this source has come about 70% of the capital invested in the sterling commonwealth since World War II. The channels are multiple: commonwealth private borrowing on the London market is at the rate of about £35,000,000 a year; the Commonwealth Development Finance company, set up in 1953, had by the early 1960s committed large sums in respect of schemes; of the United Kingdom's capital subscription to the International bank, over £60,000,000 had been disbursed in loans, mostly to other commonwealth countries; commonwealth assistance loans totaling nearly £70,000,000 had been made; and private funds were being invested in the sterling commonwealth at the rate of £120,000,000 a year (plus another £45,000,000 in respect of India). All this relates primarily to independent members of the commonwealth, and does not take account of the assistance provided to the United Kingdom's dependencies under the Colonial Development and Welfare acts. (*See* also *Production and Trade* and *Investment*, below.)

7. Scientific Co-operation.—In addition to the day-to-day work of the British Commonwealth scientific offices in London, mentioned above, periodic commonwealth scientific conferences have been held (in the United Kingdom in 1936 and 1946, in Australia in 1952). A commonwealth conference of nuclear scientists took place in 1958. In the latter year it was decided to replace full-scale scientific conferences by regular meetings of the British Commonwealth Scientific committee, consisting of the heads of the different national research organizations. A relatively new area of co-operation is that of nuclear energy, where there are extensive arrangements (not, however, formalized in any commonwealth-wide organization) for exchanges of personnel, training and technical assistance, the sharing of knowledge, the building of reactors, the provision of equipment and the supply of uranium.

One of the most important techniques of commonwealth co-operation is the interchange of scientists through the many schemes, some publicly and some privately endowed, which exist for this purpose. Among them are those of the British council, the Nuffield foundation and the Royal society (the last two bodies launched a commonwealth bursaries scheme in 1960).

A remarkable example of joint scientific endeavour was provided by the commonwealth transantarctic expedition of 1957–58, which accomplished (entirely on commonwealth territory) the first land crossing of the antarctic continent, and collected information of value to glaciology, geology, meteorology and surveying. The main crossing party was led by Sir Vivian Fuchs, and the support party by the New Zealand mountaineer Sir Edmund Hillary.

The B.C.S.O. act as a point of contact between the scientists in member countries. One important example of the services they give is the compilation of a commonwealth index of translations into English of foreign scientific papers.

Commonwealth standards conferences were held in London in 1946 and 1951, New Delhi in 1957 and Ottawa in 1959. There are regular consultations between the bodies concerned with standards in the different member countries. Similarly, on statistical questions, day-to-day informal consultation is supplemented by conferences of commonwealth statisticians, which have been held in 1920 (London), 1935 (Ottawa), 1951 (Canberra), 1956 (London) and 1961 (Wellington).

The commonwealth agricultural bureaus (*see* above) collect, collate and abstract scientific literature in all languages and publish reports and hold conferences on special issues. Increasingly their work has come to be recognized and their services utilized throughout the world. Commonwealth forestry conferences are held every five years in various centres of the commonwealth.

8. Educational Co-operation.—The Association of Universities of the British Commonwealth organizes conferences every five years, and operates a commonwealth interchange scheme which finances on average about 100 study and research visits a year. It is also instrumental in recruiting candidates from one commonwealth country for university posts in another. A new impetus was given to commonwealth educational co-operation by a conference held in Oxford in July 1959. It was attended by 150 delegates and worked out a new plan for 1,000 additional commonwealth scholarships or fellowships, mainly for postgraduate research, but with some provision both for undergraduates and for scholars of established reputation. The United Kingdom, which undertook to provide about half the additional places, set up a Commonwealth Scholarships commission to select and place students from other commonwealth countries and also to nominate United Kingdom candidates for awards elsewhere. Another major preoccupation of the Oxford conference was the urgent need for teachers in some of the developing countries, a need partially met by other members' offers of teachers and teacher-training facilities. As a result of the conference a Commonwealth Education Liaison committee was set up, with a subsidiary unit to supplement the existing channels of communication and to deal direct with in-

quiries from education authorities. A second conference in this series was held in New Delhi in 1962.

Interchange of students (by means of Rhodes scholarships, British council awards and others) is no new thing in the commonwealth. The process has been continuous too at senior academic levels. By the early 1960s it was estimated that about 7,000 university students, and three times as many students in technical colleges and other institutions and in industry, were in the United Kingdom from other parts of the commonwealth. Between 1919 and 1960 the League of the British Commonwealth and Empire arranged the exchange of more than 6,000 teachers, and it is estimated that in this and other ways more than 2,500 teachers each year go from Britain to commonwealth countries overseas.

(C. Com.)

9. Nationality and Citizenship.—As a result of the changes brought about by the nationality legislation enacted by members of the commonwealth after the 1947 conference (see *British Nationality Act*, above), each member state defined its own citizens and, with the exception of Ceylon and South Africa (which created a single citizenship only), provided that they possessed in addition a common status as British subjects or commonwealth citizens—the two terms were for most purposes interchangeable. In all instances some differentiation was made in respect of the grant of privileges between citizens of commonwealth countries and aliens, but the extent of such privileges varied considerably. The United Kingdom alone left open the door to any British subject, wherever born, to employment in the public services or the professions. For the rest the position was to be determined by reference to the nationality legislation of the state concerned. The most important consequence of the adoption of the new principle, first included in the Canadian Nationality act, 1946, and subsequently in the British Nationality act, 1948, and other commonwealth legislation, was that there was thereby established in each instance a local citizenship distinct from that of the British subject status, formerly common to the whole empire. It is from such local citizenship that a continuing common status in fact derives. For this purpose the United Kingdom and the colonial territories, for which it is administratively responsible, are grouped together in a "local" citizenship designated as citizenship of "the United Kingdom and colonies" so as to distinguish it from the common status of British subject.

(P. N. S. M.)

10. Judicial Committee of the Privy Council.—This is the final court of appeal on certain legal issues arising in Australia, New Zealand, Ceylon, Malaysia, Sierra Leone, Jamaica, Trinidad and Tobago, Kenya and Nyasaland (Malawi). Its appellate jurisdiction derives from the principle of English common law which recognizes "the right of all the King's subjects to appeal for redress to the Sovereign in Council." *See* Privy Council, Judicial Committee of.

(X.)

11. Social Security Reciprocity.—It is the policy of the United Kingdom to conclude wherever possible reciprocal arrangements with other countries, whether members of the commonwealth or not, to make health services and social security benefits available to one another's citizens, so that freedom of movement does not involve sacrificing rights acquired by residence or contributions to benefits and pensions. Agreements may vary in comprehensiveness, but they mostly include family allowances, old age, unemployment, sickness and maternity benefits. Some also cover industrial injuries insurance.

The United Kingdom has agreements with Australia, New Zealand, Malta and Cyprus, and on a less comprehensive scale with Canada. It has also certain reciprocal arrangements with the Isle of Man and the Channel Islands of Jersey and Guernsey. There is an arrangement of a similar nature with the Republic of Ireland. A very comprehensive agreement, covering practically all benefits, has existed for a number of years between Australia and New Zealand.

12. Defense.—There is no central commonwealth organization for defense co-operation; as in matters of international policy generally, the basis of co-operation is the exchange of ideas and views. A special meeting of defense ministers from some of the commonwealth countries was held in 1951, but this was exceptional. Apart from many informal arrangements, however, two members (the United Kingdom and Canada) are linked in the North Atlantic Treaty organization (*q.v.*), two (the United Kingdom and Pakistan) in the Central Treaty organization (Baghdad pact [*q.v.*]), and four (the United Kingdom, Pakistan, Australia and New Zealand) in the Southeast Asia Treaty organization (*q.v.*). Australia and New Zealand are also associated with the United States in the Pacific Security treaty known, after the initials of the three countries, as ANZUS. Some other member countries have bilateral defense agreements with the United Kingdom. (*See* also *Regional Security*, above.)

Each of the services in the United Kingdom invites officers and officials from the overseas commonwealth both to conferences (*e.g.*, at the Imperial Defence college in London) and to the training courses that are going on more or less continuously at staff colleges and similar institutions. Permanent liaison staffs are maintained by the United Kingdom in other commonwealth countries, and by those countries in London. Although the United Kingdom still has by far the largest defense responsibilities in the commonwealth, the traffic is not one way, nor is it confined to arrangements in which the United Kingdom is concerned. For example, staff colleges in Canada and Australia have reciprocal arrangements for the exchange of students with their opposite numbers in India and Pakistan.

Under an agreement concluded with Malaya in 1957, the United Kingdom, Australia and New Zealand agreed to co-operate in the defense of the federation. Since Nov. 1948 the New Zealand and Fijian governments have shared the cost of the defense of Fiji, a dependency of the United Kingdom, and the New Zealand chiefs of staff have made themselves responsible for organizing and training Fiji's defense forces. New Zealand also supplies the commander of the Tonga defense force.

Combined exercises, joint research organizations, standardization of equipment and weapons, exchange and loan of personnel, joint use of areas geographically suitable for training are all part of a system which provides a unique blend of autonomy and unity. For example, the long-range weapons establishment and rocket range, set up in 1947 at Woomera, South Australia, under the joint U.K.-Australian guided weapon scheme, has been the main centre of commonwealth research in supersonic missiles.

With this complex network of co-operation and the increasing importance of the scientific aspects of defense, the need became felt for some form of co-ordinating (but not administrative) machinery. Accordingly, in 1947, the Commonwealth Advisory Committee on Defence Science was set up. It holds conferences from time to time. Between the conferences liaison is maintained by a working party of representatives of United Kingdom departments and scientific or service advisers to commonwealth high commissioners in London.

(C. Com.)

IV. PRODUCTION AND TRADE

1. Production.—The large and varied resources of the commonwealth extend over approximately one-quarter of the earth's land area and include about one-quarter of the world's population. In terms of people, the commonwealth is predominantly Asian, as three-quarters of its citizens live in the countries of southeast Asia. One-half of the remainder are in African countries, so that those of European descent comprise less than one-eighth of the commonwealth's population. The ratio of people to land is much the same for the commonwealth as for the world as a whole, but there are, of course, great variations in population density. Densities are high for the United Kingdom, most Asian countries and the West Indies, rather low for most African countries and quite low for Canada and Australia, largely because of enormous areas of wasteland and small populations.

In this loose association of diverse countries, taken together, primary production is more important than industrial production; for although the commonwealth has one-third of the population of the "free" or noncommunist world, it has less than one-sixth of the industrial production. Industrial production, furthermore, is heavily concentrated in temperate latitude countries; the United Kingdom, alone, produces nearly one-half of the commonwealth's

industrial output and, together with Canada, Australia, New Zealand and (formerly) South Africa, more than four-fifths of this total. India (aside from Hong Kong) is the only other substantial contributor and its industrial output is less than one-fifth of that of the United Kingdom.

The accidents of geology, however, have made commonwealth contributions to the outputs of many minerals more than proportionate to its population. Canada and the former commonwealth country South Africa produce more than four-fifths of the free world's gold, Malaya and Nigeria nearly one-half of its tin, Canada two-thirds of its nickel, and Rhodesia and South Africa two-fifths of its chrome. The commonwealth also produces about one-third of the free world's output of antimony, bauxite, coal, copper and lead, the most important suppliers of antimony being South Africa, of bauxite Jamaica, of copper Rhodesia or Canada, of lead Australia, and of coal the United Kingdom. On the other hand, the commonwealth is relatively deficient as a producer of cobalt, iron, manganese, mercury, molybdenum, sulfur, tungsten and zinc.

It is more difficult to arrive at comprehensive estimates of farming production, but the position here is also uneven. Although the commonwealth has more than one-third of the free world's cattle, it produces less than one-quarter of its milk and less than one-eighth of its meat. But with two-fifths of the sheep, it produces three-fifths of the wool, mainly from the extensive pastures of Australia, New Zealand and South Africa. And if wheat production is a little below the free world average per head, rice production is considerably above it. Four-fifths of the free world's tea, moreover, is supplied by India and Ceylon, more than one-half of its cocoa by Ghana and Nigeria, and four-fifths of its peanuts by India and Nigeria. India and Pakistan also supply four-fifths of the free world's jute as well as one-fifth of its cotton. East Africa supplies nearly one-half of the sisal and Malaysia, together with Ceylon, one-half of the rubber.

2. Economic Development.—After 1940 all governments of the commonwealth became much more active in promoting the economic development of their own countries, and the wealthier members also came increasingly to accept a responsibility for helping other members to raise low standards of living. The Commonwealth Economic conference of 1952 agreed that "sound economic development schemes should be encouraged with the object of increasing productive strength and competitive power, providing employment and raising standards of life." This principle was reaffirmed at subsequent conferences.

The United Kingdom passed the first Colonial Development and Welfare act in 1940, and although little could be done during the war, subsequent acts assisted the dependencies both through the provision of exchequer funds and through loans raised by the Colonial Development corporation for commercial projects. The dependencies were, of course, also helped by guidance and technical advice. Agriculture was the basic industry of nearly every dependency and much was done to improve it. Fertilizers were supplied to peasant farmers, erosion was prevented, new land was brought into cultivation and farms were grouped into more economic units. Forest resources were developed, not only to increase timber production, but also to assist land conservation. Nor was mineral production neglected. Bauxite mining developed in Jamaica, copper and cobalt in Uganda, copper, zinc, gold and silver in Kenya, and uranium in Nigeria and Northern Rhodesia (Zambia). Two new oil fields were also opened in Nigeria. Notable developments regarding power were the Owen falls scheme in Uganda and the Pangani falls scheme in Tanganyika. Less could be done for manufacturing, but there was, in most dependencies, a new growth of plants for cement and for fertilizers. Governments were energetic in improving harbours, railways, roads and air services, especially in Africa.

Autonomous African members were also vigorously promoting development. South Africa, during its commonwealth membership, greatly increased agricultural production through irrigation and mechanization. Steel production sharply increased and new industries were established to derive oil from coal, phosphates from apatite, and cellulose pulp and paper from local timbers. Ghana had a formal development plan from 1951 to 1957 aimed, more especially, at improving transport and social services, but measures were also taken to increase cocoa production. The Volta river project promised to provide a large aluminum industry and to generate 600,000 kw. of hydroelectric power. The Federation of Rhodesia and Nyasaland sought to improve farming in order to ensure food for a rapidly growing population, and also developed mineral production; there were marked increases for asbestos, coal, copper and chrome.

Asian members were assisted, largely through the Colombo plan, by the United Kingdom, Canada, Australia, New Zealand, the United States and the International bank. But most of their development was undertaken from their own resources. India's first five-year plan, introduced in 1951, relied upon external finance for only 10% of the associated investment, and achieved a balanced expansion of real national income amounting to 17½%. A second plan envisaged an increased pace of development but was somewhat hindered by difficulties over foreign exchange. An important feature of this plan was a National Industrial Development corporation set up by the government to foster new basic industries and to help existing industries. Pakistan set up a development board in 1948, began a six-year development program in 1950, and adopted a five-year plan in 1957. This plan sought to raise real national income by 15% in total or by 7% a head, and one-third of the development expenditure was to come from overseas. Ceylon attempted to reduce dependence on rubber by diversifying its industries. A six-year investment program was adopted in 1955 and, a year later, a national planning council was established. Investment went, more particularly, to land development, irrigation, agriculture, fisheries, transport and public health services. Malaya also introduced a five-year plan, approved in 1957, paying special attention to rubber production, agriculture and electricity.

Australia and New Zealand were very successful in promoting their own economic growth. Australia's population increased by one-third after the war, partly because of an ambitious immigration scheme, and made great strides industrially. Expansion was especially rapid for iron, lead, zinc, copper, aluminum, coal, hydroelectricity, oil refining, chemicals, electrical and engineering industries. Although most of this development was associated with private enterprise, the federal government was active in regard to immigration, transport facilities and hydroelectric power. New Zealand had comparable rates for population growth and for investment. Farming production greatly increased, manufacturing industries grew and widened, and the state did much to improve both hydroelectric power and transport facilities.

Canada's economic development after World War II was such as to make it a major industrial power; even more than South Africa, it was helped by big inflows of private capital. Although this growth extended over most types of activity, it was most strikingly associated with the exploitation of oil and metallic ores: iron, copper, gold, nickel, zinc, lead, asbestos and gypsum. There were also striking developments in electric power, pulp and paper, and transportation.

3. Trade.—Commonwealth trade amounts to between one-quarter and one-third of the total trade of the free world, a proportion which has been remarkably stable within these limits since the beginning of the 20th century. Much the largest contribution is made by the United Kingdom, which is responsible for one-third of the commonwealth total. Canada has about one-half of the United Kingdom's share of trade, Australia and India each about one-fifth, the federation of Malaysia about one-seventh, and New Zealand about one-twelfth; South Africa had about one-seventh. After 1938 the United Kingdom's share of world trade fell slightly, mainly because of reduced imports after wartime losses of external assets, but Canada almost doubled its share and there was also a notable rise in the shares of Asian and African countries.

The composition of the commonwealth's trade fully reflects the diversity of its resources. Because of its high degree of industrialization, the United Kingdom exports mainly manufactures in exchange for foodstuffs and raw materials. In all other cases, except the Rhodesias, Malawi and Hong Kong, manufactures comprise less than one-half of exports. Rhodesia is an exception

only because its main export is copper, and Hong Kong, whose main exports are textile manufactures, is obviously a special case. In Canada and India, however, manufactures comprise nearly one-half of exports. Most of these Canadian exports are wood products (timber, pulp, paper and paperboard) and India exports manufactures of jute and cotton. In other cases manufactures contribute much less than two-fifths of exports and, save in areas such as Ceylon, Pakistan and Malaysia, where food imports bulk large, manufactures comprise two-thirds or more of total imports.

Australia's main exports are wool, meat and wheat. It provides nearly one-half of the free world's exports of wool, or with New Zealand and South Africa nearly three-quarters. Wool and meat are also New Zealand's main exports but dairy produce is almost as important. New Zealand provides one-third of the free world's exports of butter and nearly one-quarter of its exports of cheese. South Africa was also an important supplier of wool, but one-half of its export receipts came from gold. The most important export for both Ghana and Nigeria is cocoa, followed by manganese in Ghana and by vegetable fats in Nigeria. Tropical agriculture also provides the leading exports of east Africa (coffee, cotton and sisal), of Pakistan (jute and rubber), and of Ceylon (tea and rubber). Tea is a leading export for India, as is rubber for Malaysia, but India also exports large quantities of jute and cotton goods and Malaysia is an important exporter of tin. In the West Indies sugar, bananas and bauxite are the main exports of Jamaica, and petroleum, sugar and cocoa those of Trinidad and Tobago.

On the import side, only the United Kingdom, Ghana, Pakistan, Ceylon and Malaysia are heavy buyers of foodstuffs, and only the United Kingdom and Malaysia are heavy buyers of materials. Petroleum, however, ranks as a main import of nearly every commonwealth country. The two major classes of imports in all parts of the commonwealth except the United Kingdom are machinery and transport equipment, reflecting not only their lesser degree of industrialization but also their needs of economic development.

By the early 1960s about two-fifths of the trade of commonwealth countries was being conducted with one another, about one-fifth with the dollar area, and somewhat less than one-fifth with O.E.C.D. (Organization for Economic Cooperation and Development) countries of continental Europe.

Intercommonwealth Trade.—This trade is clearly very important, and the United Kingdom is its undoubted pivot. It ranks either as the first or second best customer of other commonwealth countries (Hong Kong excepted), and as one of their three principal suppliers. Together, they sell about one-quarter of their exports to the United Kingdom and draw about the same proportion of their imports from it. There are, however, large differences in regard to dependence on the United Kingdom. New Zealand sells two-thirds of its exports to the United Kingdom, Rhodesia one-half, Australia, India, Ceylon, Ghana and formerly South Africa about one-third, and Canada and Pakistan less than one-sixth. New Zealand is also the most dependent member in regard to imports, half of which come from the United Kingdom. For Australia, Rhodesia and Ghana the corresponding proportion is nearer two-fifths, for India one-quarter, for Pakistan and Ceylon one-fifth, and for the colonial territories as a whole one-quarter. For South Africa the proportion was one-third.

As would be expected, the outstanding feature of this trade between the United Kingdom and other commonwealth countries is its largely complementary character. Almost all of the United Kingdom's exports consist of manufactured goods, among which machinery, vehicles, iron and steel products, cotton and woolen goods are prominent. The United Kingdom's imports from the commonwealth, however, are largely farming or mining products: dairy produce, meat, sugar, tea, vegetable oils, wheat, cotton, jute, sisal, wool, tin and timber. More than two-fifths of the United Kingdom's imports are supplied by commonwealth countries.

The trade of other commonwealth countries with one another amounts to about one-half of their trade with the United Kingdom; *i.e.,* to about one-sixth of their total trade. Here, too, we find considerable variations in the proportion which, in the case of exports, ranges from about one-quarter for India, Pakistan, Ceylon and formerly South Africa, to less than one-tenth for Canada and New Zealand. For imports the corresponding range is from more than two-fifths for Rhodesia to less than one-twentieth for Canada; in most cases it ranges from one-sixth to one-third. Much of this trade is between neighbouring countries: Australia sells to New Zealand, South Africa to Rhodesia, and India to Pakistan and Ceylon. But a good deal of it derives from the natural differences of production between tropical and temperate-latitude countries. Australia sells wheat and wool to India from which it buys jute goods and tea. Canada is important to the West Indies as a market for sugar and spices and as a supplier of fish, flour and wheat. Australia provides Mauritius with a main market for sugar, and New Zealand draws most of its tea from Ceylon. The distribution of mineral deposits also has an influence. Canada buys tin from Malaysia and cobalt from Rhodesia, Australia buys asbestos from Canada and Rhodesia and petroleum from Brunei, and South Africa exports coal to Ceylon while importing zinc and copper from Rhodesia.

Some trade, however, is in manufactures from suitably developed or situated countries in competition with the United Kingdom. India is a large exporter of cotton and jute goods to Pakistan and east Africa from which, fittingly enough, it imports raw jute and cotton. Canada's large rubber and automobile industries find markets in Australia, South Africa and India, although these have been severely restricted by measures to conserve dollars. South Africa sends footwear, textiles, fertilizers and iron or steel products to Rhodesia and east Africa. Australia supplies iron and steel to New Zealand. Hong Kong exports apparel and hardware to Malaysia, India and Ceylon.

A small proportion of intercommonwealth trade is of the entrepôt type. The United Kingdom reexports some of its imports from the commonwealth, notably wool. South Africa does much reexporting to other African countries. But the great commonwealth centres for entrepôt trade are the free ports of Singapore and Hong Kong. About three-fifths of Malaysia's exports are sent out to neighbouring Asian countries. In the case of Hong Kong the proportion is similar but used to be higher before the Communists took over China.

Trade With Noncommonwealth Countries.—Among foreign countries the United States, notwithstanding dollar restrictions, is by far the most important single supplier. It furnishes about one-fifth of the commonwealth's imports and this proportion does not vary much between the members. For the United Kingdom, Canada, Australia, New Zealand, Rhodesia, India and Pakistan it ranks as one of three principal suppliers. Exports to the United States, however, are much more restricted in source and character. Three-fifths of these exports are sent by Canada, mainly timber, newsprint, furs, hides, nickel, aluminum, lead, zinc, copper and meat. The next most important supplier is the United Kingdom, for which the proportion is one-seventh, and covers a fairly wide range of manufactured goods. Australia and New Zealand send wool and hides. Tropical countries supply jute, rubber, cocoa, coffee, sugar, tea, asbestos, chrome, manganese, mica and tin.

Western Europe is of particular importance to the United Kingdom, which is responsible for almost one-half of both commonwealth exports to, and imports from, this area. Nevertheless United Kingdom trade usually shows a substantial deficit with this area, as does that of India. Other commonwealth countries, however, usually have surpluses, especially Canada, Australia and New Zealand. Canada's main export to western Europe is wheat, and that of both Australia and New Zealand is wool. Western Europe provides a market for one-quarter or more of the exports of the United Kingdom, Australia, Pakistan, Ghana and Malaysia, and for about one-eighth of the exports of most other commonwealth countries. India has been drawing one-quarter of its imports from western Europe, as has Pakistan. For the United Kingdom, Ghana and Ceylon the proportion is one-fifth, for Australia one-seventh and for New Zealand one-tenth.

Among other countries, Japan is probably the most significant in regard to commonwealth trade. It is a substantial buyer of Australian wool, Pakistan jute, and Malaysian tin and rubber. It supplies more than 5% of imports to Ghana, Ceylon, India and Malaysia.

Tariff Preferences.—Efforts were made over a long period to promote intercommonwealth trade. Tariff preferences were granted to the United Kingdom by most self-governing members of the commonwealth after 1907. Reciprocal treatment was accorded in 1919, but the United Kingdom did not decisively reverse a traditional policy of free trade until the imperial conference held at Ottawa in 1932 (*see* IMPERIAL PREFERENCE). The United Kingdom then guaranteed free entry of dominion and Indian goods, imposed additional duties upon a large number of foreign products competing with commonwealth products, and put quotas on foreign meat. For their part, the dominions and India undertook to increase preferences to the United Kingdom and the colonies over such articles as they conveniently could, and agreed not to raise protective duties to levels that would prevent reasonable competition by United Kingdom manufacturers. However, many colonies (notably those affected by the Congo basin treaties) and all mandates kept to free trade arrangements.

Soon after the Ottawa agreements attempts began at reviving world trade by reducing tariffs. An Anglo-U.S. trade agreement in 1938 led the United Kingdom to abolish duties on foreign wheat and lard and to reduce other duties. Further attempts to liberalize trade were foreshadowed during World War II by the Atlantic charter and by the lend-lease "master agreement." In accordance with these declarations a charter for an International Trading organization was drawn up at the Havana conference of 1948, aimed at a goal of multilateral and nondiscriminatory trade. Only two countries, Australia and Liberia, ratified this charter. Many more, however, signed a General Agreement on Tariffs and Trade (G.A.T.T.) as an interim measure which contained many of the provisions of the draft charter (*see* TARIFFS AND TRADE, GENERAL AGREEMENT ON). A number of sessions of the contracting parties were held, at which some duties were reduced and others were bound against increase. Members of the commonwealth abolished a few preferences and reduced others, but no important breach was made in the structure of commonwealth preferences and the United Kingdom secured a waiver in regard to preferences for colonial industries.

Preferences came to the fore again during discussions for a free trade area by members of the Organization for European Economic Cooperation (O.E.E.C.) in 1958. These discussions broke down because of unresolved differences, mainly between the United Kingdom and France, over a common external tariff, protection of agriculture and imperial preferences. The United Kingdom wished to exclude agriculture and saw difficulties in either giving up preferences or sharing them with European countries. France, the Federal Republic of Germany, Italy, the Netherlands, Belgium and Luxembourg have thus created a European Economic Community (E.E.C.) providing a common external tariff, for progressive reductions of duties between members, and for the protection of their members' agricultural industries by quantitative barriers. These reductions of internal tariffs, coupled with the common external tariff, could have adverse effects upon the trade of the United Kingdom with these countries, just as the arrangements for agricultural protection could damage the trade of other commonwealth countries.

Meanwhile the United Kingdom joined Denmark, Norway, Sweden, Austria, Switzerland and Portugal in forming a European Free Trade association (E.F.T.A.) having the more limited aims of reducing barriers against trade in industrial products and of expanding trade in agricultural products. In this connection, the United Kingdom made separate agreements with Norway about frozen fish and with Denmark about bacon and other products. These agreements had little effect upon the general structure of imperial preferences, but indicate the kind of adjustments that probably have to be made to preserve the United Kingdom's markets in Europe.

More significant, perhaps, are the modifications made by Australia and New Zealand. In 1957 Australia negotiated a new agreement with the United Kingdom providing for continued free entry of Australian goods, a guaranteed minimum U.K. preference on existing preference items, but reduced obligatory margins of preference on U.K. goods. A year later New Zealand negotiated a similar agreement, inspired, like Australia, by the hope of stronger powers of negotiation for markets outside the commonwealth. Both of these countries are concerned at the failure of G.A.T.T. agreements to secure a liberalization of trade in agricultural products comparable to that achieved for industrial products, and both are anxious that commonwealth producers shall not have greater restrictions placed on their trade with members of the E.E.C.

V. FINANCE

1. Sterling Area.—Although the self-governing members of the commonwealth are autonomous in monetary as in other matters, they co-operate with the United Kingdom in regard to international finance. This co-operation is the basis of the sterling area, comprising those countries which link the external values of their currencies to sterling, maintain balances in London for settling international transactions, and adhere to rules imposed by the United Kingdom upon its own nationals for controlling transactions with other areas, notably the dollar area.

The sterling area has resulted from a long historical development. Before World War I, when the United Kingdom adhered to the gold standard, the currencies of other commonwealth countries were also tied to gold, either directly or through convertibility with sterling. As much of their trade was conducted with the United Kingdom and most of their external loans raised there, they kept large balances in London so as to facilitate settlements not only with the United Kingdom but with other countries as well. In 1914 the United Kingdom suspended gold payments and did not succeed in restoring the gold standard until 1925. But difficulties, culminating in the onset of the world depression, led to the final abandonment of gold in Sept. 1931. From this period of confusion in international finance a sterling area soon emerged consisting of countries that tied their currencies to sterling instead of to gold or to the dollar. This area included all commonwealth countries, with the temporary exception of South Africa which kept to gold until 1932, and with the permanent exception of Canada which, after attempting to steer a middle course because of its close economic relations with the United States, finally linked its currency to the dollar. On the other hand, some foreign countries adhered to sterling, if only temporarily; these included the Scandinavian and Baltic countries, Portugal, Argentina, Iraq, Egypt, Thailand and Japan.

On the outbreak of World War II the Scandinavian countries, Portugal and Argentina withdrew from the sterling area. When the United Kingdom brought in the comprehensive exchange regulations of July 1940, these listed the membership of the area as all commonwealth countries, save Canada and Hong Kong, together with Egypt, the Sudan, Iraq and Iceland. Transactions within the area, including capital movements, were to be free from U.K. control, although members could and did impose their own restrictions. But transactions outside the area were, so far as possible, to conform to rules laid down by the United Kingdom for its own nationals. The U.K.'s gold and dollar reserves formed the basis of a "dollar pool," into which members agreed to pay dollar surpluses and from which they could pay dollar deficits, provided that they had taken appropriate measures for controlling dollar purchases. Early in the war emphasis was placed upon an expansion of dollar exports but this conflicted sharply with overriding demands of war production. By June 1941 the gold and dollar reserves had fallen to £65,000,000 in spite of heavy sales of American assets. The commonwealth was saved by the U.S. Lend-Lease act which, until the end of the war, removed all immediate anxiety about dollar funds. For a few years sterling again became common currency throughout the non-Axis world, and during these years membership came to include the Faeroe Islands, the free French colonies, the Belgian Congo, Syria and Lebanon.

When lend-lease was abruptly terminated in 1945 the dollar problem returned in a seemingly intractable form. Large parts of Asia which had previously been net earners of dollars were so affected by war and postwar disturbances as to become heavy net spenders of dollars. The main difficulties, however, were connected with the United Kingdom's position; it had sold one-quarter of its overseas assets to finance wartime dollar expenditures, it had

reduced the volume of its exports to one-half their prewar level, it had lost much of its merchant shipping, and it had incurred short-term sterling obligations to other countries amounting to £3,700,000,000. In order to assist the United Kingdom in a difficult task of recovery, the United States provided a loan of $3,750,000,000 and Canada one of $1,250,000,000. The United States, however, stipulated that current transaction sterling should be made convertible into dollars within a year, and that the accumulated sterling balances of other countries should be scaled down by negotiation. These balances belonged to relatively poor countries, such as Egypt, India and Pakistan, and no agreement could be made to reduce them; the best arrangement that could be obtained was a partial and temporary blocking. As a preparatory step toward restoring convertibility the United Kingdom redefined membership of the sterling area, now shrunk by the defection of nearly all noncommonwealth countries (although Iraq did not leave until 1959), and drew up a list of "transferable-account" countries with which the area had only small deficits or surpluses. When convertibility was restored in July 1947 it applied only to these countries along with the sterling area. But conditions for this attempt were so far from favourable that convertibility lasted little more than one month.

The economic difficulties of Europe had become so acute in 1947 that the United States arranged to provide generous grants and loans for a European Recovery program. Recipient countries set up the Organization for European Economic Cooperation in order to work with the U.S. authorities, and later a European Payments union to facilitate settlements of their trade balances with one another. The United Kingdom received $2,827,000,000 of this aid, which had striking effects in improving the whole economy of western Europe in association with the measures taken by the O.E.E.C. to liberalize trade. At the same time the United Kingdom negotiated a series of agreements with a number of countries outside both the dollar and sterling areas. These countries were given "transferable sterling accounts" through which were channeled all noncapital transactions with the sterling area, and which could be used to make payments to the sterling area and to other transferable-account countries. For a time there was also a number of "bilateral countries" which could use their balances freely only inside the sterling area, but these countries were merged with the transferable-account group and, although only eight accepted, the dollar became virtually the only hard currency for the sterling area.

There was, however, a succession of minor crises over gold and dollar reserves. In Sept. 1949 pressure on sterling led to a major devaluation from $4.03 = £1 to $2.80 = £1, all members of the commonwealth following (Canada and Pakistan excepted) and most of Europe. Another crisis followed the outbreak of the Korean war but measures were agreed upon to restore the position at the commonwealth conference of 1952 which also decided to make convertibility the goal. The American recession of 1953–54 delayed recovery but by 1955 restrictions had become comparatively slight for current transactions, and difficulties over disparities between foreign rates for official and transferable sterling were removed by the authorization of action by the Exchange Equalization account in New York, Zürich and other financial markets. Since then, sterling has been virtually convertible for all nonresidents.

The central reserves, nevertheless, again came under serious, if mainly speculative, pressure in mid-1957. Anxieties had developed about the ability of the United Kingdom to control inflation, a crisis arose over the French franc, there was uncertainty about an appreciation of the German deutschemark, and another American recession was under way. The Bank of England met the situation by a drastic rise of discount rate to 7%, and the position was further helped by an announcement, at the meeting of the International Monetary fund (I.M.F.), that the deutschemark would not be revalued. Improvement was so rapid that, on Dec. 27, 1958, sterling was made officially convertible, for nonresidents, into any currency. The same step was taken simultaneously by west Germany, France, Italy, the Netherlands, Belgium, Luxembourg, Denmark, Norway and Sweden. Sterling thus became not only a stronger but also a simpler currency. No distinction is now made between American accounts, transferable accounts or the registered accounts set up in 1954 to facilitate dealings in the London gold market; these are now merged into a single set of "external accounts." The sterling area's reserves, moreover, have since included all convertible currencies as well as gold and dollars. Although still too small for comfort, they have been strengthened, not only by the convertibility of European currencies but also by an increase of 50% in I.M.F. subscriptions and stand-by credits.

2. Banking.—All independent members of the commonwealth have their own currencies which, subject to legislative provisions, are controlled by their own central banks. These banks have a monopoly of the note issue, act as bankers and financial agents for their governments, control credit and regulate foreign exchanges. The Bank of England (*q.v.*) is a venerable institution, but other commonwealth central banks are comparatively recent institutions. The Reserve Bank of South Africa began operations in 1921. The Commonwealth Bank of Australia was established in 1911, but developed only slowly from a commercial and savings bank into a central bank; the necessary central bank powers were not finally conferred until 1945; the Commonwealth Trading bank and the Commonwealth Saving bank were not split off until 1953, and it was only in 1959 that the name was changed to the Reserve Bank of Australia. The Reserve Bank of New Zealand was opened in 1934, and both the Bank of Canada and the Reserve Bank of India a year later. The State Bank of Pakistan was set up in 1948 and the Central Bank of Ceylon in 1950. When the Federation of Rhodesia and Nyasaland was created the powers of the Central African Currency board were transferred, in 1956, to the Bank of Rhodesia and Nyasaland. In 1957 some powers of the West African Currency board were transferred to the Bank of Ghana and the remainder, in 1960, to the Central Bank of Nigeria. The Central Bank of Malaya was set up in 1958 but an agreement with Singapore and North Borneo led to powers of issue remaining with the Malayan Currency board. Most of these institutions are government owned. The Bank of England, after centuries as a joint stock company, was nationalized in 1946. The Bank of Canada, the Reserve Bank of Australia and the Central Bank of Ceylon have been state owned from the outset. The Reserve Bank of New Zealand and the Reserve Bank of India were at first partly owned by private shareholders, but the former was nationalized in 1936 and the latter in 1949. The Reserve Bank of South Africa was a mixed institution with 6 of its 11 directors elected by private shareholders, and the State Bank of Pakistan has a minority of private shareholders. The new central banks of Rhodesia, Ghana, Nigeria and Malaysia are all government institutions.

Note issues used to be prescribed by statutory regulations but these now apply only to the Bank of England, which has a prescribed maximum fiduciary issue, to the Bank of Ghana, which has a similar limitation, and to the Central Bank of Nigeria, which must have at least a 60% backing of sterling for its notes. In the case of other commonwealth central banks the tendency has been to relate legal reserves both to deposit and note liabilities but, later, to dispense altogether with statutory reserve requirements. The Reserve Bank of South Africa was required to maintain gold reserves at 30% of note and deposit liabilities, and there are corresponding requirements of 25% and 20% in Canada and Pakistan. The Reserve Bank of New Zealand, up to 1950, had to keep a reserve of 25%, but since then the reserve has been left to the discretion of its board. A similar freedom is accorded the central banks of Australia, India and Ceylon.

An important feature of commercial banking throughout the commonwealth is its concentration into a small number of large banks operating a widespread system of branches. Pakistan, it is true, has about 30 scheduled banks and India more than 100, but nearly one-quarter of India's banking is in the hands of the Imperial bank. Until the late 1950s commercial banks in the United Kingdom were not obliged to maintain deposits at the Bank of England, but their practice was to have such deposits at a fairly constant rate of 8% of their own deposit liabilities. After the publication, however, of the Radcliffe report in 1958 the Bank of

England took the power of requiring "special deposits" and made two such calls in 1960. It followed the practice of Australia, a practice which began as a wartime control but was made a regular method of credit regulation in 1945. In other commonwealth countries commercial banks are legally obliged to maintain minimum deposits with the central bank, expressed as ratios of their deposit liabilities, and these are often varied as the central bank sees fit. Canadian banks have to maintain deposits at the Bank of Canada equal to at least 5% of their total liabilities to the public. In both India and Pakistan the requirement is 5% of demand and 2% of time liabilities. The Central Bank of Ceylon may vary statutory ratios from 14% and 5% to 40% and 20%, and the Bank of Rhodesia from 6% and 3% to 25% and 10%. In New Zealand the commercial banks are required to hold balances of Reserve bank notes and deposits which cannot be less than 7% of demand and 3% of time liabilities, but which may be any higher percentages set by the bank.

The traditional methods of credit regulation, developed by the Bank of England, are variations of discount rate and open market operations. The Bank of Canada and formerly the Reserve Bank of South Africa have been able, with difficulty, to make some use of these techniques but insufficient to dominate credit conditions. The major obstacle in commonwealth countries is the lack of a strong and active market in government securities. For this reason other commonwealth banks have been given the power of varying statutory deposits required from commercial banks or, in Australia, of levying special deposits the size of which is fixed by the central bank. Direct controls have also been used. In Canada, Australia, New Zealand, India, Pakistan and Ceylon the central banks possess, and have used, wide powers in issuing directives to commercial banks. There is also, of course, much use made of procedures for consultation and "moral suasion."

3. Investment.—Most of the external finance raised by commonwealth countries, both for public and private purposes, has come from the United Kingdom. Before World War I it was estimated to have held about £3,700,000,000 of overseas investments, one-quarter in South Africa, Australia and New Zealand, and another quarter in the rest of the commonwealth. About one-fifth of these investments were disposed of during that war. The United Kingdom resumed overseas lending in the 1920s but on a reduced scale, and most of the new loans went to the commonwealth. International investment greatly fell off during the 1930s, and the United Kingdom's external loans barely exceeded reconversions of commonwealth debt in London. At the outbreak of World War II the United Kingdom was estimated to have held about £3,545,000,000 overseas securities, and at the end of it £2,417,000,000. In 1945, moreover, it incurred a debt of $4,372,000,000 to the United States, and one of $1,185,000,000 to Canada. This reduction of the United Kingdom's external assets was partly matched by corresponding reductions in the external public debts of other commonwealth countries. During World War II Canada's external debt became only 2% of its total debt, and United Kingdom holdings negligible. Australia repaid £80,000,000 of London debt, New Zealand £55,000,000 and South Africa £78,000,000. India and Pakistan, for a time, completely extinguished their external public debts. The colonies acquired £90,000,000 of dominion and colonial securities, and temporarily lent £32,600,000 to the United Kingdom.

Notwithstanding the postwar difficulties, the United Kingdom had by the early 1960s increasingly made available grants and loans for rehabilitation and development. As much as £2,570,000,000 may have been invested overseas, and three-quarters of it in the sterling area. Private loans accounted for the greater part of this investment, and it was estimated that they rose from a net figure of £120,000,000 in the late 1940s to one of more than £200,000,000 in the early 1960s. Over the same period, official loans and grants were of the order of £60,000,000 a year.

A number of official measures have been taken to promote development in commonwealth countries. A series of Colonial Development and Welfare acts provided by the early 1960s more than £220,000,000 in order to supplement local revenues and loan resources in United Kingdom dependencies. In addition, a Colonial Development corporation (*q.v.*) was established with a capital which had risen to more than £160,000,000. Most of these funds have gone to African and West Indian dependencies. But another urgent problem of development confronts the countries of south-east Asia. Commonwealth ministers, at a meeting held in Colombo in Jan. 1950, agreed upon a scheme for assisting the development of this area by means of six-year plans involving help with external finance and the provision of technical assistance. A meeting in the following year brought in, besides commonwealth countries, Burma, Cambodia, Indonesia, the Philippines, Thailand, Vietnam, the United States and the International bank. The scheme was extended first to 1961 and then to 1966. In 1958–59 external aid was running at £500,000,000 a year, two-fifths of which was provided by the United States, and one-quarter by Canada, the United Kingdom, Australia and New Zealand.

At the commonwealth conference of 1952 it was also agreed to set up a Commonwealth Development Finance company in order to assist enterprises that could not obtain external finance from other sources. During the first six years of operation only £15,500,000 had been lent, mainly to Rhodesia, South Africa, Canada and New Zealand, and almost half this sum was provided by the Bank of England. But in 1959 authorized capital was increased to £30,000,000 and thereafter commonwealth central banks were invited to subscribe as well as large private companies.

Commonwealth countries have also turned to dollar sources of finance. By the early 1960s the International bank had lent $317,700,000 to Australia, $196,800,000 to South Africa, $143,100,000 to Rhodesia, $27,700,000 to Nigeria and $24,000,000 to East Africa, as well as $577,600,000 to India, $121,000,000 to Pakistan and $17,600,000 to Ceylon. New Zealand, which did not ratify the Bretton Woods agreements until 1961, did not borrow from either the I.M.F. or the International bank but raised loans of $4,000,000 from the U.S. Export-Import bank, as well as a temporary loan of $46,000,000 from a group of American banks and an issue of $10,000,000 in New York. But the greatest flow of private dollar capital to the commonwealth has come from direct investment and the purchase of equities, mainly in Canada but to an increasing extent in Australia and other commonwealth countries.

(C. G. F. S.)

VI. COMMUNICATIONS

Communications are essential to the life of any country or group of countries. Where single countries are concerned the main interest centres upon internal communications. But for the widespread countries of the commonwealth, bound together by political associations and by ties of trade and commerce, external communications assume increased importance. After World War II intracommonwealth communications of all kinds developed considerably and all communication services were kept under constant review to meet changing conditions.

1. Shipping.—Sea-borne trade between members of the commonwealth is not the exclusive preserve of commonwealth shipping. Shipping of all flags is free to engage in it, although the large United Kingdom merchant fleet takes a major share. There are many important bulk cargo trades from commonwealth ports to attract British tramp shipping and British tankers figure largely in the bulk carriage of oil. The commonwealth also offers many opportunities for liner services, both passenger and cargo. Here again, although the liners of many flags offer services to commonwealth ports, United Kingdom companies hold a prominent position. Special associations were established with countries of the commonwealth, *e.g.*, the Orient line with Aden, Ceylon and Australia; the British Indian Steam Navigation company with Aden, East Africa, India and Pakistan; the New Zealand Shipping company with New Zealand; the Union Castle line with St. Helena and South and East Africa; the Canadian Pacific line, the Cunard Steamship company and the Donaldson line with Canada; the Peninsular and Oriental Navigation company with Aden, India, Ceylon, Malaya, Hong Kong and Australia; the Royal Mail line with Bermuda and the West Indies. Other companies which operate to commonwealth countries include T. and J. Harrison, Fyffes, Furness Withy and Pacific Steam Navigation to the West

Indies; the Ellerman and Prince lines to the Mediterranean; Elder Dempster to west Africa; the Blue Funnel, Glen and Shire lines to Malaya, Hong Kong and Australia; and the Canadian Australasian line to Fiji and Australia. After World War II some commonwealth countries, such as India, Pakistan and South Africa, developed their own fleets and Ghana and Nigeria later followed suit. In the Caribbean a shipping service operates between islands under arrangements with the governments concerned. The growth of seaborne commerce has necessitated extensive port development in many commonwealth countries since the end of World War II.

2. Air Communication.—After the inauguration of the empire airmail scheme in 1937, British trunk air services were operating only on the main routes through Egypt and East Africa to South Africa, and through Egypt, India and Malaya to Australia. Connecting services were operated from Khartoum to and from Singapore and Hong Kong. Local air services were being developed in many commonwealth countries, but little thought was then given to the problems of the organization of such services as feeders to the main trunk routes or as factors which would contribute to the development of outlying areas. Moreover, there were still many territories with no air services, and areas, such as the Caribbean, still dependent upon foreign air services, which provided no air connection with the mother country.

World War II brought revolutionary changes and immense technical advances in aviation. To meet essential war requirements transatlantic services were developed to both North and South America. When the Mediterranean was closed the main air route to the middle and far east was diverted to pass through west Africa. After the fall of Singapore connection with Australia was maintained through Ceylon and the Cocos Islands. To meet military and other needs airfields and landing facilities for seaplanes were developed in overseas territories, and many of these were later of material assistance in the development of civil air services.

In the years immediately following World War II, the main trunk air routes were largely operated with converted military aircraft or with aircraft developed from military types, while local air services had to rely mainly upon prewar or secondhand aircraft. But these years saw great progress: the main trunk routes were developed to link most countries of the commonwealth to the United Kingdom, either directly or indirectly, by air services operated by one or other of the United Kingdom corporations as well as by other commonwealth airlines; and local and regional services were promoted to act as feeders to the main trunk routes and to assist in the opening up of outlying areas not only in the larger commonwealth countries such as Canada, Australia and South Africa but also in and between many of the independent areas. Foreign air services also developed rapidly and many commonwealth territories came to be served by air lines of several nationalities. By the 1960s most of the world's leading airlines, including several commonwealth airlines, were operating on parts of the old Imperial airways route from the United Kingdom across the middle east to India, Pakistan, Ceylon, Malaya and Australia, which was still the main aerial artery of the commonwealth. Commonwealth airlines also operated on the western route of the Pacific linking the United Kingdom with Australia and New Zealand through Canada. A third major commonwealth air link between the United Kingdom and South Africa was served by British Overseas Airways corporation (B.O.A.C.) and by South African airways on a route through east Africa and the Nile valley.

The development of commonwealth air transport after World War II was marked by increasing co-operation both between governments and between airlines with the object of avoiding wasteful competition and the unnecessary duplication of services and facilities. This co-operation found expression in three different forms: joint ownership and control of airlines; parallel partnership operations; and the division of responsibility between trunk-route, regional and local operators.

Many regional services are operated by airlines based in the overseas territories of the commonwealth and to an increasing degree these operators are entering the field of long-range trunk services. "Coach-class" services were operated on certain commonwealth routes for some time, but after 1960, in addition to first-class and tourist services, economy-class and "skycoach" services at still lower fares were introduced on many other commonwealth routes.

3. Railways and Roads.—Commonwealth countries connected by rail are: India and Pakistan by the Eastern Bengal railway (Pakistani) and the North-Eastern railway (Indian) in the east, and by the North-Western railway (Pakistani) and the Northern railway (Indian) in the west; India and Ceylon by ferry services between Dhanushkodi on the Indian Southern railway and Talaimannar on the Ceylon government railway; Southern Rhodesia and the Bechuanaland protectorate by Rhodesia railways, which connect at Vryburg with the main South African line from Cape Town and pass through the eastern side of the protectorate to serve Southern Rhodesia and Zambia, and Kenya, Uganda and Tanganyika by the lines operated by the East African Railways and Harbours administration. For other commonwealth railway services *see* articles on the individual countries.

Road development has been largely designed to meet the internal needs of the individual countries concerned, but by the middle of the 20th century consideration was being given to the possibility of linking the principal commonwealth countries in Africa by main arterial roads; in particular to the completion of the Great North road to provide a highway from Cairo to the Cape of Good Hope.

4. Telecommunications.—The overseas telecommunications system of the commonwealth consists of extensive networks of submarine cables and radio stations. The technical operation of the networks is closely integrated. Together they provide for the peoples of the commonwealth a full range of telegraph and telephone services, which are operated in accordance with the International Telecommunications convention and regulations, both between the commonwealth countries and with foreign countries in all parts of the world. The cable network, in the North and South Atlantic, Pacific and Indian oceans and in the Mediterranean and Red seas, totals about 150,000 nautical miles and is the largest in the world. Most cables are owned by the United Kingdom post office and maintained by Cable and Wireless, Ltd.; the cable stations and radio stations are owned and operated by the governments of the commonwealth countries in which they are situated, though in most of the dependent territories the cable and radio stations used for external services are owned and operated by Cable and Wireless, Ltd. While the governments have complete executive independence, both as to development and operation, broad policy is co-ordinated through the Commonwealth Telecommunications board on which they are all represented. These arrangements date from 1948 when, under the commonwealth telegraphs agreement of that year between the governments of the United Kingdom, Canada, Australia, New Zealand, South Africa, India and Southern Rhodesia, these governments decided to take over the assets of Cable and Wireless, Ltd., and associated local companies in their respective territories.

The first telephone cable across the North Atlantic was laid in 1956. At the Commonwealth Telecommunications conference held in London in 1958 agreement was reached for the construction of a round-the-world cable; the section between the United Kingdom and Canada was completed in 1961 and the Australia-New Zealand section in 1962, to be followed by the North America-Australia section across the Pacific. The provision of phototelegraphic and telex services increased rapidly after the 1950s.

Internal telecommunications services are mainly the responsibility of the governments of the territories concerned, though in some areas telephone services are operated by private enterprise or statutory board. Short wave, very-high-frequency and microwave services were by the 1960s increasingly used in developing telecommunications in outlying areas.

5. Postal Services.—Each commonwealth country is responsible for the maintenance of the postal services within its territory and the nature of the services provided depends upon the state of development of the country concerned. The services provided in areas such as the far north of Canada, in the Northern Territories of Australia and in the outlying areas of Nigeria, Kenya and Tanzania (Tanganyika) must obviously differ in nature and fre-

quency from those provided in London. External postal services are maintained in accordance with the Universal Postal convention, to which all commonwealth countries are parties.

The empire airmail scheme, which was inaugurated in 1937 and provided for the carriage by air at normal postal rates of all first-class mail on the main commonwealth routes, was discontinued on the outbreak of World War II, when surcharges for airmail letters were again introduced. Surcharges at varying rates were still payable in 1960 on the main commonwealth air routes but in many local areas mails were carried by air without surcharge if this offered earlier delivery than carriage by surface transport. In addition to the normal surcharge rates for letters and postcards, special rates were made available for second-class mail and for air parcels to many commonwealth destinations. The airgraph or microfilm service which was operated during World War II was discontinued after the war, but special lightweight air letter forms might be sent at cheap rates between the U.K. to most countries to which surcharge airmail services were available.

See also references under "Commonwealth of Nations" in the Index. (A. H. SD.)

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Current history and statistics are summarized annually in *Britannica Book of the Year.*

COMMUNE (MEDIEVAL). During the central and later period of the middle ages most of the towns of western Europe (*i.e.*, to the west of the Baltic in the north and the Adriatic in the south) acquired municipal institutions which have been loosely designated as communal. A brief account is given here of these political and social institutions.

No definition embraces satisfactorily every type of commune, but most were characterized by the oath binding the citizens or burghers to mutual protection and assistance. Such an oath between equals, though analogous with other Germanic institutions, contrasts with the oath of vassalage typical of early medieval society, by which the man promised obedience to a superior in return for protection (*see* FEUDALISM). The body became an association, a *communitas* or *universitas,* capable of owning property and entering into agreements, of exercising varying degrees of jurisdiction over its members (who did not normally comprise the entire population of the town) and governmental powers. There were very marked regional differences between different types of commune. In northern and central Italy (and parts of southern France) the absence of powerful centralizing political authority and, to a lesser extent, the precocious economic development of the towns enabled the commune to acquire a degree of self-government that easily surpassed the transaction of municipal affairs. Here the towns conquered the intervening countryside and pursued independent diplomatic policies, and their *de jure* superiors, the Holy Roman emperor or the pope, were rarely able to exercise *de facto* supremacy. The stronger of these city-republics survived—at the expense of their weaker neighbours—into the Renaissance, though by this time most had fallen to a single ruler (*signore*). Milan and Florence continued as powerful states into the early modern period and Venice right up to the Napoleonic era.

Nowhere else did the towns achieve such complete independence, but the communes of Flanders were in advance of all but the Italian in size and industrial and commercial organization, and at times political relations between the count of Flanders, the French king (his overlord) and England gave Ghent in particular an individual role on the European stage. In France, "Germany" (*i.e.*, the imperial territories north of the Alps) and the Iberian kingdoms of Castile and Aragon, the towns were "judicial islands" having their own law and transacting their own business within the field of what would now be styled "local government." Here, as in the English borough (*q.v.*), the king or overlord normally retained supremacy but was willing to part with control in detail in return for financial benefits and military or other services. Obviously there are exceptions to these regional generalizations, for each town differed from all others in its social and economic development, its political history and its traditions.

The general importance in European history of the medieval commune lies perhaps in the social and political education acquired by the citizens through their exercise of self-government. It would be very wide of the mark, however, to imply that the communes were "democracies." The life of all the towns was characterized by a struggle for control, as a result of which the wealthiest and most powerful citizens (often called, by modern writers, patricians) were usually more or less successful in monopolizing power. Within the communes oligarchy was the norm. The direct inheritance of the modern nation-state from the communes was small, despite their role in parliamentary institutions, which was particularly important in the Spanish *Cortes* (*q.v.*). When monarchies were sufficiently powerful, they sought to stamp out municipal patriotism and civic organization.

Certain rural zones were also organized as communes, normally in response to the need for collective agrarian organization (pasturage and other rights or property held in common). There are important differences between such institutions and the urban communes with which this article is exclusively concerned, and which are treated here by geographic area.

ITALY

In describing the communes of Italy one is concerned with the northern and central parts of the peninsula; *i.e.*, with imperial territory and with the papal state. Certain communal institutions had developed in some of the cities of southern Italy and Sicily, *e.g.*, at Naples, Amalfi and Messina, but these were stifled by the Norman rulers of the Sicilian kingdom in the late 11th and 12th centuries. Thenceforward, with the exception of a few brief and isolated episodes, the Normans and their Angevin and Aragonese successors prevented any development of municipal independence in the south comparable with that in the rest of Italy. This contrast is the clearest illustration of the fact that the cities of the centre and north owed their powers primarily to the nominal suzerainty of an emperor who was normally absent or of a pope whose temporal resources were feeble.

The origins of the Italian communes can be ascribed to no single cause, but the essential factors which made for their strength, apart from the lack of central control which marked the medieval period everywhere, were the survival of Mediterranean traditions of living together in urban communities and the big role of the Italian towns in the expansion of commercial and industrial activity which began in the 10th or 11th centuries and continued till the 14th. Though the continuity of civic institutions was broken, some of the Roman cities, aided by their walls and by the presence of a

bishop and ecclesiastical community, had survived as centres of population through the disturbed periods of Ostrogothic and Lombard settlement. Milan, for example, retained its importance as a road centre and the head of an influential bishopric, while Pavia became a Lombard capital and housed merchants, moneyers and other craftsmen connected with the court. Characteristic of the Italian town was the large proportion of the population engaged in agriculture who often traveled long distances daily to work in the fields. This was not merely a matter of tradition: the town, because of its walls, was a more secure place of residence, and it was often situated on high ground that was relatively healthy. Even more strikingly different from the towns north of the Alps was the presence within the walls of a number of nobles holding land in the countryside: a 13th-century Italian writer was to comment on the unconventional habits of the nobles of Bologna who lived outside the city in villas "like the French." The rank of these town-dwelling nobles varied, some being viscounts and captains, while others were mere knights, usually known as valvassors; some, too, lived permanently in the town, some for part of the year only. This minor rural aristocracy had benefited greatly by the breakup after the 9th century of the vast (mainly ecclesiastical) estates, and its members had often insinuated themselves successfully as *de facto* landowners between the lord and the cultivator of the soil.

If trade was not the main concern of the leading class in the early commune, it was nevertheless to give the towns their financial and demographic strength. In the period up to the 11th century, Italian maritime commerce had maintained a link with Byzantium and the eastern Mediterranean; this was the role of Venice and, to a lesser extent, of Bari, Naples, Amalfi and Gaeta. Venice was well suited to serve as an entrepôt joining the Mediterranean with northern Europe, while Milan was the base south of the Alps of the communications extending into France. The 11th century saw a great expansion in trade in the Tyrrhenian sea and, in particular, the rise of Genoa and Pisa. Even before the first crusade (1096–97) these cities had raised naval expeditions to harry the Muslims in Sicily and north Africa. After an initial period of caution, the three great maritime towns gave their assistance to the crusaders and were rewarded by the grant of trading "colonies" (privileged quarters) in the towns of the Syrian littoral. These ports of the crusading kingdom of Jerusalem thus became the main places of transit during the great period of expansion of trade between western Europe and the east, though there was also considerable commerce with Constantinople and often with Muslim towns, such as Alexandria. The crusading movement was thus not so much the cause of increased commercial activity as the means that determined its routes and institutions. By the 12th century there were considerable communities of merchants and financiers in a number of inland cities, such as Cremona and Piacenza in Lombardy, Padua and Verona in Venetia, and Florence, Lucca and Siena in Tuscany. Some towns (Piacenza and Siena) specialized in banking, while most developed industry and crafts producing for a fairly localized market.

The Boni Homines, the Consulate and the Arengo.—The towns in which the merchant class was sufficiently powerful to play an important part in the early history of the commune were, however, exceptional. The dominant class in the 11th and 12th centuries was normally the landowning nobility, whose juridical superiority as experts on local custom and as the normal arbitrators and legal witnesses was recognized by their denomination as *boni homines* ("good men"). The crucial stage in the formation of the commune came with the desire to formalize the transaction of common municipal affairs by the *boni homines*. The need to maintain local defenses (in particular the walls) and to regulate weights and measures and other matters pertaining to markets and fairs, as well as mutual religious activities, must normally all have played a part in shaping municipal co-operation. Such matters could not be left entirely to the bishop, who was often the *de facto* (though more rarely the *de jure*) local representative of the emperor's power. At Milan and certain other towns religious disputes with the bishop did much to crystallize the nascent commune, and as the community gained in strength and confidence, it tended to take over some of the functions hitherto exercised by the bishop. Thus neighbouring towns which became subordinate often submitted in the earliest communal period to the recognized authority of the bishop, later to the bishop and commune and, finally, to representatives of the commune alone.

References to the "formation" of a commune are rare in contemporary sources: the process was a gradual one and tended to go unnoticed. The leading inhabitants of a town normally collaborated and acquired certain virtually governmental rights some time before they possessed communal institutions and officers. At Milan the valvassors revolted against the archbishop in 1035–36, but there is no surviving reference to consuls before 1097. Florence had its own weights and measures in 1079, embarked on the conquest of the surrounding countryside in 1107 but is not known to have had consuls before 1138. The appointment of a definite executive, the consulate, was thus a further stage in the formalization of an increasingly busy institution. The title consul shows the Italian lawyers' awareness of the Roman past. Most of the larger towns were coming to possess the consulate by the end of the 12th century; *e.g.*, Pisa *c.* 1084, Asti in 1093, Arezzo in 1098, Bologna in 1123, Siena in 1125 (these earliest references, however, are compatible with the existence of the institution some time before). The number of consuls varied in the different towns and from time to time. Milan had 18 (most of whom were nobles) in 1117, at least 23 in 1130, 4 in 1138, 8 in 1140, 6 in 1141. By the second half of the 12th century consuls with judicial functions (*consules causarum* or *pro placitis*) were often differentiated from those with executive duties.

In this stage of its formation the most characteristic institution of the commune was perhaps the parliament of all the citizens, the *arengo,* rather than the consulate. It was only slowly that the right of representatives (or even of a majority) to bind the commune by their decisions was recognized and that the transaction of business by a large gathering was abandoned as impracticable. The status of the *arengo* was in part the result of the private and even temporary nature of the commune in its earliest manifestations. The Genoese commune or *compagna* was in 1157 still formed for four years only, and its terms assumed that some merchants might refuse to enter this association, although a whole century earlier an emperor had confirmed the "good customs" of Genoa's inhabitants. But during the 12th century the communes were given shape by their external relations. Some received privileges from the emperor, *e.g.*, Pisa and Genoa in 1162, which recognized their right to elect their consuls; others formed the Lombard league (*q.v.;* 1167) against the same emperor, Frederick I Barbarossa. Long before this the towns had embarked on the conquest of the surrounding countryside in the attempt to secure their food supplies and to extend the area rendering them fiscal and military aid. The ecclesiastical diocese was recognized as the natural boundary to which the city could lay claim, but inevitably there were soon territorial and other disputes (Milan was at war with Pavia and other Lombard towns by the mid-12th century), and neighbours tended to become enemies. This was the great age of the citizen militia, in which nobles fought on horseback and non-nobles on foot, and the ceremonial *carroccio* (*q.v.*) was drawn into battle as the emblem of municipal patriotism. The main task of the commune was then to secure the submission of neighbouring feudatories and rural communes, and the overlordship thus gained set the town a new task in government.

The Podestà.—The last decades of the 12th century saw the breakup of the consulate in many communes. After the commune had asserted its right to exist, temporarily dormant differences of interest within the governing class tended to emerge, and this was a time of bitter disputes. Moreover, there were difficulties about the diplomatic representation of towns by a consulate which was often divided and whose juridical position was not yet fully accepted by the emperor. Already at the peace of Venice between pope and emperor (1177) a number of communes were represented by a single *rector* or *potestas* (*podestà*). The advantages of granting the supreme executive position to a single individual whose position transcended the quarrels of the local consular class were soon recognized, and the institution spread rapidly. It is found at Pisa *c.* 1169, at Perugia in 1177, at Milan in 1186, at Piacenza in

1188, at Florence in 1193, at Siena in 1199; by the early 13th century it was almost universal. At first it alternated with the consulate, but the consuls are rarely found after *c.* 1210. Soon it became normal to select the *podestà* from another town (not usually a neighbouring one) to ensure his neutrality in local disputes. He came with his own household, took an oath on arrival to serve the commune loyally and held his position for a fixed period, which was usually six months or a year. The *podestà* was a noble, and he needed a legal training. His office became a recognized profession, in which able men specialized, traveling on from one post to the next.

Naturally the commune did not convey full powers in all matters to this alien "city manager." The councils, though summoned by the *podestà* and presided over by him, retained control of internal and external affairs. The conciliar structure varied greatly from town to town and was the subject of constant experiment (as were methods of election). Most commonly there was a great council (the *de facto* heir of the parliament) and a small, inner "secret" council (*di credenza*). The great council might have as many as 800 members (as at Milan), while the smaller council occasionally numbered 100 (as at Parma) or even more, though its size was frequently limited to 24 or even 16. In addition to the regular council, a large part in communal government was played by *ad hoc* commissions (*balie*), which were often granted special powers in military, financial or constitutional matters.

The Popolo and the Capitano.—During the age of the *podestà* (roughly the first half of the 13th century), power normally remained with a governing class roughly similar in composition to that body of minor nobles—and, occasionally, merchants—which had formed the 12th-century commune. It was natural, however, that trade and finance (and, to a lesser extent, the fortunes of agriculture) should bring to the fore some men whose ancestors had not ranked among the *boni homines* and consuls. This was particularly the case in a period in which good luck and skill in overseas trade and in banking might make a man a great deal of money in a short period. Furthermore some noble families tended to recede in financial and social importance. In such a situation there was no possibility that a closed oligarchy could retain power for itself by "freezing" the constitution. New men were always coming to the fore and requiring for reasons of finance and prestige to receive a share in the government of the commune. The governing class was rarely officially sealed against new entrants, but if it failed to absorb newcomers with sufficient rapidity, it found its position threatened. The institution through which the men excluded from power expressed their ambitions was the *popolo*. The *popolo* was a sort of "pressure group" organized as a *societas* and possessing its own military structure. Essentially the organized body of nonnobles, it was frequently closely connected with the guilds (*arti*) and was divided into local regional groups, as well as craft bodies. The earliest popular societies emerged in the Lombard and Piedmontese towns in the late 12th century and early 13th, but they did not commonly capture a considerable share of political power in the commune until around the middle of the 13th century. They then often gained a position whereby, either formally or informally, they took a large part in government: as early as 1229 the general council at Modena had to include representatives of the guilds and popular associations, and four years later half the offices at Piacenza were allotted to the *popolo*. Elsewhere the *popolo*'s institutions often existed side by side with those of the commune and exercised power in rivalry with them.

At the head of the *popolo* a conciliar body, whose members (analogous to the consuls) were usually styled *anziani*, was often superseded by a single official, comparable with the *podestà* (he was normally from another city), namely the *capitano* or captain. The *capitano del popolo* is found at Milan in 1240, at Parma in 1244, at Florence in 1250 and very soon after this in many other towns. Later the *capitano* might in turn lose his predominance to a body of *anziani;* after 1282 the Florentine *capitano* was overshadowed by the six priors representing the seven major craft guilds.

The main *raison-d'être* of the *popolo* was the neutralization of the social power of the "magnates." This process was pursued largely by legislation denying magnates official position and preventing them from overawing the weaker elements in the population: the declared aim of the Bolognese statutes of 1282 was "that rapacious wolves and meek lambs should be able to walk with equal steps." There was, however, no wholesale dispossession of the original governing class, nor did "popular" gains secure advantage for the workers, the *popolo minuto*. The *popolo* sought to compensate by unity for lack of social prestige and military strength, but it was only one of a number of organized associations struggling to assert themselves within the all-embracing commune. Among these were the family-groups (*consorzerie*) of nobles and —linked with them—the Guelph and Ghibelline parties, societies of magnate families whose feuds had become assimilated into a greater system through their polarization by the two magnets of medieval Italy, the empire and the papacy.

The Rise of the Signori.—The history of all the Italian communes was turbulent, both internally and externally. Warfare was constant, and mercenary cavalrymen, many of them nobles exiled from their home towns by the hostile faction, had superseded the militia. Constitutional arrangements were unstable. Dante likens Florence to a restless man, shifting constantly because he cannot get to sleep. The willingness of the *popolo* to accept a single leader has already been mentioned, and in any crisis, military, financial or political, men were liable to entrust their cause to one able and ambitious individual. Constitutional precautions against prolonging the period of office of a *capitano* or *podestà* could be set aside. Nor were men lacking who sought to subvert republican institutions. Feudal lords and dependents of the Hohenstaufen or Angevin rulers, demagogues, successful mercenary generals, were all prepared to accept office as a town's lord (*signore*) with special powers which were at first temporary but might be prolonged to life tenure and ultimately inherited by a son or other relative. In times of bitter factional dispute republican political processes, slow and lacking both secrecy and continuity, had obvious disadvantages. Hence Guelphs, Ghibellines and popular parties tended to turn to a single saviour. The earliest significant *signorie* appear in Venetia and Lombardy in the middle years of the 13th century: by 1237 Frederick II's ally Ezzelino da Romano was holding both Verona and Padua, and by 1255 Oberto Pelavicino was *signore* of Cremona, Piacenza and Pavia. From 1258 mastery at Milan alternated between two rival families, the Della Torre and the Visconti. The earliest Tuscan *signorie* are those of the *condottieri* Uguccione della Faggiuola at Pisa and Lucca (1313–16) and Castruccio Castracani, also at Lucca (1320–28). By that period the *signorie* had become the rule rather than the exception, and lords were accepting imperial or papal titles or vicariates to legitimize their position. Where republicanism survived it did so through the control of a tightly knit oligarchy. Florence, after a series of oligarchies had dominated the commune, submitted from 1434 to the Medici, though their position as formal *signori* was confirmed only much later. Venice, where membership of the great council was "closed" from 1297, was the only Italian city-state that continued to be a republic into the modern period.

SOUTHERN FRANCE

In Provence and Languedoc the Roman towns and the custom of nobles living within them survived, and in consequence communes arose in circumstances in some ways analogous to those prevailing in Italy. The institution of the consulate is found in many of these towns, and some, such as Toulouse, Avignon and Beaucaire, secured the subordination of certain neighbouring feudatories who became their "vassals." In the course of the 13th century, however, the counts of Provence and the French kings reduced these communes to a dependent position: they had never achieved the full political autonomy of their Italian counterparts. The development of the commune of Toulouse illustrates well how the towns depended on the external situation for the acquisition of self-rule. At Toulouse the counts were willing to part with much of their control over justice, economic life and internal policing in return for the commune's alliance, particularly during the period of the count's resistance to the French crown (1226–29). After this

time, and particularly under Alphonse of Poitiers (1249–71), Toulouse lost its former status and liberties.

FLANDERS

The greatest towns of the Low Countries, Ghent, Bruges, Ypres and Arras, rivaled the biggest north Italian cities in size during the later middle ages. In the same area as these major places were a number of other towns—such as Douai, St. Omer and Brussels—of considerable economic importance. Farther to the southeast lay Liège, Huy, Namur and Dinant. The Flemish towns were situated in a zone specially suited to become a centre of commerce, for they were at the meeting point of four major routes. London and other English ports lay close at hand. To the east there was easy access to the Rhineland and the other German towns and, by sea, to the Baltic. Sea routes to the west connected Flanders with the Atlantic coasts of France and Spain and, in the later medieval period, the Mediterranean. The main connection by land was to the south, with Champagne, Burgundy and eastern France and, by Alpine passes, with Italy. This was the principal link with the Mediterranean until galleys opened up the sea route at the end of the 13th century; in the earlier period Champagne (*q.v.*), with its fairs, was a great centre of exchange. Trade was the first *raison-d'être* of these towns and brought them to life again in the 10th century after a long period during which they had been almost effaced by Viking inroads, but in the 12th–14th centuries most of the towns—Bruges was an exception—owed their greatness less to commerce than to textile manufactures; again the proximity of England was an all-important factor, for English wool was that most used for the looms of Flanders. The population of the industrial towns rose rapidly, and local production became inadequate for their food supply; they were dependent on the grain of eastern Germany and northeastern France. By the middle of the 14th century Ghent probably had more than 50,000 inhabitants, and Bruges was of comparable size. The dominance of a single industry was, however, a danger. At Ypres in 1431 more than half the workers were engaged in cloth manufacture, and already the town had been severely hit by the rise of the English industry.

Their political situation facilitated the acquisition by these towns of semiautonomous institutions. Most of them lay within the zone of the counts of Flanders, who held the territories west of the river Scheldt as fiefs of the French king and those to the east as fiefs of the emperor. The counts, however, lost many of their French-speaking subjects to the French kingdom: Artois as a dowry in the late 12th century; Lille and Douai in 1312. The great advantage of the towns was the comparative weakness of the counts, who were willing to grant privileges in return for financial and military support. This was particularly the case in times of disputed succession or division within the comital family: for example, after the murder of Count Charles the Good in 1127, when the towns helped Thierry (Dietrich) of Alsace to succeed; and again after the cession of Hainaut to John of Avesnes (1256).

Ghent, which grew up at the confluence of the Scheldt and Lys, provides an example of the emergence of a trading community and of the institutions that such a community required and evolved. There had been an abbey and probably a trading settlement at this site in the early Carolingian period. It was raided and occupied by Vikings but revived after Count Baldwin II the Bold built a castle there *c.* 900. A new *portus* of traders grew up around this castle and another round the abbey of St. Bavon, one kilometre away, where an annual fair was held early in the 11th century. By the end of that century the two *portus* were linked; Ghent had four parish churches, and its cloth industry was starting to develop. Such a body of traders and craftsmen could not be content to remain under the normal feudal jurisdiction of the count. They needed exemption from feudal services, the right to mortgage their property and the power to make their own arrangements concerning market regulations and local taxation; above all they had to have jurisdiction in a special court applying a particular type of law to itinerant merchants who needed quick justice. The burghers were organized in a guild merchant and in craft guilds and themselves evolved institutions for mutual assistance; the man who was untrue to his oath binding him to the other burghers was driven into exile.

The Échevins.—The process whereby the counts granted a degree of self-government to these communities was a simple one. The Carolingian institution of a local class of law-worthy men known as *échevins* (*scabini*) acted as the bridge. In the first place a town had its own *échevins* (usually numbering 12 or 13) who judged according to the town's law while remaining magistrates of the count. Insensibly their position altered, and they tended to become the judicial and, ultimately, also the executive representatives of the town itself. An important stage in this development was reached when the commune claimed the right to appoint the *échevins*. Nominally the count continued to appoint, but the burghers themselves made the choice *de facto* in many towns. The institution of the *échevinage* was transformed in another way by the towns: beginning as a status conferred for life, it became an annual office when it fell to the control of the burghers. The date of this change, which approximately marks that of the commune's ascendancy, is 1194 at Arras, 1209 at Ypres, 1212 at Ghent, 1228 at Douai, 1235 at Lille and 1241 at Bruges.

The *échevinage* could become the council of the commune only when the count permitted it to usurp what had been the authority of his castellan or bailiff. Where the lord resisted communal claims—as the bishop of Liège did in his own city and at Huy, Dinant and Maastricht—the burghers instituted a rival office to the *échevins*, namely the *jurés* (*jurati*). In such circumstances the *échevins* maintained control over justice, though the bishop's authority might be checked by the competence of the *jurés* in some municipal matters. This was the situation also at Cambrai, where a 50-year struggle ended in favour of the bishop after 1227.

The Flemish towns did not win great territorial "counties" like the Italian republics, but they did assert their authority in the immediately neighbouring "flat land." In 1314 Ghent forbade the production of cloth within five leagues of the town, and similar regulations were enforced elsewhere. Bruges would not permit money-changers to do business at Sluis, its own seaport. The policy of the communes, as in Italy, was normally dictated by the class of prominent citizens known to contemporary writers as *majores, ditiores* (the wealthier), *boni homines* and so on. In many places craftsmen were formally debarred from the *échevinage*, and normally a system was evolved combining the rotation of offices with a patrician monopoly. Even this was vulnerable and might be the victim of a clique within the patriciate itself: at Ghent, from 1228, 39 *échevins* were installed in power for life, the 13 *échevins* of each year being accompanied in office by those of the two preceding years.

In the period of Flemish decline the patricians were seriously challenged by the craft guilds, till both parties had to yield before the Burgundian dukes and their successors. Even in the 13th century there were occasional strikes and (in 1274) an attempted rising against the *échevins* of Ghent by the weavers and fullers. At the beginning of the 14th century the artisans found the count an ally against the coalition of Philip IV of France, and the Flemish patricians. The battle of Courtrai (1302) saved the former party, and throughout the 14th century the crafts held on to their tenuous advantage. The constitutions of most towns were now altered in such a way as to give representation to the craft guilds, the minor trades combining in "members." After 1369 Ghent had a fixed organization of three "members," of which one consisted of *poorters* (merchants, etc.), one of weavers and fullers and one of the small craftsmen; the *poorters* chose three *échevins;* the other two members, five each. Flanders' relative economic decline in this period played its part in this weakening of the oligarchy. Under Jacob van Artevelde the weavers of Ghent for a time (1338–45) used the economic and diplomatic link with England to dominate all Flanders. These courageous men suffered defeat after defeat, but by the 15th century the towns themselves, never skilful at looking beyond their own immediate interests, began to yield before the encroachments of the centralizing state. Other areas were now coming to the fore economically, in particular Holland and northern Germany, but the towns could still furnish much wealth to the Burgundian dukes. Bruges fought alone

against Philip the Good in 1436–37, and Ghent did so in 1452–53. The last flicker of the old municipal spirit in Flanders was the unsuccessful revolt of Ghent against Charles V in 1539–40.

NORTHERN FRANCE

In the French kingdom, excluding the areas of Flanders, Provence and Languedoc (mentioned above), characteristic communal institutions developed, although the towns achieved only a limited degree of self-government. A commune or *conjuratio* was formed in many French towns in the 12th century and in some as early as the 11th. The circumstances leading to this development were often, but certainly not always, revolutionary. The revolt was often against an episcopal lord (as at Laon in 1112), though in some cases a lay lord was involved: in 1070 the men of Le Mans rose against the duke of Normandy, taking advantage of his absence in England, "and they made a conspiracy which they called a *communio*" (says the chronicler) "binding themselves to each other by oath." This sworn association, which was the essence of the commune, did not necessarily arise in a time of violence or crisis. Its purpose was to ensure internal security, justice and order, to bring about conditions under which the markets and crafts could develop and flourish. Thus the inhabitants of the town swore to give each other aid at times of need and threatened the destruction of their home, or even expulsion, to those who were false to the oath. The oath was compulsory for all members of the commune. Those who had taken it, the burgesses, were the *jurés*, like the men of Beauvais "dwelling within the wall of the city and in the suburbs" who, as their charter says, "had sworn a commune." These communities were often small and their members primarily agriculturalists and craftsmen.

With the grant of royal charters and privileges the French communes emerged from obscurity, but the association was already formed (except in the case of new foundations) and might already possess its own "good customs" (those of Tournai were confirmed by Philip II Augustus' charter of 1188). From the point of view of the recipient, these charters were mainly promises of protection against unjust treatment by royal officials and in particular of alleviation of arbitrary demands for services and money. If the grantor was a lay feudatory or prelate, the charter might represent a compromise with the commune concerning jurisdictional powers to be exercised by the two parties. But the lord was often the king himself, and to an increasing extent it was the crown that shaped the development and limitations of communal institutions in France. To the king the commune was a promising source of military and financial strength and a potential ally whose anti-baronial interests overlapped with his own so long as it received privileges which made of it a satisfied but not overmighty subject. From the king's point of view the commune was "a collective feudatory," whose representatives took an oath to him, the terms of which resembled closely feudal oaths of homage. By the reign of Philip Augustus (1180–1223) at least 39 towns owed military service to the French crown, most of them providing some mounted troops or money in lieu. Poitiers owed the king service "beyond the Loire in the same places as the royal feudatories of Poitou." At the fateful battle of Bouvines (1214) Philip had the assistance of the militia of Beauvais, Corbie, Amiens, Compiègne and Arras. Many towns also rendered feudal "aids"; Abbeville, for example, had the obligation of paying 100 *livres* when the king required to be ransomed and when his son was knighted or his daughter married. The strategic use of the towns was a fundamental aspect of the policy of the counts of Anjou, and in this, as in other ways, the French were willing to learn from the Angevins. Philip's charters went mainly to towns situated near the frontiers of his domain. The communes could aid him against hostile feudatories, as did Dijon against the duke of Burgundy. The towns whose functions were most specifically military were the bastides (*q.v.*) created by the king and other lords. Where the purpose of the foundation was mainly economic it was more often known as a *ville-neuve*.

The officers of the French communes were known as *jurés pairs* or *échevins*, and the towns normally had one or more councils. They differed from their Flemish counterparts in that they had a single leading official, usually known as the mayor (*maire*). The mayor, however, was not always chosen by the commune. At Rouen he was selected by the duke of Normandy from a list of three drawn up by the council of 100, and similar methods prevailed in many other towns. As elsewhere the positions of importance were inevitably monopolized at first by a patriciate. "The rich men possess rule in the towns," says the sire de Beaumanoir, the 13th-century legal writer, but he goes on to describe "many disputes. . .the poor against the rich and the rich against each other." As in Flanders, the craft guilds usually succeeded by the later medieval period in breaking into the merchants' monopoly and in securing representation in the commune's offices. The role of the monarchy in recognizing and fostering the communes also gave it the opportunity of intervening in the towns and ultimately of depriving them of most of their independence. In the second half of the 15th century, after the end of the Hundred Years' War, the French kings, by favouring compliant oligarchies, achieved the same centralization at the expense of the communes that their Burgundian neighbours had carried out a little earlier in Flanders. After Louis XI's reign (1461–83) the very concept of a "commune" withered away, though the *villes à échevinage* lingered on.

GERMANY

In certain features the development of urban institutions in Germany resembles closely that of Flanders and northern France. The most distinctive aspects of the medieval German commune are the important role of royal and princely founders and the consequences, in the later period, of the weakness of the monarchy, the towns then joining in leagues that sought to enforce law and order and to weaken the competing power, the territorial princes.

In many western German towns near the Rhine, such as Cologne, Mainz and Worms, occupation was continuous from the Roman period, though there was a break in local institutions. The nucleus of the later commune was normally the settlement of traders (*Wik*), growing in size and importance during the Ottonian and Salian periods (936–1125) as commercial contacts with the Baltic and Slav areas increased, as German settlement in the east extended and as the merchant's way of life became less peripatetic. These trading communities, in which some quasi-political functions were normally exercised by the guild merchant, fostered their internal peace by an oath binding the burghers to mutual protection and brotherhood, forbidding private vengeance and threatening exclusion for those breaking the oath. Sometimes the earliest reference to a *conjuratio* suggests an association formed for specific action, particularly against an episcopal lord (as at Worms in 1073, at Mainz in 1077, at Speyer in 1101–11 and at Cologne in 1106 and 1112). Even when there was no such purpose the commune inevitably tended to accrete powers extending to economic regulations, taxation for the upkeep of defenses and the right to demand military service from the burghers. The merchants also required their own law giving their market special protection and granting them freedom to alienate land, etc. Through their possession of a separate law and their police powers the towns acquired much jurisdiction and often put forth a formidable mass of legislation.

The great expansion to the east was accompanied by the foundation of communes, though this movement was by no means confined to newly settled territories. About 50 communes are known to have achieved recognition before the end of the 12th century, and the number had increased by about 500 by the end of the 13th. The greatest founders were the higher nobles. Typical foundations were that of Freiburg im Breisgau by Duke Berthold III of Zähringen (1120) and of Lübeck by Duke Henry the Lion of Saxony (*c.* 1158). In each case the site was already settled, and the founder chose to grant privileges to an existing community in return for financial and military advantages. Freiburg, intended to act as a market centre for the trading routes passing through the Black forest, recruited merchants from all southwestern Germany; the duke accepted, or may actually have organized, its *conjuratio*. Lübeck, destined to an even greater future, was already a Baltic trading station before Henry the Lion privileged it, setting up its merchants with burgage building plots. Most of the "new" towns were intended as markets for local crafts rather than as

centres on main trading routes, and landowners and *ministeriales* often remained an important element in the population.

In the *Rat* (council) the commune's officials bore the titles—which seem virtually synonymous—of *échevins, jurés* or consuls. The last of these, an importation from Italy, is found at Lübeck in 1201, Erfurt in 1212 and Freiburg in 1218; soon after this it had become general in the Rhineland, Saxony and Swabia. These officers were normally appointed for a year and frequently numbered 12 (occasionally 24). There was also commonly one head official, the *Bürgermeister*. Town charters normally confirmed the constitutional status of the *Rat* and sanctioned the principle (which defended the town's population against erstwhile lords) that residence in the town for a year and a day conferred freedom. In Germany, as elsewhere, a patriciate tended to gain control of the towns in the earlier period, but during the 14th century this monopoly was diluted, the crafts normally securing representation in the *Rat; e.g.*, there was an equal share between patrician and guild representatives at Freiburg, Strasbourg, Zürich, Vienna and Mainz.

Royal policy in Germany missed an opportunity in failing to foster the communes. Frederick II went so far as to legislate (ineffectively) in 1232 against all urban (and interurban) "leagues and communities." With the breakdown of central power after Frederick's death (1250), the towns attempted to supply the need for an institution that would preserve the peace and protect their interests against the nobles. The Rhenish confederation of 1254–57 finally numbered more than 100 members. The Hanse towns, the cities trading in the Baltic under the leadership of Lübeck, were co-operating long before the official formation of their political league in the 1350s (*see* HANSEATIC LEAGUE). A league of Swabian towns formed in 1376 united with a new Rhenish league in 1381, but despite the rise to commercial and industrial greatness of some south German towns, such as Augsburg and Nürnberg, the princes were generally successful (save in the Swiss confederation) against the towns, which were divided and gained no imperial assistance.

ARAGON AND CASTILE

During the reconquest many Spanish towns were founded by the Castilian and Aragonese kings and by lay and ecclesiastical lords in territory previously under Muslim rule. The purpose of this movement, which was at its height in the 12th century, was to provide military, administrative and economic centres for newly colonized areas. The privileges (*fueros*) granted to these towns made of them "judicial islands" with their own law and market regulations. The status of these communes favourably affected that of the older Christian towns, but most of the Iberian towns gained no great degree of independence; there, as elsewhere, the organization of the town as a community in some ways made it easier for the lord to enforce his will. Altogether exceptional was the position of the great port of Barcelona within the countship of Barcelona under the Aragonese kingdom. The formation of *hermandades* (fraternities) between towns is a phenomenon closely comparable to the leagues of German towns. The major Castilian *hermandades* appeared at times of royal weakness: for example, in 1282 (first *hermandad general*); in 1295 (many *hermandades* formed, that of León and Galicia having 33 members); in 1296 (the "sea-alliance" of Cantabrian coastal towns); in 1313; and in 1315. The normally close link of the towns with the monarchy in Spain is illustrated by their role in the parliaments of Aragon and Castile. Town representatives were summoned to the *Cortes* of León in 1188 and to that of Catalonia in 1214. They were called at least ten times to the Castilian assembly during the reign of Alfonso X (1252–84) and often by his successors. As early as 1283 the towns of Catalonia secured a promise from their ruler that they would be consulted annually.

See also references under "Commune (Medieval)" in the Index volume.

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COMMUNE (OF PARIS, 1871), the name given to the insurrection in Paris which lasted from March 18 to May 28, 1871. It is difficult to determine the relative importance of the various causes of the Commune. The revolutionary tradition of a section of the Parisian population, which had been revived toward the end of the second empire by the struggle of the republicans against the government of Napoleon III, was exacerbated by an exceptional concourse of circumstances. In Feb. 1871 the people of Paris were exhausted and enervated by the physical and mental suffering of a long siege (*see* FRANCO-GERMAN WAR). Cut off from contact with the provinces for four months, they did not react to events in the same way. The election of a national assembly with royalist tendencies, composed of deputies from the rural areas, aroused their fears that the monarchy might be restored. The occupation by the Germans of a part of Paris inflamed their patriotic sentiment. Moreover, the assembly committed the error of canceling the moratorium on rents and bills and terminating the payment of national guardsmen. The feelings of Parisians were further wounded by the assembly's decision to sit at Versailles.

In order to maintain order Adolphe Thiers, who was head of the executive of the republic, decided to disarm the national guard, which had constituted itself into a "republican federation" with its own central committee; hence the name *fédérés* given to the soldiers of the Commune. On March 18 Gen. Joseph Vinoy attempted unsuccessfully to remove the cannons of the national guard parked at Montmartre and at Belleville. Some of Vinoy's troops went over to the insurgents, who shot two generals (Claude Martin Lecomte and Clément Thomas) who fell into their hands.

At the insistance of Thiers the government withdrew to Versailles. Confused negotiations then took place between the central committee and the *maires* of Paris on the one hand, and the *maires* of Paris and the government on the other. However, the heated atmosphere in which they were held rendered the negotiations abortive. Municipal elections arranged by the central committee took place on March 26. Those elected, dominated by extremists, formed themselves into a "Commune of Paris" from which the moderate elements withdrew. When the news of the insurrection became known "communalist" movements on a minor scale broke out at Lyons, St. Étienne, Toulouse, Narbonne, Marseilles, Limoges and Le Creusot, but were immediately suppressed.

After the withdrawal of the moderates the Commune comprised: 17 members of the international (notably Gustave Lefrançais, Eugène Varlin and Léo Franckel), mainly men of the artisan class who wanted social reform by legal means; 8 supporters of Auguste Blanqui (*q.v.*), who favoured a social revolution through insurrection and dictatorship; 8 members of the central committee (including Varlin and two Blanquists), chiefly concerned with military action against the government at Versailles; and about 30 men belonging on the whole to the revolutionary tradition of 1793 (such as Louis Charles Delescluze, Félix Pyat [*qq.v.*], Jules Miot and Charles Ferdinand Gambon), who were for the most part men of the middle class—journalists, students or clerks. Apart from half-a-dozen *déclassés* (such as Jules Vallès, Raoul Rigault and Charles Théophile Ferré [*q.v.*]) and two who were mentally unbalanced, they were honest men, fanatical, full of illusions and without experience.

Within the Commune, in which men of middle-class origin were more numerous than those from the working classes, there were two distinct trends. The larger group, chiefly middle class, was centralist in outlook and favoured a Parisian dictatorship which would impose its rule on the whole of France. The other, predominantly working class and inspired by the international, wanted to set up a federation of equal communes throughout the country. At no time did the Commune succeed in forming a coherent leadership (Blanqui, who might have headed the movement, was in prison in the south). It was divided into commissions (executive, military, general security, finances, justice, labour, industry and trade, public services, education and external relations), the chief of these being the executive, which was dominated by Blanquists. The Commune did not find the time to deal with social reforms. The central committee of the federation of the national guard wanted to keep control of military matters in its own hands, and this involved it in a dispute with the leaders appointed by the Commune. There were in all 30,000 effective combatants, but they were never properly organized.

Thiers raised an army of 130,000 under the command of the marshal de MacMahon. The latter moved slowly and his troops took the offensive on April 2. On the following day at Rueil, Bellevue and Villacoublaye the *fédérés* attempted a sortie, but this showed that they were incapable of mounting an offensive. MacMahon's troops captured the fort of Issy on April 30, the fort of Vanves on May 14 and entered Paris through an undefended section of the town on May 21. It took the army seven days—*"la semaine sanglante"*—to reconquer Paris. The *fédérés* put up a courageous defense, establishing barricades and setting fire to public buildings before withdrawing. The last battles took place on May 28 in the Père Lachaise cemetery (where an annual ceremony of remembrance is still held).

During the final week's fighting the Communards executed about 60 hostages, including the archbishop of Paris, Georges Darboy. The regular troops shot a large number of insurgents captured in arms. The total number of deaths caused by the insurrection is unknown. Estimates vary from 17,000 to 36,000 but 20,000 seems a likely figure. After the suppression of the Commune there were 38,000 arrests. The courts-martial which were set up sentenced 270 people to death (there were, however, only 26 executions), 410 to forced labour, 3,989 to transportation to a restricted area, 3,507 to simple transportation, 1,259 to special detention, 3,398 to terms of imprisonment, 322 to banishment, 117 to surveillance by the police and 9 to fines; 56 children were sent to reformatory institutions. Those sentenced to be transported were sent to New Caledonia. The repression affected the *faubourgs* or outlying quarters of Paris in particular, that is to say the districts inhabited by petty craftsmen: more than 50% of the painters, tilers, leadworkers, zincworkers and shoemakers, and 30% of the cabinetmakers disappeared. Karl Marx, however, saw the Commune as an episode in the struggle of the organized proletariat.

There were two amnesties, the first on Jan. 17, 1879, and the second on July 19, 1880.

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COMMUNICATION has several different and equally acceptable meanings, but no better English word has been found to denote a process both interactive and purposeful. "Communication" derives from the Latin *communicare,* "to make common, to share, to impart, to transmit." In this article the interpretation of making common or sharing of something between two or among several persons or groups of people is preferred. This definition stresses the interaction that distinguishes communications from other messages, and stresses the effects of a message. Only by the appreciable effects of, or reactions to, a message can a communication be distinguished from a message that is both understood and rejected.

The relations between the purposive and interactive functions of communications have been clarified by analogies with automations, such as servomechanisms. (*See* INSTRUMENTS, ELECTRICAL MEASURING: *Recording Instruments;* INFORMATION THEORY.) The purpose of the thermostat, for example, is to keep a room at some wanted temperature, a function it performs by reacting to lower temperatures so as to trigger the heating system, and to higher ones by closing the heating and starting the cooling system. This process also appears in the instinctive adaptations to environmental changes as made by such biological organisms as the termites (*see* SOCIAL INSECTS: *General Remarks on Insect Societies*), and in the international relations of a democratic state whose government receives wide popular support and is served by an efficient intelligence organization. Communication applies to each of these examples, from the thermostat to the national government, insofar as the reactions to its messages or questions enable the system or organization to maintain the direction of its efforts toward the efficient accomplishment of its purposes.

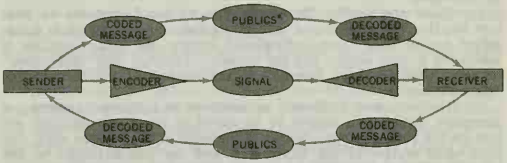
Sources of Evidence.—As a life process, communication extends beyond the frontiers of present knowledge and so beyond the range of present social controls. Hence this article attempts merely to outline the process with reference to the frontiers and to suggest some effects of public communication upon contemporary institutions and affairs. The communication process has been most profitably studied in such particular biological organisms as bees and termites. The processes of public communication, as affected by developments of the mass media within the 20th century, have been more clearly explained in such particular situations as a general election than they have been explained by reliable theoretical principles.

A theory of public communication sufficiently valid to support reliable predictions concerning even the short-run effects of public communications on public issues, *e.g.,* information campaigns, is still far to seek.

Evidence contributing to a general theory has been supplied by a wide range of arts and sciences, ranging from the arts of rhetoric and literary criticism through the biological and social sciences to mathematics. The need to synthesize and integrate the evidence supplied by each of the many contributing sources is stressed by most workers in the field. One of the more successful attempts to meet this need was made by Kenneth P. Adler in *The Communication Process* (1959), the bibliography of which includes works in philosophy; the rhetorical, dramatic and literary arts, in part applied by linguistics and semantics; learning theory; Gestalt psychology; psychoanalytic psychology; sociology; political science; psychophysics and mathematics; theoretical models; and communication effects.

The Public-Communication Process.—A bird's-eye conspectus of the process emerging from this wide range of evidence is afforded by Wilbur Schramm's chapter: "How Communication Works" in *The Process and Effects of Mass Communication* (1954). The substance may be partially represented by the diagram.

The initial component of the process is an idea or impulse in the mind of the sender; the idea may or may not be sufficiently clear to be communicable to the receiver. The second component is the formal expression (encoding) of the idea, which constitutes the message, or signal. The third component is the receiver's interpretation (decoding) of the message as received from the sender directly, and also as received indirectly via the various publics concerned with the issue; for example, in a national steel strike, messages between the union and management have such publics as congress, chambers of commerce, manufacturers needing



SCHEMATIC DIAGRAM OF COMMUNICATION PROCESS. (*PUBLICS ARE GROUPS ASIDE FROM THE SENDER AND THE RECEIVER WHO RECEIVE MESSAGES INDIRECTLY. *See* TEXT)

steel, other unions, and, of course, the public at large. The fourth component consists of the receiver's response to the message, reactions which may or may not come to the attention of the sender of the original message. If they do, they constitute a fifth component, the "feedback"; and the sender's interpretation or decoding of this response to his message would complete one round of the communication cycle. This one round is sometimes decisive, as when one world power states an issue of global importance and receives a clear answer from another world power. Normally this first round is merely preliminary to many other rounds, each adding something to what both the sender and the receiver previously knew about the other's position and hence about the possibilities of some mutually satisfactory compromise. Such interactions may, of course, serve both to sharpen hostilities and to compromise them.

Evidence supplied by the various branches of knowledge mentioned above concerns each component of the process as oversimplified by Schramm's conspectus. For example, the second component—expressing an idea persuasively to a given audience—has occupied many of the best minds of all ages and all cultures. The bare bones of the evidence include: (1) how to compel attention to the message, involving many of the forensic, histrionic and literary arts as developed and variously applied by different civilizations and cultures; and (2) how to carry the message to the given audience. The latter involves the techniques of adapting the message so closely to the dominating values, motives and aspirations of the audience that the audience is inspired and eagerly welcomes the message. Implications of similar depth and scope could be stated with reference to other components of the communication cycle, and particularly with reference to the role of the audience. The influence of audiences upon the public communications they receive is apparently greater than the influence of the communications on the audiences.

The Communication Revolution.—Fairly comparable with the Industrial Revolution (1750–1850) in its effects upon socio-economic and political institutions is the world-wide impact of mass media, such as wireless transmissions of spoken words and photography in natural colours. The technologies developed at the outset of the 20th century enabled millions to hear, see and read the same messages at about the same time, whereas only hundreds could do so before; and the communication revolution is, in the second half of the 20th century, far from completed. The high costs of installing and operating the mass media could be offset only by obtaining a favourable mass response; *e.g.,* television in the U.S. To obtain this response, great efforts were made to discover what the masses most wanted to be told or shown and then to tell or show them just that. The new mass media were indeed revolutionary to the degree that they shifted the origin of mass messages from prominent individuals—statesmen, scholars, popular authors and others—to the masses themselves.

Effects of Public Communication.—The effects of messages via the mass media are naturally more interesting to more people than any other aspect of the communication process: they have accordingly been most diligently investigated. Franklin Fearing, "Social Impact of the Mass Media of Communication," chapter VIII of *Mass Media and Education* (1954), the 53rd Yearbook, Part II, of the National Society for the Study of Education, makes the following appraisal of the evidence to date:

(a) The responses to content of the mass media of communication are determined by a large number of factors, only one of which is the content itself.

(b) More specifically, the relationship of the interpreter to content has the characteristics of perception, the course of which is determined by his need-value-motivational system, the total situation in which the process occurs, and the content. [Fearing uses "interpreter" to mean what has been here called "the receiver of the message" or "the audience."]

(c) The outcomes ("effects") of exposure to particular content are extremely diverse and cannot be predicted in any particular case except on the basis of comprehensive knowledge of the content itself, the need-value system of the interpreter, and the characteristics of the total situation as perceived by the interpreter.

(d) The outcomes or impact of exposure to content may or may not take the form of overt behaviour.

(e) Whatever form the response to content may take, covert or overt, it is always dynamic in the sense that it serves the social-psychological needs of the interpreter.

(f) In general, the content of the mass media reflects existing value systems of the society in which they occur.

Among the plausible effects of public communications the following are generally assumed: (1) integrating the society by promoting consensus on basic policies; (2) stabilizing the society by supporting majorities against dissident minorities; (3) facilitating public administration by advising officials of community problems and advising citizens of official policies and actions; (4) strengthening national defenses by reporting both external and internal threats to national security; (5) extending the range of discourse by popularizing new terms, technical and cultural; (6) reinforcing social customs, such as etiquette or personal health practices; (7) stimulating fads and fashions.

One of several probable consequences of the communication revolution is that public opinions are rather reinforced than changed by mass communications. The changes were and are made largely by interpersonal communications. The conditions that help mass communications change public opinions include the following: (1) when the audience addressed is directly reached by the given medium and is open-minded on the issue; (2) when the content and style of the communication stress events more than opinions, appeal more to emotions than to reason, talk the language (exploit familiar concepts) of the audience, are not blocked by competing communications and attack opposing opinions indirectly; (3) when the media or channels used are personal, are directed at opinion leaders and are specialized; *i.e.,* focused on appropriate interest groups; and (4) when the subject or problem discussed is new, is far away in time and space, is of relatively minor importance to the people addressed and emphasizes the personalities involved. (This outline is based on Bernard Berelson's "Communications and Public Opinion" in *Communications in Modern Society,* ed. by Wilbur Schramm [1948]).

Institutions Involved.—All institutions of national scope and many smaller ones, in western cultures at least, were affected by social forces stimulated by the new mass media. Some institutions were largely restructured, or reconstituted, including the basic institutions of government, justice, church, press, schools, commerce and industry. The degree of change in the structure, if not the goals, of each institution was largely proportional to two factors in combination: (1) the extent of arbitrary authority the institution had previously exercised; and (2) the size of the populations directly affected by the institutions. The more authoritarian and widely influential institutions were the more obliged to heed the popular criticism of their operations as the mass media steadily and geometrically increased the number of articulate critics by broadcasting the information needed to make their protests effective. Such institutions as the foreign ministries of major world powers were forced to change their procedures when both the problems and the approaches of "secret diplomacy" were broadcast by the mass media. Mass communication thus tended to move international negotiations from the smoke-filled room to the global expanse of broadcast nationalist propagandas.

Bernard Berelson's over-all generalization of the available evidence on the effects of mass communication is as follows: "The nature of the audience—its social position, attitudes, interests, intelligence, level of information, educational status, personality traits, etc.—has a determining influence on what communications will be given attention; how they will be perceived and interpreted; and what effects they will have." (Letter of Bernard Berelson to Douglas Waples.) This goes far to explain why and how the mass media, during the first half of the 20th century, managed to equalize, occasionally to reverse, the previously top-heavy ratio between the authority of the officers and policy makers of an institution and the proposals supported by the publics affected. Examples may be cited from a few key institutions.

Commerce and Industry.—The mass media were naturally first exploited in the western industrialized nations by the advertising agencies, in the other less industrialized nations by the politicians. In between was the British Broadcasting corporation (and its imitators in Australia, Canada and other members of the Commonwealth of Nations), which undertook to protect radio and tele-

vision from control by either commercial or political interests. Because the underdeveloped countries were less able to operate technically efficient services, the effects of the new media upon their institutions were less revolutionary but still apparent. In the industrially developed countries the mass media made the advertising industry so rich that it could spend much more money on communication research than any other institution could afford. Such research enabled the advertising agencies to sell more advertising, and the high-pressure mass advertising doubtless sold more goods and services, with inevitable inflationary effects on the national economies. Market analysis followed by mass advertising proved so efficient in selling commodities at home that the United States government was persuaded to employ similar methods in selling its policies abroad. The evidence so far, as suggested above, shows the effects of mass appeals to be inversely proportional to the seriousness of the issue: the masses are much more easily moved from one toothpaste or cigarette to another of similar quality and price than they are moved by the mass media to change their views on economic, political or other social issues.

The mass markets developed by mass communication had an appreciable effect, in the more highly industrialized nations, upon the relations between management and labour in industries of national scope. Management discovered that wages high enough to enable employees to become consumers of the industry's products paid double dividends. Hence, capitalism, for reasons of self-interest, was inclined, by the leveling effects of the mass media, toward labour policies progressively socialistic.

Political Institutions.—The social psychologies explaining the effects of the mass media on commerce and industry also explain their effects on political and other institutions. Mass communication stimulated urbanization: increased both social and geographical mobility; increased impersonality by enabling people to live in a city without any close friends; accelerated social changes. These and other effects of the communication revolution tended to substitute the shotgun for the rifle in presenting public issues to the voters in democratic states. The issues had to be stated broadly in order to elicit a mass response; hence, the more closely analytic (rifle) presentation was discouraged.

The most obvious effect of the mass media on political decisions was thus to substitute centralized propaganda for small group consensus. The mass media substituted stereotypes for statements of opinions based on personal experience, and the substitution had not yet proved advantageous in the second half of the 20th century. Arthur Schlesinger, Jr., asked ". . . why do we insist on propagating abroad stereotypes which impress few foreigners and have long ceased to represent the American reality." (*The New York Times Book Review*, December 20, 1959, Arthur M. Schlesinger's review of *As Others See Us: The United States Through Foreign Eyes.*)

The Schools.—The educational curricula of most modern states normally lag five or more years behind the realities of the technical and social problems that the schools teach the oncoming generations to meet. Historically, the development of educational theory has been guided by successive popular philosophies and social values as interpreted by scholars authorized to prescribe the curricula. The mass media have tended to democratize the authority of scholarship by slanting the curricula of the schools and universities toward what the students want to learn.

The Press.—Newspapers, magazines and books have been called slow media. Their mass influence is delayed by the time required to read and react to the reported details of a significant event or to an editorial analysis of it. As an advertising medium the press had certain advantages which it fully exploited. The result was an effort by publications addressed to the general public to write what their readers wanted to be told. In short, the influence of the readers on the press became greater than the influence of the editors on their readerships.

Conclusion.—The mass communication media had already by the second half of the 20th century produced important changes in the policies and organizations of many basic social institutions. Further changes may be expected until the effects of public communication on public issues are sufficiently explained to permit a society to control the effects. Such explanation requires an integration of the evidence supplied by the several fields of knowledge mentioned earlier, the integration required to produce a reliable theory of public communication in the modern world.

See also LANGUAGE; PROPAGANDA; PUBLIC OPINION; SEMANTICS, GENERAL; SEMANTICS IN LINGUISTICS.

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COMMUNION, HOLY, one of the commonest terms in English for the Christian Eucharist. The Authorized Version translated I Cor. x, 16: "The cup of blessing which we bless, is it not the communion of the blood of Christ? The bread which we break, is it not the communion of the body of Christ?" In strict usage, the term refers to participation in the sacrament and to reception of the elements, but from this meaning it has been applied to the entire sacramental action, especially in those denominations where such practices as the adoration of the Host do not obtain and where, consequently, the sacramental action consists almost completely of eating and drinking in common. *See* also EUCHARIST. (J. J. PN.)

COMMUNISM, a term used to denote systems of social organization based upon common property, or an equal distribution of income and wealth. In the past there were many small communist communities, most of them on a religious basis, generally under the inspiration of a literal interpretation of passages in the Scripture. Some early or "Utopian" socialists of the 19th century followed a similar course, though they replaced the religious emphasis by a rational and philanthropic motivation. Best known among them were Robert Owen (1771–1858), who founded New Harmony in Indiana (1825), and Charles (François) Fourier (1772–1837), whose disciples organized settlements in the United States after the model of his original "phalanx," the most famous of which was Brook Farm in West Roxbury, Mass. (1841–47). In 1848 the word communism acquired a new meaning when it was used as identical with socialism by Karl Marx and Friedrich Engels (*qq.v.*) in their famous *Communist Manifesto*. (*See* also MARXISM.) Communist writers have continued to use the word socialism to denote the type of social order known as communism in English-speaking countries.

Marx did not find the basis for the communist movement in religious or ethical assumptions but in the new social sciences. Living in the century of confident faith in science and of a rapid industrial revolution, he claimed as a disciple of Georg Hegel an infallible certainty for his analysis of the historical forces at work in society. He regarded the changing economic structure as the foundation of social life. He looked upon the industrial working class as the bearer of a new order which would emerge on a world-wide scale as the result of an immanent historical process using the class war as its vehicle.

Because Marx's doctrine was ambiguous on many points, especially regarding its application and the future course of its realization, it gave rise to various interpretations, the most noted being those developed by Russian revolutionaries. Because of the success of the Russian Revolution the term communism became associated in the 20th century with ideas and practices of the Russian Marxists, and particularly of those who became the developers of the soviet system of government.

The Origins of Communism.—Communism as developed in

Russia may be traced back to the foundation in 1883 of the Group for the Emancipation of Labour by G. V. Plekhanov and P. B. Axelrod. The latter, deeply influenced by the doctrines of Karl Marx, which were just beginning to exercise a wide influence on Russian socialism, broke with the older Populists, who had counted upon a peasant revolution as the source of Russian emancipation. The Group for the Emancipation of Labour preached the doctrine that the main pivot of revolutionary success must be the organized working class. Because of its consequent emphasis upon the class structure of society the Group may be regarded as the first Marxian organization in Russia.

But it was not until the founding in Russia of a Social Democratic party, later to be called Communist party (*see* COMMUNIST PARTIES), that the special characteristics of communism as a doctrine matured. Intraparty debate clarified these characteristics. Some members of the party believed that the first essential work was to win working-class adherents by pushing their economic claims to better industrial conditions; the vaster task of capturing the state was, in their judgment, not yet ripe. Others, of whom Vladimir Ilyich Ulyanov, known as Lenin (*q.v.*), was the most outstanding, insisted that economic discontent must be from the outset merely the base from which the capture of the bourgeois state by the working class is organized. The first group (P. B. Struve, S. N. Prokopovich, E. D. Kuskova) insisted that the overthrow of tsarism was not a duty of the working class; the latter should occupy itself with matters like hours of labour and rates of wages. Proponents of this policy were called Economists. Their opponents (Lenin, L. Martov, Plekhanov) were known later as Iskrists from the title of their journal *Iskra* (founded in 1900).

The period from 1898 until 1903 was the most critical in the development of the doctrine of communism, for ideas were in flux. The number of adherents of the new revolutionary school grew as students poured into it from universities and technical schools, founding groups of every shade of socialist opinion. The development, moreover, of liberal bodies like the Union for Liberation, of which Pavel Milyukov was leader, raised in acute form the question of the relationship of the Social Democrats to the radical bourgeoisie. There were problems, further, as to how far it was desirable to encourage those isolated acts of terrorism of which Russian history at this period was so full. The nascent Social Democratic party was then only a loosely confederated system of semiautonomous groups, doctrinally united upon the ultimate goal of creating a communist society as preached by Marx, but with no clear view either of method or of order of priority in objectives.

Debate in the years between 1903 and 1917 clarified the aims and the character of the instrument of revolution, namely the Communist party, whose opportunity to develop communism in practice came in 1917. As to the aims, some party members indicated reverence for universal suffrage and popular determination of the future government of Russia through a constitutional convention. Others, including Lenin, thought such aims secondary and subordinate to the fomenting of revolution; the hegemony of the proletariat seemed to them fundamental. They thought that revolutionary success required dictatorship of the working class over all other elements in society and also sacrifice of the freedoms formulated by the French and American Revolutions as well as of a democratically elected assembly.

The Consolidation of Doctrine.—From debates prior to 1917 communism matured as a political doctrine resting upon Marx's assumptions which communist leaders had inherited from the pioneers of 1883. To this Marxian base was added doctrine distilled from experience of the revolutionaries, especially that derived from the abortive attempt in 1905 to seize power from a tsarist government weakened by defeats in the Russo-Japanese War. Fundamental to all communist thinking was the unshakable belief in the inevitable triumph of the working class in revolution and the equally unshakable conviction that to achieve victory the working class must separate itself from bourgeois elements in society and fight them to destruction. Emphasis was upon violence in seizing power and complete denial of the possibility of utilizing parliamentary institutions to achieve working-class aims.

Communism was to be distinguished from Blanquism and terrorism. The former pinned its faith to sudden mass action without regard to time and place; the latter had confidence in the exemplary value of isolated acts such as assassination. The communist was more realistic. A successful revolution, in his view, was the outcome of careful preparation applied to a suitable conjuncture of circumstances. Insurrection, as Marx said, is an art; and Lenin laid down five rules as its guiding principles. Insurrection, first, must never be played with; once it has begun, it must be carried on to the bitter end. When, secondly, the time has been chosen, the revolutionists must mass at the proper place forces superior to those of the enemy; otherwise they will be overwhelmed. Once begun, thirdly, the offensive is fundamental, because, as Marx pointed out, "the defensive is death to the insurrection." Surprise, fourthly, is fundamental; and the moment to choose is when the forces of government are scattered. Moral superiority, finally, is vital; and the announcement of daily, even hourly, successes has great importance in depressing the enemy, in consolidating the offensive and in keeping the masses on your side. Surrounding all must be the ultimate perspective of audacity without which supreme success is impossible. Revolution, therefore, may be said, from the angle of socialism, to depend on three conditions. First, it must be not a conspiracy nor a party move but the rise of the revolutionary working class. Secondly, it must have the masses on its side and must therefore build its appeal on their most urgent demands. Thirdly, it must break out at the crux of rising activity among the friends of revolutionary change and at the moment of greatest indecision on the part of the enemy.

The working class is thus brought to power. The communist insisted that the preservation of power involves the dictatorship of the proletariat. It is essential to crush out opposition and to shatter the institutions of the defeated regime. Revolution is war and until there is complete acquiescence in the victor's terms, the methods of war alone are suitable to it. "The enemy," said Lev (Leon) Trotski, "must be made harmless, and this means he must, in wartime, be destroyed." For, willing the end, the communist cannot wipe his hands of the means. Hesitation, weakness, pity, a false worship of democracy, only stimulate the forces of counterrevolution and prevent the consolidation of the new regime. The dictatorship is exercised by the Communist party because: (1) its members have been tried and can be trusted; and (2) they represent the real will of the workers that has been suppressed and obscured by capitalism. The dictatorship is a trust for the revolution that, in its turn, is a fulfillment of the mission to which the working class is historically called.

Violence therefore wins the revolution and dictatorship consolidates it. The transition to socialism is accomplished in two stages. In the first, the oppression of classes disappears, and, with it, the state, which is merely the instrument of class oppression. The proletariat seizes power and by using it to destroy the class structure of society ceases to be a proletariat. The instruments of production are socialized. But coercive power is still necessary because the minds and hearts of men are not easily accustomed to the new regime. Government therefore continues, though growing acceptance of the new society means growing democratization of social processes. This, however, does not mean parliamentarianism, which is merely a bourgeois form of government, but the soviet system which combines the advantages of the territorial with the virtues of producers' representation. Formal democracy is replaced in the first stage by what the communist called "the revolutionary dynamic of living forces," which means that all elements in society except the working class are deliberately excluded from power. Great industrial enterprises, the banks, the means of communication and the large landed estates must be confiscated. Wholesale commerce should be nationalized; foreign trade must become a government monopoly. The means of propaganda, the press and education, must be confined to working-class direction. Small business may be left untouched, because it is futile to think that communism can be established at a stroke. Measures must be taken to associate intellectual technicians with the new order and to neutralize the

peasant classes by organizing the poorer, while repressing sternly the antagonism of the richer peasants. So, *mutatis mutandis*, with the poorer bourgeoisie of the towns.

Communism cannot be said to have had any clear view of the ultimate social order it proposed to establish. It took over from Marx phrases like the demand "from each according to his powers, to each according to his needs," and the "administration of things instead of the administration of persons." But it was mainly occupied with the immediate revolutionary task. It conceived, moreover, of the revolution thus established as a world revolution made in each country on conditions similar to those in Russia. For this purpose the formation of a world Communist party rigorously directed from a single centre and sternly disciplined from above was fundamental. To advance the revolution advantage must be taken of national, racial and economic discontent where these exist; but propaganda in relation to them must seek always to move them to significance in terms of the class war. Union should be sought with the reformist working-class parties, but always on the understanding that they are bound to fail and that if they arrive in power the communist must separate from them and fight them. Finally, it is to be noted that communism regarded religion as a capitalist instrument used as an anodyne for the workers and sought wherever possible to destroy its influence.

Revolutionary Additions.—Lenin seized power in war-devastated Russia in Nov. 1917, over-throwing the short-lived democratic revolutionary regime established through the collapse of tsarism in March 1917. During World War I he assumed an intransigent attitude against any form of "patriotism" and wished to transform the national war into a class war. He returned to Russia in April 1917; under his leadership the left wing of the Social Democratic party, the only group with strict discipline and definite purpose, emerged in the general chaos to channel the amorphous and leaderless discontent of the masses. The group established its dictatorship as a "dictatorship of the proletariat," abolished the newly won political and civil liberties in Russia, renamed the party "Communist party," and, because of the leadership of Lenin and Trotski, kept itself in power against great initial odds.

According to Leninism, political, economic and intellectual life must be regulated by the "proletariat's advance guard," the party, because the people and even large parts of the proletariat, educated in the pre-Communist era, are unable to realize the new order. The masses have to be guided in a strictly regimented fashion toward participation in the new order. Communism believes that "true" democracy cannot be realized in any non-Communist society because of the economic exploitation by private elements of society (the possibility of economic exploitation by the state itself is not considered), and that parliamentary democracy only veils the control of society by capitalists. Therefore the building of the future perfect society proceeds under an autocracy, unbound by any law or ethical consideration of the "bourgeois" age. To this future, the coming of which is assured under omniscient leadership, the happiness of the present generations and the rights of the individuals are sacrificed. Marxism and Leninism originally expected that with the triumph of the proletariat the state which Marx defined as an organ of class rule would "wither away" because class conflicts would come to an end. Communist rule in Russia, however, resulted in an ever increased power of the state apparatus. The Communist dictatorship created the first and most perfect example of the totalitarian state in which no sphere of individual life was allowed to remain outside its all-inclusive grip. In the effort to create a "true" democracy, terror was employed without hesitation; humanitarian considerations and individual rights were disregarded; and the assumption of the class character of all intellectual and moral life led to a relativization of the standards of truth and of ethics. On the other hand, communism gained much of its power over human minds by the "scientific" prediction and promise of establishing social justice and perpetual peace after the liquidation of all its actual or potential adversaries.

Though the final goal was never lost sight of, communism passed through several phases of adaptation on this road. In 1919 Lenin had founded the communist or third international, but it proved unable to make any serious progress outside Russia before World War II, and the several Communist parties existing abroad became instrumental to the policy of the Communist state in Russia. (*See* INTERNATIONAL, THE.) With the temporary abandonment of an immediate world revolution, Lenin replaced the policy of "war communism" by the "new economic policy" (NEP) in March 1921. It represented a compromise between nationalized and private economy, but in 1928 a renewed drive for the "realization of socialism" in the Soviet Union set in under the leadership of Stalin, Lenin's successor. This speedy drive toward socialism called for advanced planning in all branches of the economic and cultural life of the country. Under the form of five-year plans, the natural resources of the country were successfully exploited and large-scale heavy industry was built up; individual farms were collectivized and machinery and more efficient methods of cultivation were introduced into agriculture; illiteracy was fought and education used for the re-education of the soviet citizen. The deep-seated conviction of an "inevitable" clash between Communist Russia, the bearer of the true faith and of the only valid social order, and the outside world led to emphasis being placed on a "war economy" and the subordination of all activities to the need of "defense."

After having abandoned the hope for revolution in Europe, communism concentrated for some years upon the revolutionary movements in the orient, especially in China which by its geographic position and its potential strength became the centre of Communist interests and activities in Asia. But hopes there were temporarily frustrated by Chiang Kai-shek in 1927.

Tactical Change.—The growth of aggressive fascism in Germany and Japan during the 1930s brought about a complete tactical change in Communist policy. The U.S.S.R. joined the League of Nations in 1934 and stressed its willingness to cooperate with democratic forces against fascism. Communists outside Russia declared themselves ready to form a "popular front" with the liberals and socialists whom they had formerly vehemently combated and abused. After 1935 much greater stress was put on the U.S.S.R. as the only genuine leader and representative of communism. Communism was regarded as a new form in which the historical traditions and aspirations of the Russian empire and the Russian people were vitalized. The flexibility of Communist policy was perhaps enhanced by the ruthless "purges" of 1936–38, in which Stalin eliminated all those persons, many of them among the oldest and most renowned Communists and closest collaborators of Lenin, who could endanger his leadership. In this process several hundred thousand leading personalities of the political, economic and military life of the U.S.S.R. were liquidated as "traitors" or "enemies of the people."

This flexibility in policy, though not in Communist principles and goals, showed itself in the sudden change of the "general line" in Aug. 1939 when the Soviet Union reversed its policy of collaboration with the democracies in the struggle against fascism and lined up with aggressive fascism, which Communists had proclaimed until then the mortal enemy of the proletariat, of peace and of progress. In Aug. 1939 Stalin concluded a treaty of friendship and nonaggression with Adolf Hitler and thereby gave the green light to German aggression which unleashed World War II. The U.S.S.R. participated with Germany in the destruction and partition of Poland. In April 1941 Stalin concluded a five-year treaty of friendship and nonaggression with Japan which, however, he broke four years later. During the first two years of World War II Communists everywhere vied with the fascists in directing their attacks against democracy or, as the fascists called it, "pluto-democracy." They regarded the cause of World War II to be not German aggression but British and French imperialism. They tried to sabotage the intellectual and material defense program of the democracies against fascist aggression. The candidacy of Franklin D. Roosevelt for president of the United States in 1940 was violently opposed as that of a "warmonger" in the service of U.S. big business. The attitude of sympathy toward fascist Germany changed naturally with the unprovoked German attack on the U.S.S.R. on June 22, 1941.

For the next four years all the forces of communism were concentrated on winning the war against Germany. To that purpose an uneasy alliance with the democracies was maintained, without the Communists ever losing sight of their ultimate political goal which divided them sharply from their wartime allies. Against the strict unity and carefully planned strategy of the Communists the democracies showed neither unity nor an understanding of the issues involved. Thus the war ended not only with the military victory over Germany and later over Japan but with rich fruit to the farsighted policy of Stalin. The Soviet Union, which counted in 1939 a population of 170,000,000, acquired in central eastern Europe and in the far east additional territories with a population of more than 20,000,000. More important, however, was the spread of Communist governments which by 1950 controlled a territory stretching from beyond the Elbe river to beyond the Yangtze river and contained a population of more than 800,000,000 people, about one-third of mankind, closely integrated by unity of leadership and social philosophy. In manpower, resources, geographic vastness and contiguity, this new Eurasian axis promised to be immensely more powerful than the German-Japanese axis of a decade before.

During World War II the national patriotic trend, which had been visible already in the preceding years, became more and more pronounced in Communist Russia. Stalin himself took the lead when he called upon the Russian people on July 30, 1942, to be inspired in the war by "the daring spirit of our great ancestors." Military heroes of Russia's feudal past were set up as examples for Communist youth. The patriotic feeling of the Russian Orthodox Church was also mobilized by the Communist government, which stopped the formerly officially sponsored violent antireligious propaganda of the "Union of the Godless." In 1943 the Russian Orthodox Church was restored to its traditional splendour and became a willing instrument of Stalinist policy. The new patriarch ordered all churches to offer prayers "for the health and well-being of the God-sent leader of the peoples of our Christ-loving nation." The Russian Church tried to unite all Orthodox Churches under its leadership.

As an apparent concession to the wartime allies, the Communist international was dissolved on May 22, 1943. Yet the Communist parties everywhere continued to follow without criticism or hesitation the party line as laid down by the Russian Communist leaders. The cause of the Soviet Union was identified with the Communist cause; loyalty to the U.S.S.R. and loyalty to communism were one. This attitude continued in spite of the change from the original proletarianism of Lenin to the emphasis on Russian traditions carried through by Stalin in all fields after 1940. He restored the titles and splendours of the old regime with its ornate uniforms and its militarized bureaucracy, even in the most civilian departments. Coeducation was abolished in all higher schools, to take into account the different nature of the two sexes; the boys were trained for a stern soldier's life while the girls were educated for motherhood. A new stress was put upon family and authority. Stalin himself was regarded more and more as the object of a Byzantine adulation, surpassing even that accorded to the tsars of the past. He was regarded no longer as the autocratic leader of one empire, as Ivan the Terrible and Hitler were, but was glorified as the infallible leader of all peoples, of the whole of "progressive" mankind, the omniscient teacher of all sciences and all arts.

Postwar Revision.—At the end of World War II this stress on the Russian cultural past—which was now exalted as superior in its nature and in its achievements to all other civilizations—was combined with a new emphasis on the purity of the Leninist-Stalinist doctrine. A relentless war was waged upon all "deviations." To that purpose, Communist Russia was more strictly isolated by its rulers from any contact with the outside world than had ever been attempted before in the traditionally closed society of tsarist Russia. This policy of self-isolation was accompanied by violent campaigns against what was called "homeless cosmopolitanism" and "belittling" of the leadership of the U.S.S.R. in all fields of culture, a sin apparently committed by some Soviet critics and scientists who continued to indulge in the crime of "toadying" before the west. Communist writers and scholars outdid each other in praising the new culture of the U.S.S.R. as many times higher than all other cultures and therefore endowed with the right to teach others the new panhuman morality of which the Soviet citizen was proclaimed the highest bearer. By the middle of the 20th century, the chauvinist tradition of the superiority of the Soviet Union over the decadent west, and the Communist faith in the superiority and ultimate triumph of communism over disintegrating capitalist democracy, were thoroughly systematized in Stalinist Russia and raised to an unassailable religious dogma.

The new development of communism after World War II showed two opposite faces—a completely closed society in Russia, protected from every contact with the outside world, and, at the same time, the resumption of the original world-wide revolutionary drive. Summing up Lenin's testament to the party, Stalin had declared after the leader's death in Jan. 1924: "Lenin never regarded the republic of soviets as an end in itself. He always regarded it as a necessary link for strengthening the revolutionary movements in the lands of the west and the east, as a necessary link for facilitating the victory of toilers of the whole world over capital. Lenin knew that only such an interpretation is the correct one, not only from the international point of view but also from the point of view of preserving the republic of soviets itself." Twenty-five years later, after the victories of the Russian army and of the Communist diplomacy in Europe and Asia, Soviet communism felt a new aggressive and dynamic vitality. It saw itself as the irresistible vanguard of an immense forward movement which the military and economic disintegration of Europe and Asia seemed to favour. Nevertheless, Communists nowhere gained a majority in free elections, not even in territories which were under the control of Soviet armed forces or within the orbit of Soviet diplomacy. The weight of the continuous Communist offensive was mainly sustained not by the mighty Communist propaganda machine and its outwardly attractive slogans and appealing oversimplifications but by the power and preparedness of the Soviet army. Even in China and Korea Communist successes were due to the existence and strength of Communist armies, and not primarily to Communist programs or policies. In Italy and France, where such armies were not in existence, the numerically very strong Communist parties with their excellent financial and intellectual backing were unable to score any lasting success.

In Sept. 1947 representatives of nine Communist parties (U.S.S.R., France, Italy, Poland, Yugoslavia, Bulgaria, Rumania, Hungary and Czechoslovakia) met in Poland to establish the Communist Information bureau (Cominform). Belgrade, Yugos., was selected as its seat; a vote of confidence by international communism for the Yugoslav Communists and their leader Tito was seen in this choice. The Cominform asked all those in favour of "democracy and peace" to close ranks around it against the threat of "reactionary and imperialist" aggression led by the United States. The Communist-dominated countries outside the Soviet Union were organized as "people's democracies." Though the Soviet Union always stressed their sovereignty, they were assimilated more and more completely into the pattern of life in the Soviet Union. The often propagated thesis that the various Communist parties were independent and could follow a different and more moderate line than that taken by Russian communism, was definitely ended when in 1948 the Soviet Union and the Cominform attacked violently the Yugoslav Communists for not submitting completely to the directives coming from Moscow.

The Cominform revealed itself as the supreme directive and centralizing organ in the world-wide struggle for Communist victory. Like the Comintern before, it was unreservedly under the control of the Soviet party, and the slightest deviation from the Moscow line was mercilessly fought as treason. The Yugoslav Communists were excluded from the Cominform and its seat transferred to Bucharest, Rum. From that moment on Tito was as violently attacked by the official Communist spokesmen as a "fascist" and "warmonger" as were the moderate socialists such as Léon Blum or Ernest Bevin, or as was the "monopoly

capitalism" of the United States. All those who disagreed (or were believed to disagree) in the slightest manner with the official line of Stalinism were regarded as enemies and presented to the Communist world as one unit, acting and plotting under a common command and according to a strictly integrated plan against communism and the "fatherland of all the workers." On the other hand, the democrats found themselves in their struggle against communism, as formerly against national socialism, often hindered because they were the prisoners of their own methods of fair play and civil liberty and failed to understand the completely different nature of the Communist doctrine and methods.

The world-wide implications of Communist policy were stressed by Georgi Dimitrov, the famous Bulgarian Communist leader, who wrote on Dec. 18, 1948: "It should not be forgotten that—in spite of the fact that the Communist International does not exist—all Communist parties in the world form one single Communist front, under the direction of the most powerful and most experienced Communist party, the party of Lenin and Stalin; that all Communist parties have one common scientific theory as a guide to their actions—Marxism-Leninism; and that all Communist parties have one leader and teacher, recognized by all—Comrade Stalin." Commemorating the Communist seizure of power in Prague, Czech., of Feb. 1948, the Communist speaker of the Czechoslovak parliament, Oldřich John, declared on Feb. 22, 1949: "February 1948 was not a decision concerning only our country, but the whole world. At a decisive moment and at a decisive key position in Europe we achieved a critical shift of the forces of the world. . . . Our February . . . belongs to the working class of the whole world which is expecting its February. It will have it."

The declaration introducing the first constitution of 1923 of the newly formed Union of Soviet Socialist Republics stated that since the formation of the Soviet Union the countries of the world had split into two camps, the camp of capitalism, with national oppression, imperialist brutality and wars; and the camp of socialism, with peace and harmonious collaboration. Thirty years later, the Communists were more than ever convinced that history had put on the order of the day the final and total victory of communism. This victory, according to Communist doctrine, held with religious fervour would create a world of one faith and one leadership which would assure the peace and security for the Soviet Union and the certainty of salvation for the whole of mankind. The shift of power following World War II made, in the eyes of the Communists, the United States the leader in the opposite camp of democracy, of that western way of life which, according to Soviet communism, had been doomed by its own inner contradictions and by the irresistible march of history.

Khrushchev.—Stalin's death on March 5, 1953, ended the era of inflexible personal dictatorship over every detail within the Soviet orbit. After a brief interval of readjustment, Nikita Sergeevich Khrushchev (*q.v.*) emerged as successor to Stalin's office, but not to his policies. He introduced flexibility, abandoning Stalin's isolation from his people and the world. In May 1955 Khrushchev reversed Stalin's rejection of Tito for assuming an independent attitude. In Feb. 1956 at the 20th Communist party congress he denounced Stalin's assumption of omniscience, not only political but literary, artistic, scientific and military, as the "cult of the individual." Khrushchev's new approach, coupled with Mao Tse-tung's unwillingness in China to accept from younger men the direction he had tolerated from Stalin as a senior with long experience, set off a chain of events undermining the previously monolithic character of Communist leadership.

Polish Communists, emboldened by the new flexibility and forced to compromise by a population embittered by Stalin's program of speedy adoption of Soviet patterns, restored Wladyslaw Gomulka to the leadership from which Stalin had evicted him. Khrushchev capitulated after Soviet threats proved unavailing and accepted in Oct. 1956 the right of Polish communists to devise their own path so long as they moved toward socialization and supported Soviet foreign policy. Chinese communists, wishing greater freedom of action, supported the Poles. Hungarians misread the signs and revolted, not only denouncing Moscow's dictatorship of their policy but withdrawing from the 1955 Moscow-oriented Warsaw pact of military alliance (*see* WARSAW TREATY ORGANIZATION). Faced with armed rebellion, Khrushchev quelled the revolution with Soviet troops and re-established the Hungarian Communist party's power, but under a less fanatical leader, Janos Kadar. Hungary was permitted to satisfy demands for consumer goods but not for worker control of factories or intellectual freedom. Tito's sympathy for the Hungarian renegade Communists and granting of brief asylum to Imre Nagy, moderate Communist chief of government for the revolutionary days, aroused Khrushchev's anger.

To overcome emerging centrifugal forces, in Nov. 1957 Khrushchev summoned to Moscow Communist party leaders from states where they ruled. The meeting issued a declaration of unity under leadership of the Soviet Union's party in furtherance of "proletarian internationalism." Tito alone refused to sign, bringing upon himself subsequently renewed denunciation as a revisionist of Marxism; the Chinese Communists were even more vitriolic in the attack than were the Soviet Communists. In spite of lip service to Soviet leadership Chinese Communists asserted their right to introduce agricultural communes contrary to Soviet advice and to share in foreign policy decisions, even to having a major voice in those relating to Asia.

Communism as an international force ended the 1950s without the monolithic leadership Stalin had provided earlier and with the notable emergence within the Chinese Communist party of a demand to be heard, albeit as a party in second place to that of the U.S.S.R. International Communism was still dominated by the Communist leaders of the U.S.S.R., but the seeds of what Khrushchev called a "Communist commonwealth" had been planted. Traces of nascent duality of leadership appeared when Khrushchev journeyed to the United States in Sept. 1959 and professed to renounce force as a means of settling disputes. Chinese Communists at their 10th anniversary celebration on Oct. 1, 1959, indicated reluctance to abandon their militant policy of expansion in Asia.

See also references under "Communism" in the Index volume.

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COMMUNISM, PRIMITIVE. The concept of primitive communism was essentially a product of the evolutionary theories of the mid-19th century, according to which the early history of mankind was characterized by a stage of society radically opposite to the modern western type. Hence it was thought that early man held his property, including his land, in common, and that some kinds of relations between persons, especially sex relations, were governed by no rule within the group. To such primitive communism, it was held, there succeeded various more limited forms of property holding and marriage. In the attempt to give reality to such evolutionary schemes, the institutions of certain contemporary primitive peoples were identified as having this communistic character or as being at a stage barely removed therefrom. W. H. R. Rivers, for example, held that in Melanesia there was a fairly definite association of two kinds of communism, in ownership of property and in sexual association. He interpreted clan rights over land in Ambrym as excluding all individual ownership; he thought that at Raga communistic ownership still persisted for canoes; he looked upon the Fijian custom of *kerekere* (which allows a person to appropriate the property of others in the category of maternal uncle) as fairly definite evidence of communism; and he regarded the system of prenuptial sex relations in Eddystone Island (which had a very strict code for married people) as "a state of organized communism which may be

the survival of an earlier state in which this communism also existed after marriage" (*Social Organization* [1924]; copyright Routledge & Kegan Paul Ltd., London). Rivers, however, did not regard organized sexual communism as the earliest stage in the evolution of human society but as growing out of a condition in which the institution of family was recognized. E. Durkheim generalized such views in terms of his theory of primitive collectivity, arguing that communism of property was a necessary product of the special cohesion in primitive society which marked the absorption of the individual into the group.

The question of the validity of the concept of primitive communism, which did not receive much support from developments in anthropology in the 20th century, was revived by Soviet theorists. Some, such as P. Kushner and P. F. Preobrazhenski, held that such theories were based upon insufficient knowledge of primitive conditions, but others, such as N. M. Matorin and E. Kagarov, argued that ethnographic data had confirmed it beyond doubt. Basing their arguments largely on the views of Karl Marx and Friedrich Engels, who in turn had drawn upon the work of L. H. Morgan, they regarded the postulate of primitive communism as an augury for the future—according to the idea expressed by Marx that the new system which modern society is approaching will be the re-emergence of the archaic social type in the highest form. Most Soviet ethnographers seem to adhere to Morgan's evolutionary scheme and uphold the collective communal-clan character of early human economy as universal.

Leaving aside political implications of the concept, modern anthropology found it inadequate as a matter of ethnographic fact. The essential features of a communist condition of society are: a common ownership of the means of production, labour contributed according to ability and the product shared according to the needs of the members of the society. This is antithetical to a system of private control of productive resources. The evidence from a wide comparative study of primitive economic systems does indicate a marked communal interest in rights over property, especially over the basic productive resources: in an agricultural community the rights of any individual over land are subject to the overriding rights of the kin group of which he is a member; in a pastoral community he may seem to have no separable rights to land at all. But the system of rights is complex. All members of the community do not share alike but have their rights to ownership closely defined by rules of kinship and residence. Use of land, water, crops, cattle and canoes is governed by recognition of the primary title of some kin group or even of some individual, and other individuals base their claims upon defined kin or other status rights—as, for instance, being a sister's son. In an Australian aboriginal community the game that is killed must be shared among other members of the hunter's group, and this is not done on the basis of need of the individuals concerned but of their entitlement according to a complex set of rights and duties in virtue of their kinship to the hunter. So, even in the simplest primitive communities the principles of ownership involve complex patterns of individual rights, not undifferentiated community control and sharing according to need. When careful analysis is made of the concrete system of rights and obligations in any primitive society, modern anthropologists agree with B. Malinowski, O. Leroy and R. Thurnwald that, while these cannot be adequately described exclusively in terms of individualism, the concept of communism is equally inadequate. Primitive institutions of sex relations and marriage also exhibit analogous complex systems of rights, which frequently differ from those in modern western institutions but to which the label primitive communism is quite inapplicable.

If the material from modern primitive communities cannot be interpreted as evidence of extant primitive communism, neither does it allow modern institutions to be postulated as survivals of an earlier communistic state. Primitive institutions are intelligible in the context of other social, economic and political circumstances immediately associated with them; reference to some hypothetical past is not necessary. The argument for primitive communism as an early stage in human history remains in the realm of speculation. *See* also LABOUR, PRIMITIVE; LAND TENURE, PRIMITIVE; MARRIAGE, PRIMITIVE.

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COMMUNIST INTERNATIONAL: *see* INTERNATIONAL, THE.

COMMUNIST PARTIES, groups organized for political action designed to inaugurate a world-wide communist social order by seizing and exploiting political power and economic resources in conformity with a pattern introduced in Russia in 1917. Outside Russia, Communist party leadership followed directions given by Russian initiators for 30 years until Yugoslav Communists demanded autonomy in decision making in 1948 and refused to accept the Union of Soviet Socialist Republics as the "fatherland." Other Communist parties denounced the Yugoslav party as "revisionist."

General Characteristics.—Characteristic of all Communist parties, including Yugoslavia's, were strongly held beliefs traced in origin to the doctrines of Karl Marx and Friedrich Engels (*qq.v.*) but modified and developed by their successors. These were belief in the superior productivity of a state-planned economic system over private enterprise; the necessity of state ownership of productive resources to prevent exercise of economically derived political power by private individuals or corporations; the organization of land use by communities; the propagation of atheism; the impossibility of obtaining power except by violence; the monopolization of political power after victory by a leadership corps composed of a relatively few disciplined, politically active persons dedicated to the achievement of communism; and the preliminary favouring of the mass over the individual as essential to ultimate fulfillment of the individual. Where Communists had not achieved power or where power, although achieved, had not become absolute, goals were often compromised, as in Poland in 1956, but basic aims were reasserted when possible.

Before seizure of power and briefly thereafter Communist parties sought influence by attracting disgruntled social elements, notably ethnic minorities and the poor, to whom successful members of the pre-revolutionary society were depicted as exploiters. In extension of this tactic to the international scene powerful states blocking realization of Communist policies were castigated as "imperialist," notably France, Great Britain and Germany between the world wars, and the United States thereafter. Playing upon the universal craving for peace, Communist parties sought political advantage by claiming for their scheme of world order the role of "peace program" and calling their opponents "warmongers."

To advance their cause in states where power could not yet be seized, Communists sought membership in mass organizations, notably labour unions, social and cultural associations, military forces and the government bureaucracy, attempting to weaken the society from within, as in Czechoslovakia in 1948. Hoping to prevent such infiltration, governments of 38 independent states and semi-independent colonial areas had outlawed Communist parties by law or practice by 1960, arguing that they were not true political parties pledged to function within a parliamentary democracy but an instrument of revolution directed from Moscow. (*See* also COMMUNISM.)

Contrast With Socialist Parties.—Communist parties differed from Socialist parties in aims and organization, although Communist parties had often emerged originally as left wings of Socialist parties, and although both sometimes participated after the initial organizational split in coalitions to oppose rightist parties in parliaments. While both espoused state economic planning and held state ownership necessary to planning, Socialists believed it necessary to seize only "commanding heights"—banking, communications, key heavy industry—in contrast to Com-

munist doctrine that all economic enterprises employing labour must be state-owned. After 1958 German and British Socialists accentuated the contrast by questioning even the desirability of state ownership of key industry provided state control was assured.

Socialists, like Communists, professed working-class orientation, but Socialist parties opened membership to all. Communist parties admitted relatively few, except in countries where competition with Socialists dictated competitive membership tactics, as in Italy after World War II. Socialists thought achievement of goals possible through parliamentary procedures: Communists denied the possibility and sought power through violent revolution, although where such tactics attracted little support, conventional election campaigns were conducted until violent seizure of power seemed feasible.

Socialists left religious belief to the individual's conscience: Communists required members to espouse atheism. Communists foresaw ultimate social organization without institutionalized force to maintain order, force being unnecessary when human wants were satisfied and self-discipline learned. Socialists considered this aim Utopian, if not a mask for contemporary police regimentation. (*See* also SOCIALISM; SOCIALISM: PRINCIPLES AND OUTLOOK.)

Origin.—Industrial unrest at the end of the 19th century brought forth a small vigorous Marxist movement in the cities of Russia. Although industry developed so slowly that there were by 1890 only an estimated 2,400,000 industrial workers in the Russian empire, the influence of the more advanced working classes of western Europe was noticeable. Russian *émigrés* such as Georgi Valentinovich Plekhanov served as the funnel through which Marxist literature and concepts were smuggled from abroad to Russian groups operating at home. Most Russian workmen's groups adopted the concepts of Social Democratic thought represented by the second international, which had been formed by western European workmen in 1889. (*See* INTERNATIONAL, THE.) The first important split with the second international's approach to seeking power by peaceful parliamentary means came in 1895. Organized in St. Petersburg, it took the name of League of Struggle for the Emancipation of the Working Class. One of its influential sponsors was Vladimir Ilyich Ulyanov, known as Lenin (*q.v.*), who was later to become the principal figure of the Russian Revolution. Similar leagues were formed in other cities and these joined with a left-wing Jewish organization called the Bund to send delegates to a meeting in Minsk in 1898. At this meeting was formed the Russian Social-Democratic Labour party (R.S.D.L.P.), from which the Communist party dates its official beginning. Delegates issued a manifesto calling for a struggle against autocracy and capitalism until the complete victory of socialism. After the meeting most of the party leaders were arrested and the work of the party was reduced to activity in the local underground organizations.

The great industrial depression of 1899–1900 in Europe spread to Russia at the beginning of the 20th century, resulting in bankruptcy and unemployment. Street demonstrations and strikes appeared. Lenin, who had been exiled to Siberia in 1897, returned to take part in reorganization of party work in the fertile soil of industrial unrest. The Russian Social-Democratic Labour party was re-formed at a congress of delegates, which met in Brussels, Belg., in 1903 to avoid arrest at home. Police observation was such that this congress transferred its session to London to complete the work of organization. At this congress appeared the great split between left and right wings which plagued party unity for years.

The left wing, supported by Lenin's adherents, called for a militant, disciplined, centralized party, which would be proletarian in composition. It urged a clear line of demarcation between nonparty members, who might sympathize with party aims, and party members, who would be required to recognize the party program, pay dues, enter one of the party organizations and work actively. The right wing, to which Lev Davidovich Bronstein, known as Leon (Lev) Trotski (*q.v.*), adhered, urged a broader membership base, requiring only that a member recognize the program and render aid. The right wing's conception was adopted at this time.

The right- and left-wing factions in the party split again later in the congress. Some right-wing elements who had disagreed with the conduct of affairs withdrew so that in the vote for members of the central committee and the editorial board of the party press, the left wing became the majority. It was given the name bolshevist, signifying this fact. The minority right wing was called menshevist in turn. These labels were carried ever after, even though power passed back and forth from time to time. The split between the factions became so great that in 1905 they met separately. The menshevist faction met in Geneva, Switz. The bolshevist faction, meeting in London and led by Lenin in person, adopted his concept of membership. This remained the rule of the party.

Although there were subsequent periods in which the menshevists and bolshevists acted in concert, the split continued up to the Revolution. After the Revolution some menshevist leaders transferred their allegiance to the bolshevist cause. The menshevist faction disappeared as a political unit in the U.S.S.R.

The party named itself the Russian Communist party in March 1918. It changed its name again in 1924 to All-Union Communist party (Bolshevik) to dramatize its place within the federation. In 1952 it became the Communist Party of the Soviet Union.

External Influence.—The Russian Revolution, coincident with world-wide popular discouragement and regional impoverishment, stimulated creation of Communist parties in many lands, sometimes on a base of a prewar, Marxist-oriented group paralleling that of Russia. A Swedish group created a Communist party in 1917, and similar parties appeared in defeated Germany, Austria and Hungary after World War I and also in Greece, Yugoslavia, Poland, Bulgaria, Argentina, Mexico, Denmark and the United States. Thereafter the movement gained recruits, following Lenin's organization in Russia of the communist international in 1919 to prepare leadership for eventual world-wide revolution and to support the policies of his fledgling government.

In 1920 Communist parties were founded in France, the United Kingdom, Turkey, Australia, Iran, the Dutch East Indies and Uruguay. In 1921 they appeared in Italy, Spain, Brazil, Chile, India, Switzerland, Rumania, Czechoslovakia, China and Mongolia; in 1922 in Japan and Norway; in 1924 in New Zealand; in 1925 in Cuba and Korea; in 1928 in Ecuador and Paraguay; in 1930 in Syria-Lebanon, Costa Rica and Indochina; in 1934 in Algeria (previously under the French party); in 1943 in Ceylon and Morocco (previously under the French party); in 1946 in the German Democratic Republic; in 1948 in Israel; in 1949 in Bolivia; and in 1951 in Nepal and Vietnam.

Moscow claimed 33,000,000 members for Communist parties in 83 countries in 1959. Foreign experts believed these figures to be approximately accurate and estimated that 85% of the Communists were in the Sino-Soviet bloc. The 1960 estimates of membership (made by the U.S. department of state) were China 16,000,000; the U.S.S.R. 8,708,000; Italy 1,791,000; Poland 1,155,000; German Democratic Republic 1,473,000; Czechoslovakia 1,559,000; Korea 1,200,000; Hungary 438,000; Vietnam 500,000; Yugoslavia 984,000; France 250,000; and Bulgaria 484,000.

Between the two world wars, Communist success outside the U.S.S.R. was greatest in continental Europe and China, and weakest in Anglo-Saxon, Scandinavian, Islamic, southeast Asian, Latin-American and African countries. Various factors, including alternative outlets for discontent, satisfactory wages and working conditions, strongly held religious beliefs, and insulation from outside influence because of illiteracy or sealed frontiers, accounted for Communist failure to penetrate these areas.

Great Britain.—British workers, although class conscious, supported the Fabian socialism of the Labour party so that Communists were without effective influence in Britain. Communists at maximum strength held two parliamentary seats in 1945; they lost them in 1950 and remained without representation in 1959. Similar lack of interest existed in Canada, Australia and New Zealand.

Germany.—German Communists, to whom Lenin looked for primary foreign support, failed to gain control of the constituent assembly in 1919. Their power waned after assassination in 1919 of their leaders, Rosa Luxemburg and Karl Liebknecht (*qq.v.*), not to be regained until economic disintegration increased disillusion, evidenced by an increase of *Reichstag* representation from 4 seats in 1920 to 62 in 1924, 77 in 1930 and 81 in 1933 when 12% of the popular vote was polled. Shortly thereafter Adolf Hitler suppressed the party, although it remained underground to re-emerge with military defeat and partition of Germany in 1945. With Soviet support Communists became the masters in eastern Germany. In western Germany the party was declared illegal and the declaration was upheld by the constitutional court in 1954.

Italy.—Italian Communists won 18 parliamentary seats in 1921 but were suppressed by Benito Mussolini after 1924, not to reappear until after Italian military defeat in World War II. Their Moscow-trained leader, Palmiro Togliatti, chose to work in a leftist popular front which polled 40% of the vote in 1948. Thereafter the Communists remained a strong force to be reckoned with by Italian governments.

France.—French Communists under Maurice Thorez joined in 1934 with Socialists and Radical Socialists to create a leftist popular front to oppose rightists. This grouping won the 1936 elections to make the Socialist, Léon Blum, premier for a year; the Communists refused ministerial portfolios but promised cooperation and parliamentary support. On Blum's fall, Radical Socialist leadership eliminated the Communists from the coalition. During wartime occupation by Hitler, but only after his attack upon the U.S.S.R. in 1941, French Communists participated vigorously in the resistance. Playing upon the good will thus won, the Communist party emerged in liberated France as one of three major parties, evidencing power to make or break Socialist and Popular Republican governments by withholding votes. Ministerial posts were held occasionally in 1957, but after the electoral victory of Gen. Charles de Gaulle's party in 1958 and reorganization of the electoral system to exclude proportional representation, Communist strength dropped to ten seats in 1960. Nevertheless, the party remained a strong opposition.

China.—The Chinese Communist party was organized in 1921 with the help of Russian advisers, assuring incorporation of the Russian party's organizational principles in the rules of 1924. Seeing no hope of independent influence, Communists co-operated with Sun Yat-sen's Kuomintang party, but on his death in 1925 opposition from Sun's right-wing heirs developed into an open break in 1927. Under Chiang Kai-shek's leadership the Kuomintang formally outlawed the Communist party. Mao Tse-tung (*q.v.*), one of the 1921 founders, withdrew to interior China to establish a rural soviet, the basis for his subsequent rise to power as unquestioned leader in 1935.

Mao, concluding that Communist hegemony was impossible in the cities, developed the tactic "to encircle and subsequently to seize the cities occupied by the counterrevolution, by means of armed, revolutionary rural districts," thus providing the basis for the Chinese innovation of "agrarian Communism." As Communist military strength grew rurally, the Kuomintang attempted annihilation campaigns but without success until 1934 when they forced the Communists to retreat on the historic "long march" to northern Shensi. From there Mao launched the Anti-Japanese National United Front in 1935, designed to win popular support.

Mao effectively aroused the commander of the Manchurian army against Chiang's anticommunist policy in the face of Japanese aggression. Chiang was kidnapped by the Manchurians in 1936 but his life was spared, reputedly on Moscow's intervention and on condition of a new truce between the Kuomintang and the Communists. Although the Red Army was nominally incorporated in Chiang's army, it was actually left intact, and an emissary was sent to Chiang's capital for liaison. During the Chino-Japanese War, 1937–45, both sides continued to jockey for power. Armed clashes occurred, the most serious being in Jan. 1941. Political stalemate resulted.

Mao intensified party discipline to prepare for seizure of power following Soviet entry into the Japanese war and the gradual demoralization of Chiang's regime. In 1947 the Communist "People's Liberation Army" launched full-scale war upon Chiang while the Communist party sought popular support with a land reform program that distributed to tenants and poor farmers the lands of landlords in areas under its control. On Oct. 1, 1949, the Communists, having been victorious on the mainland, proclaimed the People's Republic of China in which the Communist party became the dominant political factor, although it organized minor subservient groups, called political parties, to unite intellectuals and small-scale capitalists in support of Communist policies.

United States.—Communism emerged in the U.S. only after Russian Communists encouraged left-wing elements to separate from the Socialist party in 1919 and to imitate Moscow by creating a Communist party. After subsequent dissention had splintered the party and deportation from the United States had removed some of its noncitizen leaders, Moscow ordered creation in 1921 of an open party to operate legally. Thus emerged the Workers' Party of America, but the Communist party was continued as a secret group until 1923 when Moscow ordered its complete elimination. Factional intraparty conflict, which became characteristic of the party, continued in the legal party, requiring Moscow's intervention to restore party discipline in 1929. A Communist party of the United States was then recreated as an avowed section of the Communist International.

Dissolution of the communist international by Moscow in 1943 to curry favour with western democracies in the joint war against Hitler's Germany required reorganization of its U.S. affiliate. The Communist party's constitution, in its revised form that had been adopted in 1938, contained no statement of relation to Moscow. The party sought to associate itself in the public mind with American democratic traditions. This trend toward masking the party's revolutionary role and its Moscow orientation was accentuated with adoption in 1940 of the Voorhis act requiring registration of organizations subject to foreign control. To escape the law's provisions the party adopted a new and less militant constitution and went so far as to re-form in 1944 into what was called a "political association," having as its stated aim collaboration within the historic U.S. two-party system for victory in the war.

Defeat of Germany and Japan in 1945 brought an immediate change for the U.S. Communist party on orders from Moscow. The mask of political association, which had proved effective in recruitment of politically uninformed Americans during the period of wartime collaboration with the U.S.S.R., was put aside. The Communist party of the United States was re-created, but its constitution sought to avoid anticipated distrust on the part of U.S. patriots by retaining the earlier espousal of democratic traditions. Revelation of the excesses of Stalin's personal dictatorship over the Communist party of the Soviet Union, following his death in 1953, caused many resignations from the party, as did mounting exposure of party aims by U.S. scholars and public associations and enactment of restrictive legislation. Membership fell to 8,000 according to a 1958 estimate of a congressional committee.

Following revelation of Communist infiltration of the federal bureaucracy and in the heat of hostility against Communist China during the Korean war the McCarran act was enacted in 1950. It made criminal "knowingly to combine or conspire with others to perform any act which would substantially contribute to the establishment within the United States of totalitarian dictatorship, the direction and control of which was to be vested in any foreign government, foreign organization or foreign individual." Laws of similar intent were enacted in some states. Communists were excluded thereby from the school system as teachers, from foreign travel and from labour union leadership without disqualification of their unions from the protection of the Taft-Hartley act. Some state laws denied them the right to run for elective office. By an act of Aug. 24, 1954, the Communist party was further hampered, and it claimed that it had been "outlawed."

Communist party senior officials were convicted in 1949 under the Smith act of 1940, and the U.S. supreme court upheld the

convictions. The 1940 act made it a criminal offense to advocate overthrow of any government in the United States by force or violence. Subsequent convictions elicited a clarification from the supreme court in 1957 that teaching and advocating forcible overthrow of the government were not punishable under the Smith act so long as such teaching and advocating were divorced from the effort to instigate action. Enforcement of state anti-sedition laws was nullified by a supreme court decision in 1956 declaring a Pennsylvania statute an unlawful assumption of authority in a field pre-empted by the federal government.

The effect of the 1954 "outlawry" remained unclear as no judicial review of the statute occurred immediately and the Communist party ceased to run candidates. The Communist party continued however to hold congresses. The 17th was held in 1959 and elected William Z. Foster as chairman emeritus, Eugene Dennis as national secretary and Gus Hall as general secretary.

A long legal battle by the U.S. Communist party against the registration requirements of the Subversive Activities Control act of 1950 ended in 1961 when the U.S. supreme court upheld the act. The party nevertheless refused to register and it was reported that all but a few of its leaders went underground to avoid prosecution.

Moscow Influence.—Formal evidence of Moscow's influence on Communist parties throughout the world appeared and disappeared over the years. After dissolution of the communist international in 1943 there was a gap until 1947 when a Communist Information bureau was established but it was dissolved in 1956. In 1957 a declaration of unity of purpose was signed by most Communist parties in Moscow, and thereafter an international monthly organ called *World Marxist Review* appeared in various languages to give credence to the conclusion by a committee of the U.S. congress that there had been revival of ideological leadership and perhaps more even though there was no formal organization comparable to the communist international.

Program.—Communist parties in all countries base their programs upon the general principles set forth by Karl Marx and Friedrich Engels in the *Communist Manifesto*, 1848. In adapting these principles to their various needs, the parties have taken into consideration the special economic and political conditions existing in the countries in which they have been active. Programs changed from time to time as conditions changed, but the ultimate objective remained the same.

The bolshevist faction of the R.S.D.L.P., appearing at the congress of 1903, prepared a program which was redrafted after the Russian revolution of 1905 to incorporate the experience of the party. It was revised again in 1919, following the practical experience of the party in governing the new state. The 1919 revision remained the program until Joseph Stalin's death in 1953, although it became considerably out-of-date with the achievement of many of its objectives. It analyzed the capitalist system of economy in Marxist terms and heralded the liberation of society from recurring depressions and oppression by social revolution, brought about by the dictatorship of the proletariat, and its vanguard, the Communist party. It set as the aim of the party the realization of the highest type of democracy, and declared this as requiring a continually rising standard of culture, organization and activity on the part of the masses. It expressed its firm belief that the cornerstone of such progress was the principle of state ownership of the means of production—the land, forests, waters, subsoil and industry; as well as transportation, banking and trading instrumentalities.

Equality of all nationalities was demanded and the federative system of organization favoured. Even political separation was regarded as a right, but the party was directed to consider such requests in the light of which class expressed the desire for separation and the level of historical development of the nation. Separation had to be a progressive step to receive party sanction.

Jurisprudence was to represent class interests. Courts were to be simple and accessible to the population, and judges to be elected from the working masses and only by the working masses. In the absence or incompleteness of decrees, judges were to be guided by Socialist conscience. Sentences were to be designed to rehabilitate rather than to punish. The school was to be made an instrument for Communist regeneration of society. It was to transmit to the semiproletarian and nonproletarian sections of the toiling masses the intellectual, organizational and educational influences of the proletariat in order to educate a generation capable of establishing communism. The immediate aims included the introduction of free and compulsory general and technical education for children of both sexes to the age of 17, use of the local native language in instruction, preparation of a staff of teachers imbued with the the ideas of communism, removal of all religious influence, spreading of a system of self-education, making all universities accessible to those desiring advanced work, opening of art museums and the development of propaganda of Communist ideas on a wide scale.

Separation of church and state was favoured, together with an ultimate aim of liberation from religious superstition, without offending the religious susceptibilities of believers. An economic base of state ownership of the means of production was demanded. Emphasis was placed upon labour unions as the organizing apparatus of socialized industry, and as a means of establishing a new Socialist discipline. Agriculture was to be organized on a Socialist base through communes, state farms and assistance to co-operative farming societies. Private trade was to be replaced by distribution through co-operatives. Banking was to be a state monopoly. It was appreciated that money would not be abolished, but its use was to be reduced. A progressive income and property tax was favoured, with ultimate financing of the state by income from the various state monopolies. Housing improvements, protection of labour by progressive labour laws, social insurance and expansion of public health were also advocated.

China's Communist party's program was frequently modernized in contrast to the Soviet party's long-unchanged program. In its 1956 version the Chinese party demanded application of Marxism-Leninism in a flexible and creative way, developing theory by integrating what it called the universal truths with China's revolutionary practice. Emphasis was placed on industrialization, on modernized agriculture, communications, transport and national defense, as essential to consolidation of what was called China's people's democratic dictatorship based upon centralism and with reverence for discipline.

The Communist party of the United States declared in the 1957 preamble to its constitution that it was a working-class political organization based upon the principles of scientific socialism. It claimed to champion against capitalist exploitation and oppression the fundamental interests of the workers, farmers, the Negro people and others who labour by hand and brain. It called for common ownership and operation of the national economy under a government of the people led by the working class and declared that it based its theory particularly on the principles of scientific socialism as developed by Marx, Engels and Lenin.

The Yugoslav Communist party under Tito's leadership incurred Moscow's anger by adopting a program in 1958 deviating from traditional Moscow theories. It denied the absolute necessity of revolution to achieve power for the working class in non-Soviet states; it envisaged working class assumption of power through democratic processes as capitalism decayed and entered into a phase called "state capitalism." It also rejected as dogmatic Moscow's concepts of the steps necessary to transform society in a state under Communist party control to a condition of complete communism.

Rules.—Membership requirements and party structure were defined for each Communist party by its constitution or "rules." The Soviet party's rules provided the model. In their revised form of 1952 the party was declared, in continuation of concepts established by Lenin in 1905, to be a unified, militant organization held together by conscious discipline. Any deviation from the program or rules, any violation of discipline or any organization of factional groupings was cause for expulsion. Freedom of discussion within party organizations was guaranteed, but only to individuals. No prior arrangement with others to support a particular view in meeting was permitted. No strengthening of a resolute minority by organization of a voting bloc was to be per-

mitted by the majority when a matter was introduced for discussion. Attempts to organize such blocs were made, but when discovered and overcome, their organizers were frequently expelled from membership.

Decisions taken by party groups were made binding on all members. No lobbying for reversal and no public speeches in opposition were permitted. An opportunity to criticize had to be awaited when the matter was reopened for discussion. Punishment for violation of discipline ranged from mild admonition through public censure, temporary removal from party or government office to expulsion. If the act causing expulsion could be identified as criminal under the laws of the state, prosecution by state officials followed. The party assumed no power to order punishment more severe than expulsion. Consequently, Stalin's severest political critics were accused of conspiracy to overthrow the Soviet state to make possible conviction and execution for commission of crime.

Membership was not easy to attain by the 1952 rules. All candidates, except for persons who were members of other political parties before the Revolution, were required to present recommendations from three party members of not less than three years' party standing. Mere social acquaintance was not reason for recommendation. Support of the applicant had to spring from association at the candidate's place of work. Recommendations could not be given lightly since the rules declared that those who recommended applicants were responsible for the good quality of their recommendation. This meant that a supporter might lose his own membership if his candidate proved undesirable for reasons which could have been known prior to his admission to membership. Former members of other political parties before the Revolution were required to provide two recommendations from persons who had been party members before the Revolution and three recommendations from party members of at least ten years' standing. Admission of such a candidate was further restricted since the ratification of the central committee of the party was required. All applicants accepted for membership were required to spend one year as candidates before final admission to membership. During the probationary period they were required to study and perform assignments designed to determine their ability, performance of orders, discipline and self-sacrificing willingness to place everything in a position secondary to party demands. Applicants for admission to membership were required to be at least 18 years of age.

Admission to membership in Communist parties outside the U.S.S.R. was also made difficult. While requirements varied, the principle was recognized that the membership must be composed of devoted persons willing to work vigorously for party objectives and prepared to accept party discipline. In non-Soviet countries rewards were few for members of the Communist party. For this reason it was not necessary to guard against admission of persons seeking successful public careers to the same extent as in the U.S.S.R.

This difference in requirement was reflected in provisions permitting resignation from membership in the parties in China and the United States. In the U.S.S.R. resignation was implied as a possibility but not specifically stated as a right. In practice resignation was discouraged and a desire to resign was treated as indication that a member had become hostile to party aims and unqualified for leadership of any kind.

Structure.—Organization of Communist parties was everywhere hierarchical, there being an organization for the state as a whole, several intermediate bodies at provincial and county levels and primary organizations at the bottom. Each level sent representatives to the next higher level. No direct election of representatives to the supreme congress was provided. Under the 1952 rules of the party in the U.S.S.R., the party's organizations were created as separate from the organizations of the state, but they paralleled them in most instances. There were organizations for the union as a whole, for each of the republics (except for the Russian republic where a co-ordinating bureau existed) and for provinces, counties and large cities.

The All-Union Congress with its central committee and auditing commission was placed at the top of the Soviet party hierarchy. Convened in regular session every four years or in special session on demand of one-third of the previous congress's membership, it had limited functions compatible with its large unwieldy size and brief sessions. It elected its central committee and auditing commission, approved policy decisions taken by the central committee or proposed by it, and approved amendments presented by the central committee to the party program or rules.

The central committee carried the major burden of party work in its meetings, required at intervals of not more than six months. It named members of its three agencies designed to sit in perpetual session. The first, called the Politburo prior to 1952 and thereafter the presidium, directed the work of the central committee and was in fact the initiator of party policy. The second, the secretariat, appointed the men to execute policy at lower levels and conducted the paper work of the party. The third, the commission of party control, verified fulfillment of party decisions and instituted disciplinary proceedings against violators.

The secretariat proved under Stalin to be the seat of power, for it was from here that he launched his campaign after Lenin's death in 1924 to establish himself as dictator by appointing loyal supporters as party functionaries throughout the party. On Stalin's death his heirs resolved publicly to direct the party as a collective leadership functioning through party procedures, but no institutional change was made. By 1957 Khrushchev from the position of first secretary had established dominance, but he ruled with less severity than Stalin, perhaps because the expanding ranks of educated specialists and technicians made necessary by industrialization of the economy created pressures preventing recurrence of Stalin-type purges in which large numbers of the new technical experts had been imprisoned and even executed on allegations of treason or sabotage.

Party organization at intermediate levels corresponded to that at the top. There was a periodic meeting of delegates from below, organized as a congress, and also an executive committee and a secretariat. At the bottom membership was grouped in primary party organizations, sometimes known as "cells," stemming from the instruments designed prior to the Revolution to infiltrate and undermine the tsar's government. These cells were organized in factories, villages, collective farms, educational institutions and units of the armed forces.

Intermediate level party organizations were directed to execute the centre's decisions by publishing a local press, and by organizing, explaining, assembling and crystallizing opinion for transmission to higher organizations.

The U.S. Communist party under its 1957 constitution was organized on the basis of "clubs" created in industries, shops, towns and electoral districts. All clubs in a state comprised the state organization, which created necessary subdivisions in counties, cities, regions or sections. Thickly populated states might be split into districts, each with state organizational status, while thinly populated states might be grouped in one district with state status. A national organization united all state and district organizations.

Each club elected annually by secret ballot an executive committee and officers, all being subject to removal by majority vote of club members. A state or district organization comprised a convention of delegates chosen by subdivisions to meet every two years and a committee to meet quarterly similarly chosen, but subject to confirmation by the convention. Representation on both bodies was proportional to party membership in the group represented. The convention might add to the committee up to one-third more members at large, thus retaining power over the committee, but the committee might dismiss convention officers by affirmative two-thirds vote. The national organization was similarly composed of a convention and committee but also had a smaller executive committee including officers. Executive committee members were chosen from among those who had been party members for five years.

Supporting Organizations.—The youth of the Soviet Union has been influenced by the party through three youth organizations, specializing in young people of three age groups. These organi-

zations were given the names of the All-Union Leninist Communist League of Youth, known as Komsomols, the Pioneers and the Little Octobrists.

The Komsomols were organized in 1918 with a membership of young people who had banded together in youth organizations during the revolutionary months of 1917. Many had fought in the Red guard. While only 22,000 members were represented at the organizational meeting, the number grew to 400,000 in 1920, when it began to fall. After the civil war ended there was no further necessity of military activity among the youth, and the Komsomols lost their purpose for existing. In 1922 a new purpose was established. The organization was directed to engage its members in health, sport, education and publishing activities. It was also directed to aid in mobilizing youth to take part in special industrial projects. The best known of these were the construction of the city of Komsomolsk-on-Amur in the far east and the Moscow subway project. With this new appeal membership rose from a combined total of members and candidates in 1924 of 632,000 to approximately 6,000,000 on the eve of World War II and 18,500,000 in the mid-1950s. Membership in the Komsomols was opened to young people of both sexes from the ages of 14 to 26.

The Pioneers were designed for children between the ages of 10 and 15. Admission was made easy, for any child could be admitted to candidacy, without regard to his or her social class and without recommendations. Two months were required as a candidate. Members were to be organized in brigades, attached to the local Komsomol cell. One member of this cell was to be the brigade leader.

The organization for very young children, called the Little Octobrists, was re-created in 1957 to provide politically directed recreation for children prior to entry into the Pioneers. It had been abolished during wartime disruption of preschool education, and its functions absorbed in part by the Pioneers and preschool teachers.

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COMMUNITY CHEST, a term used largely in the U.S. to describe a voluntary organization of social welfare agencies in a community. Its general functions are (1) to raise funds each year, by community-wide appeal, for local voluntary social welfare and health agencies and to distribute those funds in accord with a mutually agreed upon budget procedure; and (2) to promote the social welfare and health of the community by coordinating existing programs and improving standards of social work, preventing duplication, conducting research, administering common services and developing better public understanding and support. In many cities the community chest has expanded its scope to become a "united fund," which may include in its annual campaign funds not only for local services but also for national causes, such as the American Red Cross, heart and cancer research, and aid to crippled children. Allied with the community chest in many cities is a central health and welfare planning body, the community welfare council (or council of social agencies), which may include in its membership both governmental and voluntary agencies.

Denver, Colo., had the first joint financial campaign for its social agencies in 1887, but the Cleveland, O., Federation for Charity and Philanthropy, in 1913, first used the community chest principle of budgeting to determine needs and resources. A national association, United Community Funds and Councils of America, Inc. (formerly Community Chests and Councils of America, Inc.), was established in 1918. (B. A.)

COMMUNITY PROPERTY, a form of marital-property ownership involving joint proprietorship by the husband and wife without a merger or impairment of their individual property rights. In the United States, eight western and southern states follow community-property practices. The concept of a community of family goods came to the U.S. through the civil law of Europe, where it had been received from Germanic sources. In five states (Arizona, California, New Mexico, Louisiana and Texas), community-property laws were an outgrowth of earlier Spanish and French colonization. In Idaho, Nevada and Washington the institution was adopted in reaction to rigid common-law practices and because of the influence of California. Wide variations among the statutes of the eight states make any reference to a single community-property system misleading. There are, however, significant contrasts between the community-property concept of dual ownership and the practices of the common law, even when the latter have been greatly altered by legislation. In the 42 noncommunity states, there are only two classes of matrimonial property, the husband's or the wife's. This means that the principal form of family property, *e.g.*, the wages or salary of husband or wife, belong to each separately. In contrast, the community states provide for a third fund of property which includes all of the gains of the marriage. Each spouse, however, may still own separate property, which is defined as property owned before marriage or acquired afterward from sources outside the marriage, *i.e.*, by gift or inheritance.

Ownership of community property is separated from its administration. The husband has larger powers of decision in the management and control of the community property. However, there are limits placed on the husband's power of disposition; powers affecting personal property are usually broader than those over real property. The common-law and equity interests of the spouses in each other's property, such as dower (*q.v.*) and curtesy or their statutory substitutes, are incompatible with community-property practices and generally do not exist in the community states. A distinction is carefully preserved between the separate property of each spouse and the family property, *i.e.*, the community property. In a majority of community states, the income or increase from any separate property remains separate. This result is derived from the language of the statutes and represents a fundamental change from the attitude of the civil law, which treated the usufruct, or gains of separate property which were used by the family, as community property even though the ownership of the separate property itself was unchanged. Strong social policy favouring the class of family property exists in the form of a legal presumption which resolves doubts about the character or origins of property in favour of community property. This presumption may be overcome only by a clear showing of the origin or character of property as separate.

The community states have enacted Married Women's Property acts much like those found in the noncommunity states. However, their main significance lies in the removal of procedural disabilities and not, as in the noncommunity states, in the granting of property rights to married women.

The efforts of several noncommunity states before 1948 to adopt community-property laws solely for income-tax purposes revealed the breadth of misunderstanding about the institution. In community states, husband and wife own the family property together. In the noncommunity states, on the other hand, the main sources of the family property, *i.e.*, the husband's wages or salary, are separate property notwithstanding the nature of the obligations discharged out of such income. In the community states, husband and wife own equal interests in each other's wages and salaries, which comprise the family property and out of which family liabilities and claims must be paid first, even though creditors may in some cases have recourse against the separate assets of one or both spouses. Generally, upon the death of either spouse the survivor continues to own his or her equal share of the community property, the other portion of the community property being subject to the testamentary disposition of the deceased spouse.

The average family lives under a community administration of family goods whatever system of law prevails. Thus the family as an economic unit is recognized. A majority of married persons in western civilizations live under formal community-property regimes either statutory or contractual in application. The laws of France, Spain, Switzerland, Quebec, South Africa, Scandinavia, the Low Countries, the Latin-American countries and the U.S.S.R., since 1922, embody community-property principles. In Germany and Sweden, recent developments have been directed toward an intermediate system combining the best features of separation and community practices. A workable legal concept of family property that takes into account the problems of divorce, administration and accounting and the liabilities of the family unit and the individual spouses is still developing.

See also WOMEN, LEGAL POSITION OF; HUSBAND AND WIFE.

(R. E. CL.)

COMMUNITY THEATRE: *see* THEATRE: *20th Century: United States: Community Theatre.*

COMMUTATIVE LAWS, in mathematics, are two laws relating to numbers, one with respect to addition and the other with respect to multiplication. The symbolical forms for these laws are, respectively, $a + b = b + a$ and $ab = ba$. Thus, they are equivalent to the statement that a finite sum or product is unaltered by reordering the terms or factors. The laws, however, do not hold everywhere in mathematics. For example, the commutative law does not necessarily hold for conditionally convergent series such as $1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots$ unless no term in the rearrangement is displaced more than a fixed number of places from its original position. Also there are numbers, such as quaternions, for which the commutative law of multiplication is invalid. The vector product obeys the law $a \times b = -b \times a$ instead of the usual law.

See also ARITHMETIC; ASSOCIATIVE LAWS; GROUPS; NUMBER: *Addition and Multiplication;* ALGEBRA. (R. W. BD.)

COMMYNES (COMINES), **PHILIPPE DE** (*c.* 1447–1511), French statesman and chronicler, whose *Mémoires* establish him as one of the greatest historians of the middle ages, was born at the castle of Renescure, in western Flanders, of a noble family. His father, the lord of Commynes (now Comines), was a knight of the order of the Golden Fleece. The godson of Philip the Good, duke of Burgundy, Philippe de Commynes was brought up at the Burgundian court and in 1464 became squire to Philip's son, Charles of Charolais (*see* CHARLES the Bold, duke of Burgundy). He took part in the war of the League of the Public Weal against Louis XI (*q.v.*) of France in 1465 and accompanied Charles the Bold on his first expedition against Liège (1466–67). When Charles succeeded to the duchy of Burgundy in 1467 he appointed Commynes his counselor and sent him as ambassador on missions to England, Brittany and Spain. In 1468 he was present at the famous meeting at Péronne when Charles had Louis XI virtually as a prisoner, and it was Commynes who negotiated an agreement between them. Recognizing Commynes' abilities as a diplomat, Louis in 1472 persuaded him to desert Charles the Bold and to enter his service as his chamberlain and confidential adviser. As Charles confiscated his property, Louis in compensation bestowed on Commynes estates taken from the house of La Trémoïlle (including the principality of Talmond and the viscountship of Thouars) and appointed him seneschal of Poitou. Moreover, through his marriage in 1473 to Hélène de Chambres, Commynes acquired other large estates, including Argenton (hence his title of sire d'Argenton). He played an active part in the signing of the treaty of Picquigny between Louis XI and Edward IV of England and in the settlement of the Burgundian succession. Louis also sent him as ambassador to Florence and to Savoy.

After Louis' death in 1483 Commynes was at first one of the counselors of the regent Anne of Beaujeu, but he intrigued against the government with the duc d'Orléans (the future Louis XII of France) and was implicated in the "Mad War" between the two. As a consequence he was imprisoned for several months and sentenced to have a quarter of his property confiscated and to be confined for ten years to his castle of Dreux. Nevertheless, he was restored to favour by Charles VIII at the end of 1489 and was one of the negotiators of the treaty of Senlis (1493) between Charles and Maximilian of Austria. Charles subsequently sent him as ambassador to Venice at the beginning of his expedition to Italy (1494–95). Although during the first years of Louis XII's reign Commynes was—contrary to his expectations—not given any position, he later helped to formulate the king's Italian policy and accompanied him on his campaign against Genoa. He died at Argenton on Oct. 18, 1511.

The Mémoires.—The first part of the *Mémoires* of Commynes, dealing with Louis XI's reign, was written during 1489–91. The second part, dealing with Charles VIII's Italian expedition, was compiled during 1495–98. Commynes, who had received little formal education and knew no Latin, was a writer of considerable talent, remarkable for his psychological perceptiveness, his sense of the picturesque and the vividness of his narrative. Despite his resentment against Charles the Bold and his admiration for Louis XI he succeeded in achieving a fair degree of impartiality. His writings are also interesting for their revelation of his political theories: he insists on the reduction of taxes, which, moreover, he thought should not be levied before they had been approved by the estates-general; and—as befits a contemporary of Louis XII, who was known as "the father of his people"—he maintains that the state should encourage the development of the country's economy. Finally, regarding history as an accumulation of useful experience, he draws examples from it for the guidance of princes and offers reflections on the destiny of states. In this respect he may be compared with Niccolò Machiavelli.

Editions of the *Mémoires* (first printed 1524, 1528 and 1552) include those by Mlle E. Dupont, 3 vol. (1840–47), by R. Chantelauze (1881), by B. de Mandrot, 2 vol. (1901–03), and by J. Calmette and G. Durville, 3 vol. (1924–25). There is also an edition of Commynes' *Lettres et négociations* by J. M. B. C. Kervyn de Lettenhove, 3 vol. (1867–74).

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(MI. M.)

COMNENUS, the name of a Byzantine family from Paphlagonia whose members occupied the throne of Constantinople for over a century (1081–1185). Its first member to appear in Byzantine history was Manuel Eroticus Comnenus, an able general who served Basil II in the east. His son Isaac I, the leader of the military nobles and the soldiery of Asia Minor, was emperor (1057–59) after the abdication of Michael VI Stratioticus, the feeble representative of the civil aristocracy. Isaac's nephew Alexius I (1081–1118), the founder of the Comnenian dynasty (1081–1185), was succeeded by his son John II (1118–43), his grandson Manuel I (1143–80) and his great-grandson Alexius II (1180–83), with whom the elder line of the family died out. Alexius II's successor, Andronicus I (1183–85), the son of John II's brother Isaac, was the last Comnenian emperor, but the family continued to play an important part in affairs of state and was allied by marriage to other ruling families such as the Angeli and the despots of Epirus. After the Latin conquest of Constantinople in 1204 Andronicus I's grandsons Alexius and David founded with Georgian help the empire of Trebizond (*q.v.;* Trabzon), which lasted until 1461, when David Comnenus, its last ruler, was deposed and executed by Mohammed II. *See* also BYZANTINE EMPIRE.

See C. du Cange, *Historia Byzantina* (1680).

COMO, a town of the Lombardy region, northern Italy, capital of Como province and an episcopal see, is located 40 km. (25 mi.) N. of Milan. It is built on a slope that rises to 663 ft. at the extreme southwestern end of Lake Como. On all but the lakeside it is surrounded by mountains. Pop. (1957 est.) 74,387 commune.

In the oldest part of the town the streets are narrow and the buildings irregularly close-packed. The city's centre is in the newer part. The modern Piazza Cavour, open to the lake on the north, divides the lakeside promenade into eastern and western sections. The tower of the Porta Vittoria or Porta Torre (about 130 ft.) is in the Roman style. Two of the oldest buildings are the church of S. Carpoforo (6th century), regarded as the first Christian church and standing on the site of a temple to Mercury,

and the basilica of S. Fedele, built in the second half of the 13th century. The church of S. Abbondio, formerly the cathedral, was consecrated by Pope Urban II in 1095.

The cathedral of Sta. Maria Maggiore was rebuilt in the 15th century and is a lovely example of the fusion of Gothic and Renaissance styles. It contains many art treasures including paintings by Bernardino Luini and Gaudenzio Ferrari and 11 tapestries by Fiandra. Near the cathedral is the Broletto (1215), the ancient Palazzo Communale, a Gothic building of gray, white and pink calcareous stone. Another medieval palace is the Palazzo Rusconi. In the Palazzo Giovio is the civic museum of archaeology with objects from the lake dwellings of lakes Como and Varese. Printing is an ancient art in Como and it was there that Baldassare di Fossato printed the *Opus statutorum* of Alberico di Rosate in 1477 and the *Vita di S. Giovanni da Capistrano* in 1479. The two Plinys were born at Novum Comum. The physicist Alesandro Volta is buried in the cemetery of Camnago and is commemorated by the Tempio Voltiano built in 1928.

Como is connected with Milan by railway and road. It is on the international Gotthard line (Milan-Lugano). The most important industry is the old-established one of spinning and weaving silk. The National Institute of Silk, with large workshops and laboratories, offers vocational training. The beautiful surroundings and mild climate, which is particularly suited to winter visits, attract a large number of tourists.

History.—The ancient Comum had perhaps a Gallic origin. It was conquered in 196 B.C. by the consul M. Claudius Marcellus. Under Julius Caesar it became a Roman colony. It was a diocese from A.D. 379, when St. Ambrose consecrated St. Felix as bishop. In the middle ages, after the struggle with the Lombards and the Franks, it became a free commune. In an attempt to regain territory lost in a war with Milan, Como took sides with the emperor Frederick Barbarossa in his struggle with the cities of the Lombard league. The emperor built the fortress of Baradello there in 1159. After the treaty of Constance, Como made peace with Milan and became a seigniory, first under the rule of Filippo Maria Visconti and then of Francesco Sforza. During this period its silk industry and wool trade played an important part in the Milanese economy. Como followed the fortunes of Lombardy and was successively under Spanish, French and Austrian rule. During the Risorgimento it was ruled by a provisional government until the defeat at Novara (1849), after which it fell once more under Austrian domination. It was liberated in 1859 by Garibaldi. In World War II Como was not liberated by the Allies until the last few days of the fighting. (M. T. A. N.)

COMO, LAKE (Lago di Como), in Lombardy, north Italy, lies 52 km. (32 mi.) due north of Milan (it is sometimes called Lario, from its ancient name of Lacus Larius). The lake has three branches, all of approximately equal length (about 25 km. or 16 mi.) projecting northward, southwestward to the town of Como (*q.v.*) and southeastward beyond Lecco (this branch being also known as Lago di Lecco), the promontory of Bellagio marking the bifurcation. It is formed by the Adda, which flows westward along the Valtellina, into the northern branch and out of the southeastern. The area is 146 sq.km. (56 sq.mi.), the surface lies 650 ft. above sea level and the greatest depth is 1,345 ft. The lake fills a remarkable depression cut through the limestone ranges that enclose it, and the northern arm once doubtless extended as far as Chiavenna, enclosing the area now covered by the lake of Mezzola. The north wind, the *tivano,* blows during the morning and the south, the *breva,* in the afternoon. The lake is associated with Virgil, the two Plinys and Claudian. The shores are bordered by splendid villas; perhaps the most lovely spot on the lake is Bellagio.

Lecco is a manufacturing town which lies toward the southeastern end of Lake Como. Pop. (1957 est.) 44,990 commune. The Ponte Grande, which spans the Adda, was built in 1336–38 by Azzone Visconti but subsequently enlarged. There is a monument to Alessandro Manzoni (1785–1873), author of the novel *I promessi sposi.* The town is also a centre for mountain climbing. Lecco is connected by railway with Colico, Chiavenna and Sondrio northward and Bergamo to the south.

Cadenabbia, at the centre of the western shore of Lake Como, is with Tremezzo (almost joined to it) a very popular holiday resort. Several of the towns and resorts on the shores of the lake, including Menaggio and Varenna, are connected by steamer services, including car ferries.

COMODORO RIVADAVIA, Argentine city located at the Gulf of San Jorge on the Patagonian coast. Pop. (1956 est.) 45,779. Founded in 1901, it is the major Argentine city south of Bahía Blanca and the centre of the national oil industry. The surrounding arid, windy plain supported only sheep prior to the discovery of oil near the port in 1907. A nationalized corporation, Yacimientos Petrolíferos Fiscales, administers the oil wells. In 1944 the city became headquarters of the Comodoro Rivadavia military district which controlled the fields. Oil tankers and a national highway link the city with Buenos Aires, and in 1949 a natural-gas line, 1,050 mi. long, was built to the national capital. A further administrative change in June 1955 made provinces of the remaining Chubut and Santa Cruz national territories and divided the district at latitude 46° S. The city and northern area were included in Chubut province; the remaining area to the cape was incorporated in Santa Cruz province. (Js. R. S.)

COMORIN, CAPE, a headland in Madras state forming the southernmost point of India. It is in latitude 8° 4′ 20″ N., longitude 77° 35′ 35″ E., at the southern end of the Cardamon hills, themselves a continuation of the Western Ghats. At the apex of the headland is Comorin village, with the temple of Kanya Kumari, the "virgin" (an attribute of the goddess Devi). This is a much-frequented place of pilgrimage which has been famous at least since the beginning of the Christian era (when it was so described by the author of the *Periplus*). (L. D. S.)

COMORO ISLANDS (French Territoire des Comores), a group of volcanic islands at the northern end of the Mozambique channel, lie roughly halfway between the Malagasy Republic (Madagascar) and the African mainland in latitude 11° to 13° S. After 1947 the islands were an overseas territory of France. Pop. (1958) 181,288. Area 832 sq.mi.

Physical Geography.—From southeast to northwest the islands are: (1) Mayotte (144 sq.mi.), which has a basalt plateau rising to 2,165 ft. and a coastal plain on the west. Mayotte is partly encircled by an irregular coral reef, within which are the islets of M'Zambourou and Pamanzi. On Pamanzi is Dzaoudzi, the capital of the group. Opposite it on the main island is the port of M'Sapéré. (2) Anjouan (164 sq.mi.) is a triangular island rising centrally in a volcanic massif (M'Tingui) reaching 5,177 ft. Mutsamudu on the northwest coast is its chief town. Pomoni on the south coast is an anchorage formerly used by British warships for coaling. (3) Mohéli (81 sq.mi.), the smallest of the group, is a basalt plateau about 1,000 ft. high, ending in the west in an escarped ridge reaching 2,592 ft. Its chief towns are Fomboni on the north coast and Nioumachoua in the southwest. (4) Grande Comore (443 sq.mi.), the largest and loftiest island, rises near its southern end in the dome-shaped active volcano of Kartala (7,746 ft.). In the north many truncated conical volcanic peaks rise from a plateau of about 2,000 ft. In the southwest is Moroni (pop. [1958] 6,448) and on the north coast the town of Mitsamiouli.

Climate.—The tropical climate has two clearly marked seasons: a fresh, dry period between May and October and a hot, humid season between November and April. In November the onset of the monsoon (*cascassi*) brings the highest temperatures (Dzaoudzi, average minimum in December, 82° F.). The highest rainfall occurs in January (11–15 in.) and the summer also bring cyclones, often accompanied by waterspouts and damaging tidal waves. During the winter the temperature falls with the southeast trade wind (*coussi*), reaching a minimum in July (Dzaoudzi, 73° F.). The annual rainfall varies between 39 and 118 in.

The hydrology of the islands is of importance, especially on arid Grande Comore. Rain sinks so deeply into the lavas and porous rocks that wells (*foumbous*) deep enough to reach the water table can be sunk only in the coastal lowlands, where the water obtained is brackish. Hence most of the supplies for Grande Comore and Dzaoudzi are drawn from reservoirs filled in the rainy season. In the other islands it is possible for streams to form

on the decomposite basalt lavas and wells can be sunk.

Vegetation and Animal Life.—The character of the vegetation varies with height and degree of exposure to the wind. Only about 16% of the land remains covered with the primitive forest. A coastal zone of mangroves is followed by one of coconut palms, mangoes and bananas up to about 1,300 ft., above which the forest zone (mahogany, rosewood, tacamahac) rises to about 5,900 ft. On the highest peaks only broom, heather and lichens grow. The animal life is allied to that of Malagasy rather than to the mainland of Africa; it includes some land birds and a lemur peculiar to the islands. Turtles abound along the coasts and are exported. In the 1950s a number of specimens of the primeval coelacanth (*q.v.*) were caught in the surrounding waters.

History.—The Comoro Islands were shown on Diogo Ribero's world map of 1527 but the first European to visit them appears to have been the British mariner James Lancaster about 1591. The dominant influence and civilization in the islands was then and for long afterward Arab. In 1843 France took possession of Mayotte and in 1886 the sultans of the other three islands were placed under French protection. In 1914 the group was subordinated to the governor general of Madagascar and in 1925 was given its own local administration; in 1947 it became an overseas territory of France. In a referendum held in 1958 the Comoro Islands voted to retain overseas territory status. In 1960 they were granted internal autonomy.

People.—The people are of diverse origins. Malay immigrants and Arab traders have mixed with Sakalavas and other Malagasy tribes and with various African peoples brought in as slaves. The most important community are the Antalaotra, who are of mixed origin and are most numerous in Anjouan (hence their incorrect name Anjouanais) and Grande Comore. Most of the people are Shafi'i Muslims living in single-story whitewashed stone houses surmounted by a terrace for prayer. They converse mainly in Arabic; Swahili, the language used for commerce, has been transcribed into Arabic characters. In the late 1950s there were in the islands 35 elementary schools with more than 2,500 pupils, 1 secondary and 1 technical school. Of the population, about half live on Grande Comore and about one-third on Anjouan. There are about 1,000 Europeans.

Economy.—The lack of pasture and of flat cultivable land calls for a large importation of foodstuffs. Subsistence agriculture on small plots shaded by coconut palms or fruit trees and tilled on a family basis yields cassava, sweet potatoes and other vegetables; some mountain rice is grown. There are about 25,000 goats and about 10,000 cattle. European plantations dating from the early 19th century first cultivated sugar cane; this was supplanted in the 20th century by vanilla, to which were added perfume plants (ilang-ilang, citronella, bitter orange, basil). Later, coconuts, coffee, cocoa and (in Anjouan and Grande Comore) sisal were cultivated. The plantations, which cover 35% of the total area, are mostly managed by companies which also own trading posts, sawmills and soap and oil factories. There are three hydroelectric power plants.

The plantations, while providing a living for part of the population, do not succeed in balancing the economy, and the value of imports substantially exceeds that of exports. Emigration is extensive, and in 1956 alone about 40,000 persons emigrated to the Majunga province of Malagasy.

Regular shipping services call at the islands, all four of which are linked with Majunga by daily air services. In the 1960s there were about 400 mi. of roads.

See C. Robequain, *Madagascar et les bases dispersées de l'Union Française* (1958); H. Isnard, "L'Archipel des Comores," *Cah. d'Outremer*, vol. vi, pp. 5 ff. (1953). (J. D.)

COMPACT, INTERSTATE. The compact is one of many methods, ranging from informal administrative agreement to judicial settlement, for achieving interstate co-operation and adjustment within the federal system of the United States.

Authority for the states to compact with one another is contained in art. i, sec. 10 of the United States constitution, which provides that "No State shall, without the Consent of Congress, . . . enter into any Agreement or Compact with another State, or with a foreign Power, . . ." The history of the compact, however, predates the constitution by well over 100 years, and several such agreements were concluded during the colonial period and under the Articles of Confederation, from which the present compact clause was derived.

The compact possesses several distinguishing characteristics. It is a formal contractual agreement between states that takes precedence over ordinary state statute, usually receives congressional consent and is enforceable in the United States supreme court. While the exact wording of the compact clause would indicate that congressional consent must always be obtained, judicial construction has to some extent modified this provision. Beginning with the decision in *Virginia* v. *Tennessee*, 148 U.S. 503 (1893), the court held that consent may be implied where subsequent acts of congress have recognized action taken under provisions of the compact. In the same decision the court also said that only those agreements that affect the political balance of power within the federal system must have congressional consent.

Prior to the 20th century the interstate compact was used infrequently and for limited purposes such as the determination of boundary lines and criminal jurisdiction over boundary waters. In 1921 creation of the Port of New York authority established by compact the first joint administrative agency of a continuing nature. One year later the Colorado River compact, which provides for allocation of waters among the upper and lower basin states, marked the first use of a compact to meet common problems on a regional basis. It also marked the beginning of a series of water allocation compacts in the western states. With the formation of the Interstate Compact to Conserve Oil and Gas in the mid-1930s, which provided for membership of all oil-producing states, the use of the compact transcended the regional level. The Interstate Compact for the Supervision of Parolees and Probationers, also drafted in the 1930s, sought and finally achieved the co-operation of all the states in a joint administrative operation. After that time the compact device was used increasingly on a regional and national basis to provide interstate co-operation in a variety of fields including conservation, control and use of natural resources, provision of welfare and correctional facilities, education, law enforcement, mental health and civil defense.

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COMPAGNI, DINO (*c.* 1257–1324), Italian historiographer, the value of whose work owes much to his personal experience of politics, was born in Florence of a substantial family of the *popolo* (*see* FLORENCE). Well educated, he was enrolled as a master in the silk merchants' guild in 1280 and rose to be one of the priors of the *signoria* (1289), gonfalonier of justice (1293) and prior again (1301). In 1301, however, the Black Guelphs, with the help of Pope Boniface VIII and Charles of Valois, overthrew the White Guelph faction to which Dino belonged. He then withdrew from public affairs.

Dino's *Cronica delle cose occorrenti ne' tempi suoi* is valuable for its detailed analysis of the events between 1280 and 1312 in which he and Dante lived and for its revelation of the author's character—a loyal citizen and a devout Christian. First published by L. Muratori (1726), it was edited by I. del Lungo, *Dino Compagni e la sua Cronica*, 3 vol. (1879–87; Eng. trans., *The Chronicle of Dino Compagni*, 1906). The authorship of an allegorical poem in Provençal, *L'intelligenza* (ed. by V. Mistruzzi, 1928), generally ascribed to Dino, is sometimes contested.

COMPANY, the name given in the United Kingdom to incorporated groups of persons; *i.e.*, a number of persons considered as a legal entity or fictitious person with property, powers and liabilities separate from those of its members. In British usage the term denotes the historic chartered companies of the 17th century as well as the modern industrial and commercial organizations. In the United States the latter are commonly called corporations, a term that is used in Great Britain chiefly to refer to noncommercial organizations. (*See* CORPORATION.) The terms company and corporation are often loosely used interchangeably

This article will trace the economic and legal development of the modern limited-liability company which carries on its business for the purpose of profit in England. For further discussions of specialized types of company *see* BANKING; CHARTERED COMPANY; INSURANCE; FRIENDLY SOCIETY; PARTNERSHIP; and SAVINGS AND LOAN ASSOCIATION.

HISTORY

Medieval Period Until 1500.—The concept of incorporation has been of the greatest importance in the development of trade and industry. The idea of the *persona ficta*, taken over from Roman law by the canon law, was accepted by the common law at first in connection with ecclesiastical bodies and later with other bodies of which the boroughs and guilds were the most important. By the 15th century the common law classified corporations into the corporation sole (ecclesiastical offices such as bishop or vicar but also including the crown) and the corporation aggregate (incorporation of a group of persons). Incorporation generally required a grant from the crown under the royal prerogative, but it was accepted in this period that incorporation could also be conferred by statute. Control was thus kept over various associations of persons which might threaten the state's power. Although there was little legislation on the subject, certain fundamental characteristics of incorporations began to emerge from case law. A corporation is a person in law distinct from its members, and it holds its own property distinct from theirs. The individual property of members cannot be taken to pay the debts of the corporation and vice versa. In matters of conveyance and contract the corporation is bound only if its seal is affixed, except in matters of small importance. There was, however, little tendency to work out logical deductions from these principles and further development was slow. It depended more on expediency than on principle and had little connection with the early forms of commercial association—the guild (*q.v.*) and the medieval contract of partnership.

The guild was a close association of members of a trade bound together for purposes of mutual aid and protection, the benefits of the associate being often enhanced by trading rights and privileges granted by the state. Sometimes the guild would undertake a joint transaction but usually this was left to individual members who might be grouped together in trading partnership. The trading communities of the middle ages spread from Italy and produced two forms of such partnerships. One, the *commenda*, was an early form of limited partnership, in which a financier lent capital to his active partner, his liability being limited by the amount of such capital. This form did not take root in Britain although it flourished on the continent and later its example became an important argument in the struggle for limited liability. In its earliest days, the *commenda* was regarded as a purely temporary arrangement for trading purposes. The *societas* was a more permanent association, linked by the same idea of brotherhood that permeated the guilds, and English law soon established the principle of the unlimited liability of each partner to creditors. Such a form of association is suitable only for a small number of active partners but, owing to the difficulties in obtaining incorporation, this form later became the basis upon which lawyers provided, with the help of the peculiarly English doctrine of the trust, an unsatisfactory although workable approximation to incorporation.

The earlier form of chartered company, the regulated company, developed from the trade guild. It dealt mainly with overseas trade and its members traded on their own account. The *societas* not only influenced the later form of the regulated company, the incorporated joint-stock company, but also formed the basis for the unincorporated joint-stock company.

1500–1720.—The great growth of the chartered company, incorporated by royal charter for the regulation and development of foreign trade, took place in the 16th century. Permission to incorporate depended on government policy, including questions of regal revenues, and trading monopolies and privileges. At first each member traded with his own stock and such associations were known as regulated companies, but later a common or joint stock was formed in which members had transferable shares. In the later part of this period, due to difficulties in obtaining a charter (especially for internal trade), unincorporated joint-stock companies were also created. These could be formed only on the basis of an enlarged partnership, despite its legal defects. Commerce and industry became established upon a capitalist basis, with a banking and credit system and a market in shares and stock. The wealthier classes, seeking to invest their capital, came into association with merchants and entrepreneurs. The foundation of the Bank of England in 1694 was of great importance, for it was carried out on the joint-stock principle. The individual loans from financiers to the government were changed into the joint stock of the new bank on the incorporation of the lenders. The bank held government securities upon which it could create credit.

By the end of the 17th century enough joint-stock companies had been formed to give rise to the specialized trade of stock-broking. The boom years of 1692–95 were followed by a slump in 1696, when the government intervened to regulate the brokers and check gambling. Despite this warning, promotion of companies, trafficking in charters and speculation in shares increased, revealing the fact that the law was incapable of stopping rash or even fraudulent promotions. Such uncontrolled speculation culminated in the speculative boom of 1719–20 and the disaster of the South Sea Bubble (*q.v.*). The South Sea company had taken over the national debt of about £31,000,000 and thus established a fund of credit for its grandiose schemes. Although the terms were unfavourable, the government's approval of the scheme (secured by bribery) and the glowing prospects of expansion of trade encouraged a general speculative mania. Panic-stricken, parliament intervened and passed the Bubble act (1720), an exceptionally ill-drafted measure whose most important provisions were never clarified although the act was not repealed until 1825. It purported to make action as a corporate body and the raising of transferable stock illegal, unless with specific legal authority. Acting under obsolete charters was also made illegal, but there was a declaration that nothing should prevent the carrying on of trade in partnership in accordance with the current law. Immediately ensuing prosecutions under the act and its uncertain effect brought about a general crisis in which many companies were destroyed.

1720–1825.—The result of the crisis was to discredit the unincorporated joint-stock company and until the 19th century official opinion remained hostile to incorporation by charter or statute, except for public services such as banking, canals, water supplies and fire and marine insurance (*see* PUBLIC UTILITIES). This view found support in a well-known passage in Adam Smith's *Wealth of Nations* (1776). It seems probable that the economic effect was not large although industry must have been deprived of some capital which would otherwise have been available to accelerate the onset of the industrial revolution. Thus, faced with the impossibility of obtaining incorporation by statute or charter, and sheltering under the very uncertainty of the Bubble act, businessmen and lawyers combined to re-establish unincorporated joint-stock companies. Ingenious legal use was made of the trust in combination with partnership, and many joint-stock companies were formed by means of deeds of settlement. Under such a deed the subscribers agreed to be associated in a company with a joint stock divided into transferable shares. The deed appointed trustees in whom the property of the company was vested, and who were authorized to sue for wrongs to such property. In this way some of the procedural difficulties of suing could be avoided. Sometimes the deed provided that members were not to be liable beyond the amount of their shares for the company's debts, although such a provision was almost certainly not valid in law. However, practical immunity from creditors seems to have been secured through the procedural difficulties involved in suing a fluctuating body of members.

Many such companies were founded before 1800, mainly for insurance. After a minor prosecution in 1723 no further actions under the Bubble act were undertaken until 1807 (*R* v. *Dodd*). The court dismissed the case, on the ground that there had been no major prosecutions for 87 years, but warned that for the future the act could not be ignored; the main question of illegality was

left undecided. From the subsequent confusing litigation it emerged that a limited power of transfer of shares was legal, and the decision whether or not the association was beneficial to the public and outside the mischief of the Bubble act was a question of fact for a jury. Incorporation remained difficult to obtain but by way of compromise an act was passed allowing unincorporated companies to sue and be sued in the name of a principal officer, a privilege expensive to obtain and therefore denied to most companies.

During the boom of 1824 the inadequacies of the law allowed promoters to make quick profits from a gullible public, and the undoubted abuses gave strength to the old arguments against joint-stock enterprise. Parliament repealed the Bubble act in 1825, making no attempt to regulate joint-stock companies and leaving the legality of joint-stock companies as a question for common law. However, pressure of economic demand for the joint-stock form was sufficient to offset the legal doubts and the hostility of the authorities. Formations at this time included 74 mining companies, 29 gas, 20 insurance, 54 canal and railroad, 67 steam navigation, 11 trading, 26 building, 24 provisions and 292 miscellaneous companies.

1825–1856.—The slump of 1826 led to the disappearance of most of the companies promoted in 1824. According to one estimate, 624 companies had been formed with a total capital of £372,000,000 of which only 127 survived until 1872; 136 companies formed before 1824 also survived the slump but many of these were canal, gas and insurance companies.

As the industrial revolution gathered momentum, freedom to incorporate with limited liability (subject to suitable safeguards) became even more urgently needed. Official, and even a preponderance of commercial, opinion remained bitterly opposed to reform on the grounds that a sound economy must be based on private enterprise with unlimited liability, except in the case of public utilities, and that joint-stock companies sapped enterprise, tended to monopoly and encouraged rash speculation and fraudulent promotions. Nevertheless the great growth of joint-stock banking between 1826 and 1835 when 60 such banks were founded, and the great railway boom, which was at its height between 1835 and 1837, encouraged more realistic arguments in favour of constructive legislation. Little opposition was offered to the granting of limited liability to the railway companies by private act of parliament and a minor step forward was taken through the Trading Companies act of 1834. This act empowered the crown to confer by letters patent such corporate privileges other than limited liability as could be obtained by charter or by special act. For the first time under a general act registration of members was required.

In 1836 and 1837 the great debate as to limited liability continued with reference to the joint-stock banks and a proposal to amend the law of partnership by introducing limited partnerships. The report made in 1837 to the board of trade on the latter issue advised against the adoption of limited partnerships which were then the general practice on the continent and in the United States. However, parliament amended the act of 1834 by the Chartered Companies act, 1837, making the important addition that letters patent could expressly limit the liability of members to a specified amount per share. If the board of trade had not adopted a very restrictive policy in granting such letters patent (only 50 obtained these privileges between 1837 and 1854), this hybrid and illogical form of quasi-incorporation might have become established as the pattern for commercial companies, thus delaying fundamental reform. As it was, the continuing pressure to form joint-stock companies and in particular some notorious instances of fraudulent insurance companies (satirized by Dickens in *Martin Chuzzlewit* in 1843–44), caused the board of trade to secure the appointment of a parliamentary committee on joint-stock companies in 1841 and Gladstone, who had become president of the board of trade, took over the chairmanship in 1843. The committee thoroughly investigated the regulation of joint-stock companies and recommended, as an antidote to fraudulent promotions, publicity by a system of registration and sound regulations for the constitutions of companies. The Joint-Stock Companies act (1844) which followed was indeed epoch-making. Incorporation was to be obtained merely by registration, and thus the basis of the modern system was laid. For the first time, a distinction was made between a joint-stock company and the ordinary partnership, by requiring registration of all companies with more than 25 members. Publicity was secured by requiring the filing of particulars prior to the issue of a prospectus and the acceptance of deposits on shares, leading to provisional registration, followed by full registration after the deed of settlement had been registered. The act required half-yearly returns of members to be made. Auditors were to be appointed, and the directors were to cause full and fair balance sheets to be made up and filed with the registrar of companies (whose office was then inaugurated). Existing companies who wished to become incorporated were required to register certain particulars and to amend their deeds of settlement to conform with the act.

In the seven lean years of depression which started in 1837, introducing the social unrest of the hungry '40s, the success of the railways was a noteworthy exception to the general stagnation. However by 1844 funds seeking investment had accumulated, and a new railway boom no doubt contributed to economic recovery in the following years. The railways expanded from less than 2,000 mi. in 1843 to 5,000 mi. in 1849, their capital increasing from £65,000,000 to over £200,000,000. This development stimulated a great number of investors and the growth of local stock exchanges, bringing about what has been called the democratization of the money market. By 1856 nearly 1,000 companies were registered under the act of 1844. Almost half of them were public utilities such as gas and water companies, and shipping and mining were prominent. The list included only 1 woolen and 13 cotton companies, but breweries and food totaled 30. One contemporary estimate reckoned that capital was increasing at the rate of £40,000,000 a year.

The economic expansion increased the agitation for limited liability. The broad principle of laissez-faire, then at its height, was paradoxically invoked to attack the previous arguments based on the virtues of unlimited liability and private enterprise, on the ground that there should be freedom to all to contract on the basis of limited liability. The restrictive policy of the board of trade in granting corporate privileges was heavily criticized, as savouring of monopoly and prerogative. Social reformers, influenced by the revolutionary activities of the 1840s, desired to give the working classes the opportunity of co-operating in joint enterprises and of investing their small savings. Parliamentary committees were set up in 1850 and 1851, and a royal commission was appointed the following year; it proceeded to hold a very wide canvass of current opinion both at home and abroad. Foreign opinion was mainly in favour of limited liability, but in England the opinions of experts were evenly divided and in 1854 the report of the commission, signed by a bare majority, advised against it. The report was heavily and widely criticized. Eventually in 1855, when the country was preoccupied with the Crimean War, the government, possibly sensitive to criticism that it was doing nothing constructive at home, hastily secured the passing of the Limited Liability act, which extended the privilege of limited liability to companies securing registration under the 1844 act, except in insurance and banking. This act was re-enacted as the Joint-Stock Companies act, 1856, whose provisions reflected the current supremacy of the laissez-faire principle. Some of the safeguards in the acts of 1844 and 1855, such as registration of the prospectus and the requirement of minimum paid-up capital, were dropped. Incorporation was to be obtained by the simple registration of the memorandum and articles of association by any seven persons. The word limited (usually abbreviated Ltd.) had to be added to the name of the company. Limited liability was extended to banks in 1858 and to insurance companies in 1862. The limited liability company was thus established and became the most important of all forms of commercial associations.

There was a striking increase in the number of promotions. Between 1856 and 1862, 1,575 companies were registered (excluding abortive and small companies), covering a wide field of activities. Formations included 272 mining, 114 cotton, 30 iron and steel, as

well as shipping, streetcars, household goods, food and provisions, breweries, flour mills, hotels, theatres, newspapers and chemicals.

1856 Onward.—The act of 1856 and other acts were consolidated by the Companies act, 1862. Company history since this period may be stated briefly. The board of trade began the practice of appointing committees of experts to review company law at intervals of about 20 years. The main acts passed as a result of these committees are the Companies (Consolidation) act, 1908, the Companies act, 1929, and the Companies act, 1948. This legislation tended to give greater protection to the investing public by tightening statutory requirements regarding company accounts and prospectuses. Here the London stock exchange and the increasingly high standards set by the professional accountancy bodies have had great influence.

Companies may still be incorporated by act of parliament and many private companies were formed this way by private act in the 19th century—the Company Clauses acts, 1845–89, providing a general code of corporate powers and duties for this purpose. Some of these companies remain but others have been transformed under measures of nationalization into public incorporated boards. Building societies and co-operative societies also have their special forms of statutory incorporation. Friendly societies and trade unions have reached quasi-incorporative status. In many ways the law is chaotic, more especially in regard to companies that do not come under the Companies act, 1948. Case-law development has thus been of great importance; and, indeed, some of the fundamental principles are the result of important decisions by the house of lords in the last quarter of the 19th century, including the doctrine of *ultra vires* and the principle of the maintenance of capital. Their lordships' decision in the famous case of *Salomon* v. *Salomon* in 1897 firmly established the company as a separate legal entity, distinct from its members, and enabled small businesses to take advantage of the act of 1862. Parliament accepted this practice in the Companies act of 1907 when provision was made for registration of private companies with at least two members. Ironically, in the same year the Limited Partnerships act at last permitted a partnership to include partners with limited liability on the continental model, a concession which has been little used owing to the greater attractions of the private company. During the 20th century case law developed continuously, not always with completely acceptable or consistent results.

Company law now forms the legal structure for the major part of the economic and business activities of the country though it is still largely based on the model constructed in 1862. In conclusion, mention must be made of certain wider issues which might lead to substantial modifications of the law and thus of the structure of individual companies. On the assumption that the greater part of industry and commerce would not be taken over by the state but would remain in private hands, it was suggested that company law ought to be extended to cover the responsibility of the company to the employees and the consumer as well as to the shareholders. In the case of the bigger corporate bodies, which are managed in effect by self-perpetuating boards of directors, the legal theory of control by the shareholders is largely illusory; the employees of the company are in more intimate relationship with management than are the shareholders, and in many cases have more to lose. In the early 1960s on the continent of Europe, legislation appeared to be strengthening employee representation. As regards the consumer, tentative steps have been taken since World War II in the form of laws against monopoly and restrictive price controls, culminating in the Restrictive Trade Practices act, 1956, and the establishment of the Restrictive Trade Practices court. These measures do not appear to be as stringent as the antitrust legislation of the United States, which makes monopolistic practices subject to the criminal code. *See* also MONOPOLY.

COMPANY LAW

Types of Company.—Incorporation may be obtained in three ways: (1) By statute, involving promotion of a private bill in parliament. The use of this method is declining and is beyond the scope of this article. In addition, a public statute may provide for incorporation and this method was widely used in connection with nationalization. (2) By royal charter or letters patent (by petition to the crown). In practice this is confined to nonprofit-making cases; *e.g.*, a new university might be founded in corporate form by such means. (3) By registration under the Companies act, 1948. In theory 15 different types of company are registrable, but in practice the commonest registrations are companies limited by shares (public and private) for commercial profit-making purposes and guarantee companies (with or without a share capital) for multifarious purposes not involving the making of profit.

A list of incorporated bodies would include local authorities, water boards, universities, building societies, co-operative societies, provident societies, public boards (for nationalized industries and services), as well as the various types of company incorporated under the 1948 act. All of them are distinguished from unincorporated associations, such as partnerships and clubs, by the legal fact of their being separate legal entities having a common seal. This diversity raises numerous problems for the legislature (*e.g.*, of organization and taxation) and for the courts (*e.g.*, interpretation of statute law and questions of criminal and civil liability).

Companies Under the 1948 Act.—The basic requirement is the filing of the memorandum and articles of association of the company, together with related documents, with the registrar of companies. On the payment of any fees and duties applicable, the registrar issues a certificate of incorporation which is conclusive evidence of incorporation. Normally the memorandum provides for the constitution of the company, while the articles provide for internal regulation of its affairs. Model clauses for both documents were set out in the Companies act, 1862, and this practice was followed in subsequent acts. The memorandum must state the name of the company and its objects and whether the registered office is in England or Scotland. If the liability of the members is limited by shares or guarantee, this limitation must also be stated, together with the share capital if any.

In practice the objects are widely expressed so as to mitigate the application of the *ultra vires* doctrine, which was developed by the courts after a leading case decided by the house of lords in 1875. Under this principle, any act of the company which is not covered by its objects is null and void and cannot be ratified even by the consent of all members. (The better legal opinion is that this doctrine does not apply to chartered companies.) The effect of the principle was further mitigated by changes in the 1948 act, which make it easier for the objects clause to be altered, but the principle remains as a trap for the unwary. There is no statutory requirement as to the contents of the articles (except as mentioned below for private companies); great variations, therefore, are found. In practice public companies have their own articles, while private companies usually adopt the model form with some special articles of their own. The public generally is deemed to have notice of the contents of the articles as well as of the memorandum, since both are open to public inspection. Changes in the articles can be made by special resolution (defined below).

Public and Private Companies.—The formal distinction between public and private companies was first made in the Companies act, 1908. The legislature thus recognized that it was reasonable for individual traders to turn their businesses into companies. Public companies must have at least seven members, but the private company need have only two. Its popularity is clear from the fact that at the end of 1958 private companies numbered 318,800 with paid-up capital of £2,623,000,000, while public companies numbered 10,933 with paid-up capital of £4,608,000,000. A private company must by its articles restrict the right to transfer shares, limit its members to 50 (with exceptions) and prohibit any invitation to the public to subscribe for its shares or debentures. Clearly, therefore, a company which needs to raise capital from the public usually must be a public company, while the private-company form provides the facilities and benefits of incorporation for individual traders and partnership firms.

The legislature granted certain privileges to private companies, the most important perhaps being freedom from having to publish accounts. This privilege tended to be abused when public com-

panies started to form private subsidiary companies, and in the 1948 act private companies were subdivided into exempt private companies which retain the old privileges, and the rest, which do not—the intention being to restrict these privileges to the genuine private business. The 1948 act also defined subsidiary companies and provided for the publication of group accounts. The statutory definition of the exempt private company may be summed up as follows: all shareholders must hold in their own right and not as nominees; no corporation must hold any shares; debenture holders (see *Borrowing*, below) must be limited to 50; there must be no arrangement by which the policy of the company is determined by persons other than its directors, shareholders or debenture holders. Private companies which are so successful as to outgrow the private-company form are easily converted into public companies by altering the articles and complying with the requirements of the 1948 act regarding the filing of a prospectus or statement in lieu mentioned below.

Promotion and Flotation of Public Companies.—It is necessary to protect members of the public asked to subscribe for securities in a public company. Two main aspects of such protection may be mentioned.

First, the courts themselves, with little assistance from the legislature, have laid down a standard of duty based on good faith which will apply to anyone who takes steps to form a company, public or private. Such a person is called a promoter. Although not technically a trustee for the company, he is held to be in a fiduciary position toward it and may, for instance, be liable to account for secret profits made by him which have not been disclosed to an independent board of directors of the company. (The man who turns his own business into a private company is a promoter and there will probably be no independent board, but presumably he does not need protection against himself.)

Secondly, in the case of public companies the legislature constantly added to the requirements of the prospectus defined by the 1948 act as meaning "any prospectus, notice, circular, advertisement or other invitation, offering to the public for subscription or purchase any shares or debentures of a company." The 1948 act requires a considerable amount of information to be set out in the prospectus. The emphasis is on protection by publicity and disclosure, and there is no onus on the registrar or any other public authority to check the accuracy of the information. Subscribers, however, are given a statutory right to sue promoters and directors for loss or damage sustained by reason of any untrue statement, and there is also criminal liability for issuing a prospectus containing untrue statements. In addition, in many cases the proposed issue will be subject to scrutiny under stock-exchange regulations; *e.g.*, if it is necessary to obtain stock-exchange permission to deal in the securities offered.

One vital item that has usually to be stated in the prospectus is the minimum subscription. This is the estimate of the directors of the minimum amount required to be raised by the issue to pay for any property to be purchased, to defray preliminary expenses and to provide working capital. While the 1948 act and the decided cases established the principle of maintenance of capital once subscribed (see *Capital*, below), this provision is the only legal requirement tending to ensure that adequate capital is available. The company cannot proceed to carry on business unless it is raised. Usually, not only the minimum subscription but also the whole issue will be covered by underwriting; this is a form of contract under which professional underwriters agree to take up shares not subscribed for in return for a commission which must not exceed 10% of the issue price of the shares or exceed any less percentage stated in the company's articles. The rate of commission, if any, has to be stated in the prospectus and its rate is some indication of the market prospect for the issue. The normal common-law and equitable remedies may also be available to subscribers who suffer loss through a fraudulent or inaccurate prospectus. The Prevention of Fraud (Investments) act, 1958, was mainly designed to protect small investors by preventing share-pushing, but it also has some wide provisions which overlap the prospectus requirements of the 1948 act (*e.g.*, it prohibits written invitations to buy or sell a company's securities unless made by a member of a recognized stock exchange or licensed dealer or unless there is a proper prospectus under the act).

Capital.—In a business sense the word capital may be used to refer to the loan capital as well as to the share capital of a company, but in its legal sense it means only the share capital. The 1948 act required that the memorandum shall state the amount of the share capital (usually called the nominal capital) and the division thereof into shares of a fixed amount, and it is common for detailed provisions to be set out in the articles. The usual division is into ordinary shares and preference shares (corresponding to the U.S. distinction between common stock and preferred stock): preference shareholders rank before the ordinary shareholders, being entitled to be paid a limited dividend and to return of capital in a winding-up before dividends are paid or capital returned to the latter. From the accounting and business point of view the capital may be looked upon as the value of the net assets of a company after all its liabilities are discharged. Two important principles of law were laid down to ensure that share capital is actually raised and maintained. First, shares can only be treated as paid up to the extent of the money actually received in cash or in assets equivalent to the value transferred. Secondly, the principle of maintenance of capital was worked out by the courts and the legislature, the two most important rules being that any reduction of capital has to receive the consent of the court and that dividends must not be paid out of capital. Premiums received on shares must be paid to a share-premium account and are for most purposes treated as capital. (*See* also STOCK.)

Rights of Shareholders.—A person becomes a member of a company either by signing the memorandum or, more commonly, by applying for and being allotted shares, or by taking a transfer of shares from another shareholder. A certificate sealed by the company is issued to him and is prima facie evidence of his title and ownership which the company is normally prevented from denying. The company must also keep a register of members. Shares are usually transferable by a deed of transfer. Share warrants which pass title by mere delivery, although allowed, are not much used in Great Britain. The voting and other rights of shareholders are provided for in the articles, which usually also contain provisions for the variation of rights of different classes of shareholders. The rights of minorities of shareholders receive considerable protection. Case-law decisions have held that a minority may sue in the company's name or in their own names according to the circumstances. There are various provisions in the 1948 act under which minorities can refer matters to the court and, under a new section, the court was given powers to protect oppressed minorities by issuing orders for regulating the conduct of the company's affairs or for the purchase of shares, as an alternative to the drastic power of ordering a winding-up. In addition, the act increased the powers of the board of trade to appoint inspectors to investigate and report on a company's affairs, powers which are very wide and which are available in case of fraud, misfeasance, misconduct and oppression. In addition, a new power was given to investigate the real ownership and control of a company (this was the legislative answer to the criticism of the common practice of nominee shareholdings).

Direction and Management.—This is usually vested in a board of directors who need not be shareholders unless the articles require a share qualification, as they usually do. The 1948 act defines director as including any person occupying the position of director by whatever name called. Directors, other than the initial directors, are normally appointed by the company at a general meeting. The articles usually provide for retirement of a proportion of the directors annually, those retiring being eligible for re-election. In order to increase the control of the directorate by the shareholders in a general meeting, the 1948 act provided that a company may, by ordinary resolution (*i.e.*, one passed by a simple majority of votes), remove a director before the expiration of his term of office, despite any other provision in the articles or agreement between the company and the director. A director so removed may have a legal right to compensation or damages for breach-of-service agreement, which may deter shareholders from exercising this power of removal. The articles commonly em-

power the directors to appoint from their ranks a managing director or directors. It is now firmly established by the case law that the board of directors is, for certain purposes, not merely the agent of the company but the company itself. There is thus a division of powers between the general meeting and the board. Except as powers are expressly reserved to the general meeting, they will be exercisable by the board, which is not so much an agent as a primary organ of the company. Where there is a managing director there will be a further division of powers. No doubt the general meeting retains ultimate control, which it exercises by its power to amend the articles or to remove the directors.

Individual directors are agents of the company and not trustees, although they owe fiduciary duties to the company: they must, for instance, act bona fide in what they consider is in the interests of the company as a whole; they must not fetter their discretion as to future acts; nor must they place themselves in positions where their personal interests conflict with their duties to the company. Since the strict application of these rules would vitiate any contract between the company and any of its directors, it became common to relax such rules by special provisions in the articles, and there are statutory provisions regulating the position of directors and making disclosure of personal interest by them necessary. It is also clear that directors must not make secret profits, and difficult questions may arise in the case of offers being made to take over all or any of the shares (take-over bids): a statutory duty compels directors to disclose payments that may have been made to them personally in connection with the transaction. In addition, the total amount of remuneration paid to directors must be included in the annual balance sheet of the company, and a separate register of directors' shareholdings, which is subject to a limited right of inspection by members and debenture holders, must be kept by the company. Directors, as agents of the company, incur no personal liability for proper acts done in good faith but will be liable to the company for acts of misfeasance, including negligence and breach of duty. Any article which exempts a director in this regard is void under the 1948 act; the act, however, empowers the court to grant relief if it appears that he has acted honestly and reasonably and ought, in the circumstances, to be excused. Directors may also incur personal liability to third parties under the principle of breach of warranty of authority in respect of *ultra vires* acts. Directors, like other agents, may also incur criminal liability, and the 1948 act provides for the imposition of penalties upon directors and other officers who fail to comply with certain provisions or who permit their companies to fail to comply.

General Meetings.—The ultimate residue of power in a company resides in the general meeting of members of the company. Apart from the meeting required to be held by every public company within three months after it is entitled to commence business, at which time a report on its initial activities is made, the 1948 act requires an annual meeting to be held. The articles usually divide the business transacted into ordinary and special, ordinary business being the declaration of a dividend, the consideration of the accounts or balance sheets, the reports of the directors and auditors, the election of directors and the appointment of and the fixing of the remuneration of the auditors. All other business is special, the general nature of which must be stated in the notice of the meeting. Extraordinary meetings can also be held at any time. These can be called either by the board of directors or by a stated minimum of members under the requisitioning procedure in the 1948 act. The members and the auditor must be given 21 days notice of annual general meetings and of all other meetings at which a special resolution is to be proposed, and 14 days notice of other meetings. The articles may, however, restrict the right of certain classes of shareholders in regard to attendance and voting at meetings.

Three types of resolution are available: ordinary (passed by a simple majority), special and extraordinary (both passed by a three-quarters majority of votes cast). Voting is usually by show of hands in the first instance, but a poll may be demanded by a statutory minimum of members, when voting will usually be on the basis of one vote for each share held. There is also a statutory right to appoint a proxy or agent (who need not be a member) to attend and vote. A proxy may vote on a poll and join in demanding one. Almost complete control is given to the member or members who hold three-quarters of the voting shares, since this provides power to pass any type of resolution. However, a simple majority of voting shares gives effective control. In the case of large companies with numerous members each holding only a few shares, it is often stated that effective control is obtained by the acquisition of 25% to 40% of the voting shares. The position may be complicated, however, by the issue of nonvoting shares or by weighted voting which may enable control to be exercised by members holding only a small proportion of the company's share capital. The question of control is also basic to the accounting provisions in the 1948 act with respect to holding companies and subsidiaries.

Accounts and Auditors.—It was not until 1908 that companies were required to publish their balance sheets. Under the 1948 act every company must keep proper books, as may be necessary to give a true and fair view of the state of the company's affairs and to explain its transactions. The directors must lay before the annual general meeting a profit-and-loss account and balance sheet. The 1948 acts lays down in considerable detail what these accounts shall contain and, for the first time, provides that a controlling company must publish group accounts in which the accounts of its subsidiaries are included. Under the definition in the act, company B will be a subsidiary of company A if A is a member of B and controls the composition of its board of directors or if A holds more than half in nominal value of its equity capital (which will normally be the ordinary capital but would include participating preference capital). The definition appears to leave loopholes for evasion. A subsidiary may be either a public or private company (but cannot be an exempt private company, for reasons stated above).

An auditor of a company must have proper professional qualifications and must not be a director, officer or servant of the company. These provisions are relaxed in the case of the exempt private company.

Profits and Dividends.—It is a cardinal rule of company law that dividends can be paid out of profits only and must not be paid out of capital (as this would infringe the principle of maintenance of capital). The case law is complicated. Two points may be stressed here. First, no provision need be made to make good a loss or depreciation of fixed assets (*e.g.*, land, factories, plant, machinery), but losses of circulating assets (*e.g.*, stock-in-trade) in the current accounting period must be made good (although such losses in a previous accounting period can be ignored). Secondly, the courts have constantly stated that the question of what constitute profits is one of fact for businessmen rather than one of law. If the articles allow, it is also possible to pay a dividend out of a capital profit, although this is not usual. The power to declare what dividend shall be paid is usually reserved to the board of directors, which must, of course, take into account the rights of the shareholders under the articles.

Borrowing.—Power to borrow is normally included in the objects clause of the memorandum, although it would be implied in the case of a commercial company. The articles often limit the exercise of this power by the board of directors. Money borrowed is commonly called loan capital, but the legal principles applicable are distinct from those concerning share capital; *e.g.*, the interest on loan capital will be a debt due from the company and may, if there are no profits, have to be paid out of capital. The 1948 act allows a loan to be made irredeemable, but otherwise it may be repaid according to its terms without any need for the consent of the court. Loans may either be unsecured or, more commonly, secured on all or some of the assets of the company. The security given by the company is usually called a debenture, a written document which defines the property charged and contains the conditions of the loan. Generally speaking, the form of the document will have to take account of the relevant body of law applicable to the type of asset charged (*e.g.*, real-property law in the case of a fixed charge on land).

The charge known as a floating charge (commonly given by a

debenture) is only possible in the case of companies but not in that of an individual trader or firm. This type of charge, which is not permitted in Scotland, is a charge on the assets of the company generally which permits the company to deal with its assets in the normal course of business until the security is enforced by the lender, whereupon the charge is said to crystallize and attaches to the actual assets then held (subject to any prior charge on such assets). Indeed, one of the advantages of incorporation (*e.g.,* for the small trader) is the greater credit facilities thus made available. When the lenders are numerous, debenture stock is usually issued, sometimes accompanied by a trust deed with trustees in whose favour the charges are created. The prospectus provisions will apply to an invitation to the public to subscribe for debentures. Power is nearly always given to the debenture holders or their trustees to appoint a receiver to seize and realize the assets and repay the money secured, or a receiver can be appointed by the court. In accordance with the policy of publicity, particulars of all charges by a company must be registered within 21 days of their creation with the registrar of companies. If not so registered, any security given will be void against the liquidator and any creditor of the company.

Liquidation (Winding-Up) and Dissolution.—A company may be wound up compulsorily by the court or voluntarily; a voluntary winding-up may be, but seldom is, continued under the court's supervision. Of the circumstances in which a company may be wound up compulsorily, the most important is insolvency. The court has a broad jurisdiction in cases where winding-up is just and equitable; *e.g.,* where the substratum of a company has gone, where the company was initiated to carry out a fraud or where a minority is being oppressed. The winding-up proceedings may be initiated by a creditor, a member or the company itself and, when the compulsory winding-up order has been made, a liquidator usually nominated by the creditors is appointed by the court. The liquidator realizes the assets, pays the debts (some of which are, by statute, preferential) and distributes the surplus among the members. He has extensive powers, though in many cases these are subject to the discretion of the court or, in some cases, of a committee of inspection. Voluntary winding-up is the most common, initiated by the company itself by special resolution or, if it is insolvent, by extraordinary resolution. If the company is expected to pay its debts within 12 months, the liquidator is appointed by the members, with whom the control continues for the 12 months, after which control is transferred to the creditors if the debts are still unpaid. In other cases the ultimate decision in choosing the liquidator rests with the creditors, and provision is made for the appointment of a committee of inspection, upon which the members may be represented, to assist the liquidator. The liquidator has much the same powers and duties as in a compulsory winding-up and can, if necessary, obtain the directions of the court.

Dissolution is effected in a compulsory winding-up by a court order and in a voluntary winding-up after the liquidator has laid his final accounts before the members and creditors. A company may also be dissolved without winding-up if it is moribund.

Reorganization and Amalgamation.—Reconstruction can be effected by means of a scheme of arrangement with the sanction of the court, under a statutory procedure which enables a three-quarters majority in value of any class of creditors or members present at a meeting convened by the court to bind the whole of the class. Before the court gives its sanction, it must be satisfied regarding the fairness of the scheme. Procedure also exists for a solvent company to reconstruct, by special resolution, into a new company, substituting shares in the new company for shares in the old, such reconstruction being subject to the right of dissenting members to have their interest purchased. These procedures are also available for amalgamation and, in addition, a statutory procedure enables outstanding shares to be acquired by another company where it has already acquired 90% of those shares.

Nonprofit-Making Companies Under the 1948 Act.—Incorporation holds many advantages for noncommercial associations and ventures of many kinds. Usually, such bodies will register as guarantee companies without a share capital, a member's liability being limited to the fixed amount guaranteed by him as stated in the memorandum, which will also provide that all profits shall be used to further the company's objects. Where such a company is formed for promoting commerce, art, science, religion, charity or any other useful object, the board of trade may license it to dispose with the word "limited."

Overseas Companies.—Companies incorporated abroad and carrying on business in Great Britain are subject to certain requirements of the 1948 act and must register their constitution and file annual accounts. They must also comply with prospectus provisions similar to those required for native companies.

Incorporation and Nationalization.—After 1945 nationalization led to the statutory creation of various public corporations for the control of certain basic industries and public utilities. The boards of management are appointed by a minister of the crown who is responsible to parliament. They may be regarded as an interesting development of company law. A decision of the court of appeal supports the view that they are not servants or agents of the crown, that their employees are not civil servants and that their property is not crown property. They have no shareholders or capital and are not subject to the 1948 act, but their liabilities at common law and under general statute law appear to be the same as those of companies registered under that act. *See* also references under "Company" in the Index volume.

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COMPANY, CHARTERED: *see* CHARTERED COMPANY.

COMPANY, MILITARY. In military organization, the company is the smallest body of troops that functions as a complete administrative unit. Although the term "ship's company" remains in naval usage to designate the officers and crew assigned to a vessel, company is most commonly taken to refer to army units. Two related terms—battery of artillery, troop of cavalry—have been retained in most armies as equivalent to company.

A military company consists of a headquarters for its internal control and administration and two or more platoons organized and equipped to perform the company's operational functions. It is usually commanded by a captain, although in British commonwealth armies majors have sometimes commanded companies. This practice has also spread to other armies as the equipment and technical operations of companies have become more complex. The company headquarters keeps administrative records pertaining to the personnel, equipment and supply of the company. The company commander discharges the basic responsibilities for training, discipline and providing for the welfare of the personnel.

In medieval armies the term company referred loosely to the body of men accompanying a lord or knight into the field. During the 14th century discharged soldiers sometimes formed themselves into "free companies" and plundered at their pleasure. Some free companies were taken into the service of France against Spain; others served as mercenaries in European wars of the next three centuries. One such company was immortalized by Sir Arthur Conan Doyle in his novel *The White Company.*

As the organization of European armies developed, individual companies were brought together in larger tactical formations, and eventually became subdivisions of brigades or regiments. Gustavus Adolphus in 1631 organized the Swedish infantry into 150-man companies, with four companies to a battalion and three battalions to a brigade. French, British and early American infantry regiments usually consisted of ten companies of about 100

men each. Gen. James Wolfe, the hero of Quebec, added elite light-infantry companies to be posted on the flanks of a regiment in battle. As the rifle replaced the musket in the 19th century, infantry companies adopted more dispersed tactical formations and were organized in battalions within the regiment for control.

During World War I all armies experimented with the tactical use of supporting weapons in infantry companies, but such weapons were generally too heavy to be carried by foot soldiers. It was not until World War II, when lighter machine guns, mortars and antitank weapons had been developed, that crew-served weapons became a normal part of the infantry rifle company. In the United States army, the rifle company in 1945 had a strength of 6 officers and 187 men, and was composed of a company headquarters, three rifle platoons of three squads each and a weapons platoon in which were placed light, crew-served weapons for close fire support. Although some modifications in personnel and organic weapons took place after World War II, the basic structure of the rifle company, *i.e.*, headquarters, three (sometimes four) rifle platoons and a supporting weapons platoon, remained basically the same through several U.S. army reorganizations that drastically altered the size, composition and even the names of other types of units. Rifle companies of other nations were similarly organized.

Companies in modern armies vary widely in size and equipment, usually being built around a function or mission (*e.g.*, signal repair, medical ambulance, engineer bridge, reconnaissance, military police companies) or around a weapon or class of weapons (*e.g.*, tank, rifle or infantry, mortar companies). One characteristic all companies have in common, however, is basic administrative unity so that they can be absorbed as required into larger military formations such as the battalion (*q.v.*). (E. SR.; X.)

COMPARISON, or grading, in linguistics, refers to the modification of an element of speech (an adjective or adverb in English) to denote varying degrees of quantity, quality or relation, usually in Indo-European languages, advancing grades; declining grades are indicated by correlates.

Some languages (*e.g.*, Welsh) have forms for an equative degree ("as good as"), and some have comparisons in nouns (Sanskrit *aśvas* "horse," but *aśvataras* "sort of horse," *i.e.*, "mule"). Historically these forms are strictly intensive, not comparative or superlative. But most frequent are the comparative degree, formed by inflection (for example, "kinder") or other means ("more kind"), intermediate between the positive ("kind") and the superlative ("kindest" or "most kind") degree. Generally speaking, the comparative degree now compares two units and the superlative more than two. As double comparatives such as "lesser" (originally vulgarisms) come to be accepted, the comparative value of the suffix (*e.g.*, *-ter* in Latin *noster* "ours," *i.e.*, "not yours"), which was at first purely relative or relational, may be lost.

In rhetoric, the general term comparison implies that the units being compared have more similarities than differences, or may be classified together. Comparisons in the form of figures of speech (*q.v.*) include metaphors, similes and analogies. In a simile the comparison is made explicit, often with the words "as" or "like," whereas in a metaphor it is implicit. An analogy usually shows the resemblance of two things not in themselves, but in several points of similarity.

See E. Sapir in *Philosophy of Science*, vol. 11, pp. 93–116 (1944). (J. WH.)

COMPASS, a term, the evolution of the various meanings of which is obscure; the general sense is "measure" or "measurement," and the word is used thus in various derived meanings—area, boundary, circuit.

It is also more particularly applied to a mathematical instrument (pair of compasses) for measuring or for describing a circle, and to the mariner's compass.

The mariner's compass is an instrument by which the course of a ship can be regulated and by which the direction of landmarks, etc., can be observed. The use of the mariner's compass in slightly differing forms has been extended to aircraft, to land vehicles and to purposes of surveying. Though the actual requirements of each differ, the basic principles remain the same.

Compasses for these purposes fall into three main categories: the magnetic compass, which depends upon the earth's magnetic field to obtain its directive force; the gyrocompass (*q.v.*), which obtains its directive force from the rotation of the earth; and the solar or astrocompass, the use of which depends upon the sun or a star being visible. Some magnetic compasses can be made to drive repeater compasses. If a gyroscope is used in such a system either to stabilize the magnetic element or to smooth out oscillations in the transmission system the arrangement is correctly called a gyromagnetic compass, though it is sometimes described as a gyrocompass.

HISTORY OF THE MARINER'S COMPASS

The discovery that a loadstone, or a piece of iron which has been touched by a loadstone, will direct itself so as to lie in a magnetic north and south position, and the application of this discovery to direct the navigation of ships, have been attributed to various origins. The Chinese, the Arabs, the Greeks, the Etruscans, the Finns and the Italians have all been claimed as originators of the compass. There is little doubt that many writers on the history of the subject have lost sight of the fact that the ancients could and did make long voyages out of sight of land, using a steady wind to give them their direction and an occasional sight of the sun or stars to inform them of any change. When the compass made its appearance it was not at first used to steer by, but merely to check the direction of the wind when thick weather prevented the use of heavenly bodies.

A belief that the Chinese were the first inventors of the compass arose from legends of the use of a south-pointing chariot in which a human figure with outstretched arm always indicated the south. According to the first of these legends, the emperor Huang-ti fought a battle in the year 2634 B.C. against the rebellious prince Ch'ih-yu. The latter raised a great mist to screen his movements, but the emperor sent a south-pointing chariot to the head of his troops and this guided them through the mist so that the rebel was taken and executed. Stories of other chariots appear to have been added much later, and there is no evidence that any contained a magnetic element. It is much more likely that the guiding figure had a mechanical drive.

The Chinese traded in ships to the Persian gulf and the Red sea in the 9th century A.D., but there is no evidence that they used a compass. The fact remains that the earliest report of their use of the compass appears in a work entitled *P'ing-chou-k'o-t'an*. The date given is the end of the 11th century A.D.

When Europeans first penetrated into eastern seas it was noticed that the compasses used by the Chinese differed from and were inferior to their own. Some writers have suggested that the compass must therefore have been independently invented in Europe and in China, but there seems to be no reason why the designs used in the two places should not have progressed along different lines from a single stem.

It has also been claimed that the compass originated with the Arabs, their superiority in scientific learning and their early skill in navigation being adduced in support of the conjecture.

It has been asserted that the Arabs, Turks and Persians have no original name for the compass, it being called by them *bossola*, the Italian name, which shows that the thing signified is foreign to them as well as the word. The Rev. G. P. Badger, however, pointed out that the name of *bushla* or *busba*, from the Italian *bussola*, though common among Arab sailors in the Mediterranean, was very seldom used in the eastern sea—*da'irah* and *bait al-ibrah* (the "circle," or "house of the needle") being the ordinary appellatives in the Red sea, while in the Persian gulf *giblah-hamah* was in more general use. (*Travels of Ludovico di Varthema*, trans. by J. W. Jones, ed. by G. P. Badger, Hakluyt Society, note, pp. 31 and 32, 1863.) The earliest traced reference to the use of a compass by Arab sailors appears to have been made by Mohammed al-Awfi in a collection of Persian anecdotes written in 1232, and probably referred to a floating compass seen by him in 1220.

Bailak Kibdjaki, an Arabian writer, shows in his *Merchant's Treasure* (1282) that the magnetized needle, floated on water by means of a splinter of wood or a reed, was employed on the Syrian

seas at the time of his voyage from Tripoli to Alexandria (1242) and adds, "They say that the captains who navigate the Indian seas use, instead of the needle and splinter, a sort of fish made out of hollow iron, which, when thrown into the water, swims upon the surface, and points out the north and south with its head and tail" (Klaproth, *Lettre*, p. 57). By the time of the incursion of the Portuguese into eastern seas, the Arabs had become accomplished navigators with equipment at their command which compared favourably with that of Europe. João de Barros describes a map of all the coast of India, shown to Vasco de Gama by a Moor of Gujarat (about July 15, 1498), in which the bearings were laid down "after the manner of the Moors," or "with meridians and parallels very small [or close together], without other bearings of the compass; because, as the squares of these meridians and parallels were very small the coast was laid down by these two bearings of N. and S., and E. and W., with great certainty, without that multiplication of bearings of the points of the compass usual in our maps, which serves as the root of the others." Further, Jeronymo Osorio says that the Arabs at the time of Vasco da Gama "were instructed in so many of the arts of navigation, that they did not yield much to the Portuguese mariners in the science and practice of maritime matters." (See *The Three Voyages of Vasco da Gama*, Hakluyt Society, note to ch. xv by H. E. J. Stanley, p. 138, 1869.) Also the Arabs who navigated the Red sea at the same period are shown by Ludovico di Varthema to have used the mariner's chart and compass (*Travels*, p. 31).

In Scandinavian records there is a reference to the nautical use of the magnet in the *Hauksbók*, the last edition of the *Landnámabók* ("Book of Settlements"), "Floki, son of Vilgerd, instituted a great sacrifice, and consecrated three ravens which should show him the way [to Iceland], for at that time no men sailing the high seas had loadstones up in northern lands." Haukr Erlendsson, who wrote this paragraph about 1300, died in 1334; his edition was founded on material in two earlier works, that of Styrmir Kárason (d. 1245), which is lost, and that of Hurla Thordson (d. 1284), which has no such paragraph. All that is certain is a knowledge of the nautical use of the magnet at the end of the 13th century.

It will thus be seen that the earliest authentic information concerning the use of the compass comes from China (*c.* A.D. 1100), from Arabia (A.D. 1220) and from Scandinavia (*c.* A.D. 1250), while, as will be shown, the earliest western European date is A.D. 1187. In any of these areas the compass may well have been known long before it was recorded. It is not, therefore, possible to state with any certainty where the first discovery occurred, and whether knowledge of the use of the compass was transmitted from one nation to another or whether it was the result of independent invention. For the early history of the compass and the many claims and theories as to its origin *see* A. Crichton Mitchell, "Chapters in the History of Terrestrial Magnetism," *Terrestrial Magnetism and Atmospheric Electricity*, 37:105–146 (1932), 42:241–280 (1937), 44:77–80 (1939), 51:323–251 (1946).

The earliest definite mention as yet known of the use of the mariner's compass in Europe occurs in a treatise entitled *De utensilibus* written by Alexander Neckam about 1187. He speaks there of a needle carried on board ship which showed mariners their course when the polestar was hidden. In another work (*De naturis rerum*, ch. xcviii) he writes, "Mariners at sea, when, through cloudy weather in the day which hides the sun, or through the darkness of the night, they lose the knowledge of the quarter of the world to which they are sailing, touch a needle with the magnet, which will turn round till, on its motion ceasing, its point will be directed towards the north" (W. Chappell, *Nature*, 14:147, 1876). The magnetic needle and its suspension on a stick or straw in water are clearly described in *La Bible Guiot*, a poem written about 1206 by Guiot de Provins, which states that through the magnet (*la manette* or *l'amanière*), an ugly brown stone to which iron turns of its own accord, mariners possess an art that cannot fail them. A needle touched by it and floated by a stick on water turns its point toward the polestar and, a light being placed near the needle on dark nights, the proper course is known. There are a number of similar references during the 13th century.

The earliest detailed work on the magnetic compass is contained in the remarkable *Epistola de magnete* of Petrus Peregrinus de Maricourt, written in 1269. The first part of the epistle deals generally with magnetic attractions and repulsions, with the polarity of the stone and with the supposed influence of the poles of the heavens upon the poles of the stone. In the second part Peregrinus describes first an improved floating compass with fiducial line, a circle graduated with 90° to each quadrant and provided with movable sights for taking bearings. He then describes a compass with a needle thrust through a pivoted axis, placed in a box with transparent cover, cross index of brass or silver, divided circle and an external alidade provided with a pair of sights.

The earliest type of mariner's compass probably consisted of a magnetized needle thrust through a crossbar of wood or reed so that it would float in a bowl of water. It is possible that there was an even earlier type in which an actual lump of loadstone was floated on a piece of board. The next step was to use a needle pivoted on a pin rising from the bottom of the bowl. At first only the north-south direction would be considered, then the points were marked in the bottom of the bowl and the instrument was kept turned until the north point painted in the bowl was under the north end of the needle. Finally a card, marked with the points required, was attached to the needle itself.

There is a tradition that the compass was first introduced into the Mediterranean by sailors from the port of Amalfi. The story first appeared in print about 1450, and during the next 150 years

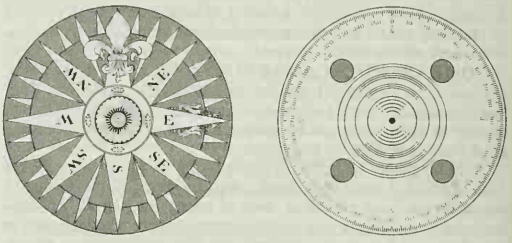

FIG. 1.—(A) 18TH-CENTURY COMPASS CARD DIVIDED INTO POINTS AND HAVING ORNAMENTATION AT THE EAST POINT; (B) U.S. NAVAL COMPASS CARD MADE OF METAL WITH GRADUATIONS PERFORATED THROUGH IT

was gradually expanded, by steps which can be recognized, until it was said that the compass was invented by Flavio Gioia of Amalfi in 1302. The ease with which both name and date could be shown to be late interpolations soon threw discredit upon the whole tradition. It is, however, quite possible that there was some truth in it; Amalfi may have introduced the compass several centuries earlier, or may have learned to attach the card to the needle about the year 1300.

The *rosa ventorum* or wind rose is far older than the compass itself, and the naming of the eight principal winds goes back to the Temple of the Winds in Athens built by Andronicus of Cyrrhus. The earliest-known wind roses on the charts which accompanied the *portolani* or Mediterranean pilots almost invariably have the eight principal points marked with the initials of the principal winds, tramontana, greco, levanter, sirocco, ostro, africo (or libeccio), ponente and maestro, or with a cross instead of an L to mark the east point. The north point, indicated in some of the oldest wind roses with a broad arrowhead or a spear, as well as with a T for tramontana, gradually developed by a combination of these, about 1492, into a fleur-de-lis, still almost universal. The cross at the east, or rather the ornamentation into which it developed, continued on British compass cards well into the 19th century (*see* fig. 1). Wind roses with these characteristics are found in Venetian and Genoese charts of the early 14th century and are depicted similarly by the Spanish navigators. The naming of the intermediate subdivisions making up the 32 points or rhumbs of the compass card is probably due to Flemish navigators, but they were recognized even in the time of Geoffrey Chaucer, who in 1391 wrote, "Now is thin(e) Orisonte departed in xxiiii.

partiez by thi azymutz, in signification of xxiiii. partiez of the world: al be it so that ship men rikne thilke partiez in xxxii" (*Treatise on the Astrolabe*, ed. by W. Skeat, Early English Text Society, 1872). Francesco da Buti, the Dante commentator, in 1380 says that sailors use a compass at the middle of which is pivoted a wheel of light paper, on which wheel the needle is fixed and the star (wind rose) painted. This is the earliest recorded reference to the compass card. The gimbals or rings for suspending the compass bowl, hinged at right angles to one another, have been erroneously attributed to G. Cardano, the proper term being *cardine*, that is hinged or pivoted. The earliest description of them dates from about 1537. The term binnacle, formerly bittacle, is a corruption of the Portuguese *bitacolo* denoting the housing enclosing the compass, and probably originated with the Portuguese navigators.

The earliest reference to a compass being used in a particular ship occurs about 1345 when "twelve stones, called adamants, called sailstones," were bought in Flanders for 6*d*. for the king's ship called "La George" (Sir N. Harris Nicolas, *History of the Royal Navy*, ii, p. 476, 1847). The name compass appears in about 1410 when the "Christopher" had "iij compas j dyol" but it is possible that the word did not then have the modern meaning. The origin of the name is obscure but it is thought to have been first applied to the compasses attached to pocket sundials.

The improvement of the compass was a slow process. *The Libelle of Englyshe Polycye*, a poem of the first half of the 15th century, says with reference to Iceland (ch. x):

> Out of Bristowe, and costes many one,
> Man haue practised by nedle and by stone
> Thider wardes within a litle while.
> (Richard Hakluyt, *Principal Navigations*, p. 201, 1599).

From this it would seem that the compasses used at that time by English mariners were still of a very primitive description. William Barlow in his treatise *Magneticall Advertisements*, printed in 1616 (p. 66), complains that "the Compasse needle, being the most admirable and useful instrument of the whole world, is both amongst ours and other nations for the most part, so bungerly and absurdly contrived, as nothing more." This plaint was echoed in very similar words by Matthew Flinders almost exactly 200 years later: "the compasses, even in the Royal Navy and to this day, are the worst constructed instruments of any carried to sea" (*Voyage to Terra Australis*, 1814). The form recommended for the needle by Barlow was that of a "true circle, having his Axis going out beyond the circle, at each end narrow and narrower, unto a reasonable sharpe point, and being pure steele as the circle it selfe is, having in the middest a convenient receptacle to place the capitell in."

During the 16th century, to get over the difficulty of pivoting the needle itself at the centre, two needles of iron wire were used, bent apart at the centre and joining at the ends so as to form an almost oval shape. By the middle of the 18th century this form had changed until the two wires were generally bent into the form of a parallelogram. The method of magnetizing was crude and the material used did not retain its magnetism. Difficulties were also caused by an inequality in the magnetic moment of the needles so that an error of direction often occurred. In 1766 Gowin Knight took out the first English patent for a compass. He perfected a method of using better steel for the needle and for giving it a greatly increased magnetic moment. He went back to the idea of a single needle with the cap for the pivot screwed into its centre. These compasses were a great advance on anything seen before. They were adopted by the Royal Navy and were copied in Germany.

Single flat needles became the usual custom until about 1840 when the admiralty compass committee of 1837 designed a new compass for the Royal Navy which was so successful that it was adopted by all the principal navies. In this compass four needles placed on edge were used, each being made of laminated steel plates. The needles were symmetrically arranged at such distances apart that the angle at the centre of the card between the similar poles of adjacent needles was 30°. This arrangement was chosen to give greater steadiness by equaling the moments of inertia in the north-south and east-west planes. The researches of Capt. F. J. O. Evans and Archibald Smith, published in 1861, showed that this arrangement was also of value in preventing the introduction of certain compass errors.

The new compasses, though a considerable improvement over their predecessors, were still by no means perfect, being much affected by the vibration of steam vessels. As early as 1813 Francis Crow had proposed filling the bowl with liquid to damp out any oscillations of the needle. Many difficulties were encountered with this type of compass through leakage or expansion of liquid, discoloration of paint, difficulty of replacing a worn pivot, etc. Though such compasses at first had too many disadvantages to allow their adoption in ships they were extensively used for row boats, whose jerky motion made any other type of compass useless. Many attempts were made to produce satisfactory liquid compasses and great advances were made by E. S. Ritchie in 1862 and W. R. Hammersley in 1866. The former patented a float which, being attached to the card, took most of the weight off the pivot, thereby reducing friction and wear and removing the necessity for frequent replacement or sharpening. Hammersley invented an expansion chamber and this, together with improved methods of jointing, did much to prevent leaks or bursting of the bowl.

Ritchie's compass was eventually accepted for the U.S. navy but in the Royal Navy liquid compasses were introduced for use only in bad weather and during gunfire.

In 1876 Sir William Thomson, afterward Lord Kelvin, broke new ground by inventing the light type of dry-card compass. His equipment was ultimately adopted in the Royal Navy but it must be admitted that this step was encouraged more by the advantage of his binnacle, which had full provision for compass correction, than by the advantages of his compass. The adoption of this compass gave the liquid compass a setback and it was not until 1906 that liquid compasses were finally adopted by the Royal Navy. The compass then introduced by Capt. L. W. P. Chetwynd, R.N., differed only in minor details from the compass used today. (W. E. My.; Ad. H.)

Variation.—During the 15th century it became apparent that the compass needle did not point to the true north but made an angle with the true meridian. This angle is called the variation by seamen, the alternative term, declination, being liable to cause confusion with the declination of heavenly bodies. Claims have been advanced that the Chinese knew of the existence of variation at the end of the 11th century and that it was referred to by Roger Bacon in his *Opus minus* in 1266. The references on which these claims are based are, however, extremely vague. Although the first authentic record of a definite value for the variation was made by Georg Hartmann in a letter of 1544 referring to observations of 1510, there is no doubt that the existence of variation must have been known a century earlier. The discovery of variation has been attributed to Columbus, but there can be no doubt that its existence was known before he commenced his voyages. Some of the compasses which he used on his second (1493) voyage had their needles mounted askew on the cards to correct for variation.

William Gilbert (*De magnete*, 1600) was the first man to put forward the hypothesis that the directive power of the compass was the result of the fact that the earth itself was a great magnet, but he had thought that variation was caused by the magnetic attraction of land masses. Gerhardus Mercator had earlier attributed the fact of variation to the situation of a magnetic pole in about 85° N. and longitude 180° from the meridian of the Azores, then used as a prime meridian because of the supposed absence of variation along it.

While charts showing the variation are said to have been made by Alonzo de Santa Cruz about 1536, the first world variation chart of modern type was produced by Edmund Halley in 1701. The earliest of these charts were intended for use in determining the longitude from the variation, a scheme dear to the hearts of many inventors of the period.

Later charts were intended as an aid to navigation to enable ships to know what allowance should be made in shaping courses

and also to enable them to obtain the deviation by subtracting the variation from the observed total compass error. Captain Evans' chart was the forerunner of the regular admiralty variation charts which are published from time to time. Variation charts have, of course, been published in other countries.

LATER DEVELOPMENTS IN THE MARINER'S MAGNETIC COMPASS

The term magnetic compass covers a number of apparently dissimilar instruments, all of which perform the function of determining the direction of the horizontal component of the earth's magnetic field. They are conveniently divided into two groups: (1) pivoted-needle compasses; (2) inductor compasses. Into the pivoted-needle group fall the mariner's compass, aircraft compasses and surveying instruments. The mariner's compass is subdivided into the liquid compass and dry-card compass types. Inductor compasses, aircraft compasses and surveying instruments are discussed under *Other Types of Compasses,* below.

The Liquid Magnetic Compass.—This compass is now almost universally used by mariners.

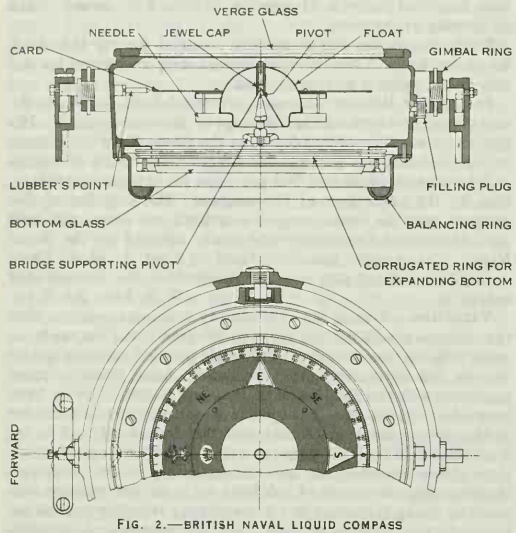

FIG. 2.—BRITISH NAVAL LIQUID COMPASS

The card is usually of mica with the graduations reproduced photographically on the underside and backed with a thin coat of white paint. The system of marking generally used is a clockwise graduation in degrees right around the card from 0° at north to 359°. This graduation has now generally replaced the earlier one by quadrants running from 0° at north and south in each direction to 90° at east and west. In some compasses graduation into points in addition to degrees is used, while a few fishermen still cling to compasses graduated in points only.

The card is attached to a float which carries the magnets or "needles." Both bar magnets and ring magnets are in common use. When bar magnets are used, there must be an even number, two being the most usual. With such a system, the magnets must of course be parallel with the north-south diameter of the card, and they are placed so that the similar poles of the magnets subtend an angle of 60° at the centre of the card.

If more than two bar magnets are used, the angles subtended are modified accordingly; *e.g.,* a four-magnet system requires an angle of 90° subtended by the poles of the outer magnets and 30° by the poles of the inner magnets. A ring magnet must be set with its magnetic axis (or diameter) parallel with the north-south diameter of the card. All these systems have a moment of inertia that is constant about any line in the horizontal plane, and thus any tendency to unsteadiness when the ship is rolling or pitching is considerably reduced. Certain errors, to which a single compass needle is subject when compass correction in an iron ship is carried out, are also avoided.

The system of card, float and magnets must be as light as possible to avoid friction at the pivot. It is also made bottom heavy in order to counteract the downward pull of the vertical component of the earth's magnetic field, which would cause the system to tilt. At the centre of the card is a metal cap containing a jewel which rests on a pivot rising on a stem from the bottom of the bowl. The pivot is tipped with iridium.

The bowl is filled with a mixture of alcohol and water which will neither freeze nor boil at temperatures normally encountered. To prevent the verge glass (*see* fig. 2) from bursting or bubbles from forming because of the inevitable expansion and contraction of the liquid, the bottom is attached by a corrugated ring which adjusts itself to the change of volume. To avoid the effect of liquid swirl, the card is considerably less in diameter than the bowl. The bowl is closed at top and bottom by sheets of glass so that the card can be illuminated from below and read from above. A pointer, known as the lubber's point, projecting from the inside of the bowl, indicates the compass course of the vessel. The bowl is hung by pivots in the athwartship line in a ring, known as a gimbal ring or cardan ring, which is itself hung in fore-and-aft pivots. A lead weight on the bottom of the bowl ensures that the bowl will remain horizontal whatever the heel of the vessel. The pivot point should be at the intersection of the lines joining the gimbal axes and should, together with the lubber's point and card, lie in the same horizontal plane through them.

The Dry-Card Compass now used differs from its predecessors in that the card is very much lighter and the moment of the magnets less. The card is made of paper secured to an aluminum ring, usually ten inches in diameter. This ring is fastened to a small central one by radiating silk threads while small needles, generally eight in number, are hung below the card, also by silk threads. The inner ring fits over a cap containing the jewel, the cap being in this way easily renewable. The pivot on which the cap rests is slid into a hollow column in the bowl so that it also can easily be withdrawn. These compasses with their large cards are easy to read (liquid compasses with cards in excess of seven inches in diameter are unwieldy). They are, however, very liable to be disturbed by vibration or shocks and, once deflected, are slow to settle again. The card must be protected from these effects, and so the bowl is usually hung from complicated spring suspensions. The liquid compass has, therefore, very considerable advantages over the dry-card type.

Azimuth Instruments.—A ship usually has at least two magnetic compasses unless a repeating magnetic compass is fitted. One, known as the steering compass, is used for directing the ship on the appropriate course.

The standard compass is that by which the ship is navigated, all bearings being taken from it and all courses shaped. Hence an all-round view and freedom from magnetic interference are to be aimed at in selecting its position in the ship. To enable bearings to be taken with accuracy, the standard compass is fitted with an azimuth instrument which rotates either round a central pin in the glass cover of the compass or on the outer verge ring of the compass. These instruments are of several types. The simplest form consists of two sight vanes mounted on a framework and joined by a thread. The vanes can be trained until they are in line with the object required and the eye must then be transferred to read off the card graduation which comes under the thread. In the next form a prism is fitted at the eye vane so that the required object can be seen direct at the same time that the card graduation is seen in the prism. As the near edge of the card is read instead of the far, it requires a second set of graduations 180° out of phase with the normal one. In another type a prism is fitted below the object sight vane, thus eliminating the need for additional graduations, though it is usual to have a second set of figures reversed. If the prism is at a height above the card equal to the radius of the card, the eye vane can be dispensed with since small errors in directing the instrument have no effect

on the bearing observed in the prism. By the use of a magnifying prism a large image is obtained. With this type it is usual even to reduce the object sight vane to a mere V in the top of the prism. It is easy to use and can be handled with speed and accuracy. In all these types a mirror is hinged to the object sight vane or magnifying prism so that the image of sun or star can be reflected down to the line of sight.

In the Kelvin type of instrument a tube, carrying a 60° prism at the top with a lens below it, is fitted in an inclined position over the far end of the card from the observer. Two methods of use are available. For low objects the eye is kept down and the card is seen reflected in the prism while the object is observed above it. In the second method, which can be used for high or low objects, the head is raised so that the card can be seen directly through the lens while the prism is turned until the object is reflected in it. This instrument is particularly useful for observing stars in altitude.

Azimuth instruments are also made in which the sight vanes are replaced by a telescope. An optical arrangement built into the telescope enables card and object to be seen in the same eyepiece at the same time. Other instruments incorporate an auxiliary arrangement of cylindrical mirror and prism by means of which the sun can be made to throw a line of light onto the card, thus indicating its bearing.

The Binnacle.—The mariner's compass is mounted in a pedestal, usually of cylindrical form, called a binnacle. This binnacle has, at the top, bearings to take the gimbal pivots. It is fitted to take the various magnets and soft-iron bodies necessary for the correction of the compass for the magnetic effects of the ship's hull. These correctors usually consist of an iron sphere on each side, a vertical iron bar, called the Flinders bar, usually on the foreside, and magnets placed in vertical and in fore-and-aft and athwartship horizontal positions. In some binnacles a number of holes or racks are provided for the horizontal magnets; in others they are placed in carriages which are either slid up and down a vertical tube or are raised and lowered by gearing. The binnacle is fitted with a hood to protect the compass from the weather, and with some form of illumination. In some ships it is necessary to place the compass overhead in order to get it farther from the steel of the ship: the card is graduated on the underside and the compass is illuminated from above.

A device known as a projector binnacle is used in submarines, and in a simpler form in some surface vessels. In the former case, the compass bowl is mounted outside the steel hull of the vessel and an image of the card is projected optically onto a screen in front of the helmsman. The optical system is contained in a pressure-tight tube, which forms the binnacle where it protrudes from the hull. Such a device enables a reasonable magnetic position to be found in a submarine. The projector binnacle for surface vessels enables the standard compass, on the compass platform, to be used for steering by a helmsman on the deck below. He is provided with a viewing screen upon which an image of the compass card is projected.

Repeating Magnetic Compasses.—It is often undesirable to place the compass at the navigating or steering position because of the unsatisfactory magnetic conditions there. In such circumstances a repeating magnetic compass may be used; *i.e.*, a compass which transmits the reading of a master compass unit to one or more repeaters. Thus the master compass containing the magnet system may be placed in a position where the magnetic conditions are suitable. Since an indication of the vessel's heading is required by various modern navigational aids (*e.g.*, radar), a repeater mechanism may be fitted in the instrument concerned.

There are several well-tried methods of obtaining transmission from a pivoted-needle compass, their common feature being that the magnet system is not subject to any disturbing torque, the actual work being done by a follow-up system. Bridge circuits are the most usual and the most accurate; they give a null indication when operating correctly. Capacity bridges may be operated by a small capacitor mounted on the magnet system, the excitation being preferably at a high frequency. Inductive bridges may be operated by varying the coupling between coils in the circuit of a radio-frequency oscillator; resistance bridges can be employed in which the relative position of card and bowl electrodes determines the balance or otherwise of the bridge, the compass liquid acting as a resistive path for electric current, and photocells may be energized by a light beam shining through a slot in the card. In all these systems, zero balance of the bridge is associated with a definite alignment between a follow-up member (which may be the bowl itself) and the compass card, the output from the bridge being amplified and used to drive a follow-up motor geared to the follow-up member. Thus the latter, be it the bowl or some external element, is electrically locked to the card and regardless of the movement of the ship is a north-seeking device driven by electrical power. Any transmitting system, therefore, can be coupled to the follow-up member and distant repeaters will faithfully reproduce the ship's head as indicated by the compass card.

Transmission can be obtained from a pivoted-needle compass by the aid of an inductor system, as mentioned below, and inductor compasses themselves, by their very nature and their associated electrical circuits, are inherently repeating compasses.

Another repeating system is that in which a very light synchro transmitter is coupled to the compass needle by a slave magnet, providing a universal and self-aligning coupling. This, unfortunately, imposes an appreciable torque on the needle and certain cyclic errors are introduced, but where accuracy of a high order is not required this system has advantages by virtue of its simplicity.

The Gyromagnetic Compass.—Reference will be made below to the acceleration errors which are a source of trouble in aircraft (and to some extent in small, fast ships). These errors are produced when the compass system relates itself to the false vertical during acceleration. By mounting the compass, which must be nonpendulous (*e.g.*, a double-pivoted needle or an inductor element), on a stable platform that is always maintained horizontal by a gyroscope, acceleration errors are largely avoided. One such compass consists of a saturable inductor mounted on a vertical gyroscope. The magnetic element therefore is always horizontal and is unaffected by the vertical component of the earth's magnetic field. The headings given by this compass are correctly related to the direction of magnetic north in the horizontal plane.

The combination of a vertical gyroscope and a magnetic compass is not always a convenient arrangement from the point of view of weight and space. Another system uses the azimuthal stability of a horizontal gyroscope. Such a gyroscope provides the primary heading reference and by conventional means provides transmission to repeaters and to a comparison device whereby the gyroscope heading and magnetic north, as indicated by a compass system, are referred to one another. Should there be any difference a correcting signal is initiated which is employed either to correct the transmission so that it is driven into alignment with the compass element or to precess the gyroscope which in turn aligns the transmitting system with the compass element. Drifting of the gyroscope is thus continually corrected by comparison with magnetic north.

Any perturbations of the compass system, due to accelerations and the like, result in the gyroscope heading being referred to a "false north." Since the compass system is designed to have a comparatively short period of oscillation, and since the correcting signal need only be large enough to ensure complete control of the gyroscope drift rate, very little disturbance of the repeater system takes place during successive oscillations of the compass. The false control signal is unable to deviate the repeater system appreciably before the return swing of the compass reverses the control signal, and so stability of headings is assured in spite of accelerations acting on the compass system. Pivoted needles and inductors are both equally suited to gyromagnetic compasses. The former provide a convenient comparison means by coupling the follow-up element of a repeating magnetic compass (*see* above) to the gyroscope's transmission system. Unless the follow-up element is correctly aligned, a signal is generated which provides the necessary correction by acting upon the gyroscope

or its transmission. By this means the follow-up system is aligned with the compass system.

Similarly an inductor system may provide the magnetic heading information, comparison between it and the gyroscope's transmission system being made by, for instance, a resolver or sine-cosine potentiometer coupled to the gyroscope or its transmission. Incorrect alignment again gives rise to a signal which persists, and is used for correction, until the gyroscope's transmission is driven into alignment with the magnetic compass datum.

Ship's Magnetism and Deviation of the Compass.—If any magnetic material is brought near to a magnetic compass it will tend to deflect the needle from the magnetic meridian. The angle of deflection, known as the deviation, will depend on the relative strengths of the earth's and of the deflecting magnetic fields and on their relative directions. Although the fact that iron brought close to a magnetic compass will deflect it was noted as early as 1538 by João de Castro, it was not generally known to seamen until well into the 19th century, and any irregularity in the pointing of the compass was attributed to the imperfections of its manufacture or of the loadstone with which it had been "touched." During his voyage to Australia in 1801–03, Flinders became the first man to carry out proper experiments into the phenomenon and to propose a corrector, the vertical bar of soft iron which now bears his name. He stated that the deviation in H.M.S. "Investigator" depended upon the sine of the ship's head and upon the dip. (He should have said the tangent of the dip.) On his return to England Flinders urged the admiralty to have experiments conducted in a number of ships to discover whether their compasses obeyed the same rules and these were carried out in 1812.

The admiralty compass committee of 1837, besides designing a compass, laid down rules to ensure that it would be fitted in a place as free as possible from magnetic disturbance. Because of adverse reports on a system of correction devised by Sir G. B. Airy, the Royal Navy preferred to observe and apply the errors of the compass rather than to attempt to correct them. This practice remained the almost universal rule until the introduction into the navy of the Kelvin compass in 1889, although for many years it had been found necessary to reduce the deviations to manageable proportions, in the larger ships, by magnets let into the deck. In merchant vessels the practice of compass correction was much more usual. In 1824 Siméon Denis Poisson published in France a mathematical investigation into the deviation of the compass. The theory was taken still further by Smith in 1851, and between 1855 and 1865, in conjunction with Captain Evans, he carried out a series of investigations into the behaviour of magnetic compasses in ships the results of which appeared in a number of papers read to the Royal society and other bodies and in the *Admiralty Manual for Ascertaining and Applying the Deviations of the Compass*, first published in 1862.

The effect of the magnetism of the ship on the compass can be divided into two parts, that resulting from the magnetism which is more or less permanent in character (sometimes referred to as the hard-iron effect) and that caused by magnetism transiently induced which changes with the direction of the ship's head and with its location on the earth (sometimes called the soft-iron effect). For convenience, the magnetic field of the ship may be resolved into three components, fore and aft, athwartship and vertical. The errors due to hard iron can be corrected by placing permanent magnets in the vicinity of the compass in the three directions stated so that the field resulting from each magnet cancels the corresponding component of the disturbing field. The hard-iron or permanent magnetic effect is subject to changes caused by aging and change of geographical position but in general it settles down by the time a ship has been in service about a year, so that thereafter it is necessary to correct the ship's compass only about once a year. If a ship is struck by lightning or subjected to severe shocks because of the explosion of shells, bombs, etc., its magnetic state may undergo a considerable change. The effect of this magnetic disturbance may take several months to settle down.

Permanent magnets were first proposed by Airy but fell into some disrepute, particularly in the Royal Navy, because their use was not properly understood. At one time it was usual to fit a single magnet let into the deck at an angle to the fore-and-aft line to do the work of both sets of horizontal magnets. Lord Kelvin's binnacle was one of the first in which proper provision was made for accommodating horizontal magnets. By the 1950s the practice had been introduced of using a pair of magnets pivoted at their centres like a pair of scissors. When the scissors are closed with unlike poles together the magnets neutralize one another, but as they are opened the ends form two parallel virtual magnets, whose strengths increase as the distance between the ends is increased. Finally, when the scissors are completely open the strength of the two full parallel magnets is obtained. This type of corrector is frequently employed for the correction of aircraft compasses. One form of the corrector has a pair of crown wheels, each with a magnet attached, so mounted that the two wheels turn in opposite directions when a pinion, geared between them, is rotated. Three pairs of wheels and magnets can be used to correct for permanent magnetism in three mutually perpendicular directions, viz., fore and aft, athwartship and vertically.

The effect of soft iron or induced magnetism is slightly more complicated since it depends on whether the main direction of the iron under consideration is fore and aft, athwartship or vertical and whether the nearest magnetic pole to the compass is before or abaft, to one side or above or below it. The horizontal components of soft iron are corrected by soft-iron spheres placed one on each side of the compass and the vertical components by the Flinders bar already mentioned. The spheres, having magnetism induced in them by the earth's field corresponding to that induced in the ship, produce a correction which holds good for all values of the earth's horizontal force.

The correction of the soft-iron effect by masses of soft iron was first suggested by Airy. He preferred to use boxes filled with soft-iron chain, nails, etc., a method still used by the Dutch navy in 1940. Spheres were first tried in the Royal Navy in 1854 and in 1860 the Liverpool compass committee advocated cylinders placed end-on to the compass. Spheres were finally adopted in the Royal Navy with the introduction of the Kelvin binnacle. It has been stated earlier that the spheres are magnetized by induction from the earth's magnetic field. This is not the only factor, since in practice the spheres are partly magnetized by induction from the compass needles, the amount caused by the needles depending on their magnetic moment and their distance from the spheres and being independent of latitude. With the Kelvin compass the magnetic moment is so low that the induction caused by the needles is negligible, but with some liquid compasses this is not the case. It follows that if a ship in which the spheres have been properly adjusted proceeds to the equator (where the induction in the ship's hull is greater because of the greater horizontal force of the earth) the induction in the spheres caused by the earth increases proportionally but that caused by the compass needles remains unaltered so that part of the error remains uncorrected.

In the French navy the errors to be corrected became so large, because of the nonobservance of rules for design of compass positions, that it became quite impracticable to fit spheres large enough to obtain sufficient correction. Lieut. C. Morel, therefore, introduced the fitting of a small soft-iron bar so close below the compass needles that it received nearly all its induction from them, that from the earth being negligible (*Revue maritime*, 185:499, 1910). With such a bar very large errors can be corrected but the adjustment has to be repeated after quite a small change of latitude. The method was adopted by the French navy and by the German, where the position of the bar or bars was varied so that they were sometimes above and sometimes beside the compass instead of below it. The bar was also occasionally used in the Dutch navy and in the Italian navy where it was also used in conjunction with spheres. In Great Britain it has been used for the correction of compasses in armoured fighting vehicles where the error to be corrected is usually large and the change of latitude difficulty does not apply.

In order to correct the compasses of a ship a process known as swinging is performed. The spheres and Flinders bar are first placed by estimation. In an old ship the results of observations

on previous voyages may be available; in a new one the positions can sometimes be fairly closely estimated since sister ships require the same length of bar and almost the same sphere positions. The vertical magnets are then placed so that the vertical magnetic force at the compass position is slightly less than that ashore. For this a heeling error instrument, which is a modified form of dip needle, is used.

The ship is then placed with her head on north, east, south and west in turn, the horizontal magnets being adjusted until there is no error, the fore-and-aft on east or west and the athwartship on north or south. Afterward the ship is placed on one of the quadrantal points (northeast, southeast, southwest or northwest) and the spheres are moved closer to or farther away from the compass until there is no deviation. It is advisable to check each of the corrections given above on opposite headings and, if any error is found there, to readjust by removing half the error. In a ship in which the compass is placed off the centre line or where magnetic material in its vicinity is unsymmetrical it may also be necessary to slew the spheres. Finally, the ship is turned slowly round while the residual errors are observed and tabulated to give the deviation card. It is usual to observe on every other point of the compass; *i.e.*, a total of 16 readings is taken. In some navies it is customary to observe every 15°. The whole revolution of 360° should be carried out slowly and steadily and should take at least an hour. The tabulated deviations are used for the correction of courses steered and bearings observed and are also subjected to mathematical analysis. From this analysis it is possible to diagnose the errors made in the correction and also any unusual magnetic forces acting on the compass.

During World War II it became necessary to protect ships from magnetic mines. One of the protective measures used was to encircle the ship with a coil carrying electric current which, by setting up an opposite magnetic field, opposed the magnetic field of the ship so that the resultant field below the hull was too weak to operate a mine. These coils, while they were energized, naturally changed the magnetic field at the compass position and it became necessary to correct for their effect.

To this end each binnacle was fitted with coils which when energized produced magnetic fields in three directions, viz., fore and aft, athwartship and vertical. (The U.S. navy preferred to use its horizontal axis coils inclined at 45° on each side of the fore-and-aft line.) Each coil was fed from a potentiometer which was supplied from the same source as the main coil. In this way the current in the corrector coil could be adjusted to produce a field to neutralize the magnetic field caused by the main coil. This adjustment was made during a second swing with protecting coils switched on after the compass had been adjusted in the ordinary way with the coils switched off.

The Compass Position in a Ship.—To ensure that the magnetic compass of a ship shall operate with sufficient accuracy, care must be taken in designing the bridge or other position in which it is to be fitted. Steel plating may have magnetic poles of such strength that if placed too close, their effect cannot conveniently be corrected and even if sufficient correction can be applied their strength may change appreciably. This is particularly the case if the plating is subjected to excessive heating, as in the case of that of a funnel, when the strength of the magnetic field produced may be subject to considerable fluctuation. In addition, the changes of magnetic field because of moving materials (cowls and davits and the permanent magnets in telephones and loud-hailers) and the existence of occasional electromagnetic fields when electrical instruments are in use must be considered.

In the Royal Navy a set of rules relating to the "safe distance" from the compass of magnetic and electrical material and equipment has been laid down.

OTHER TYPES OF COMPASSES

Aircraft Compasses.—The use of pivoted-needle compasses in aircraft emphasized the errors due to acceleration. Let the craft be supposed to turn in a clockwise direction at constant speed; then, since the magnet system of the compass is bottom heavy, it will no longer hang in the true (gravitational) vertical, but will swing outward and take up its position with respect to a false vertical, the resultant of gravitational and centrifugal accelerations. As the heading of the craft passes through magnetic north, the magnets swing out to the west and the system is acted upon by a component of the earth's vertical force which, making it act as a dipping needle, introduces easterly deviation; *i.e.*, the magnet system turns in the same direction as the craft. Similarly, when the heading of the craft passes through south, the magnet system is deflected to the west; *i.e.*, it turns in the opposite direction to that of the craft. As the heading of the craft passes through east or west, the magnet system is tilted in such a way that the vertical component of the earth's field does not turn the magnet system but merely alters the value of the directive force.

The above phenomenon is known as northerly turning error and its effect is to minimize the turns through north and to exaggerate the turns through south, irrespective of the direction of turning of the craft. The error is almost imperceptible in ships except for such vessels as fast patrol boats, but in aircraft, with higher speeds, it attains considerable proportions. If, when the craft turns through north, the error is equal to the angle turned through, no turn is indicated by the compass; if the error is greater than the turn, the compass will indicate an apparent turn in the wrong direction. The error is at maximum when the heading is north or south and is gradually reduced on other headings until it becomes zero on east and west.

Again, if the craft is accelerating on a straight course, the magnet system will tend to lag behind and align itself again in the false vertical. Once more, the effect of the earth's vertical force will cause the magnet system to turn, but in this case the effect is maximum on east and west courses and zero on north and south. This effect is known as east-west acceleration error.

These errors are observed as actual errors only while the craft is turning or accelerating. The more general effect, however, is that they cause oscillations of the magnet system when the craft is steering a nominally straight course. For instance, yawing can be considered to consist of a number of short turns which will result in alternating turning errors causing the magnet system to swing from side to side of the meridian. Rolling and pitching will introduce accelerations of the compass position which will again

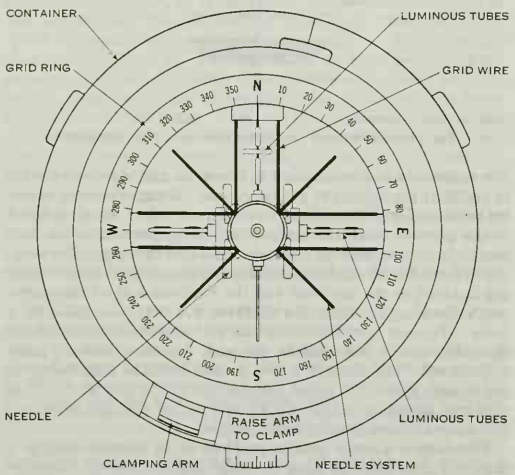

FIG. 3.—PLAN VIEW OF AIRCRAFT COMPASS SHOWING GRID AND MAGNET SYSTEM

result in oscillations of the magnet system. The effect of yawing and rolling will be at a maximum on north or south courses and the effect of pitching will be at a maximum on east or west courses.

In a ship the acceleration errors are usually not large. Magnets of a fair size can be used together with a large enough card to be read with considerable accuracy. In the case of aircraft the

accelerations caused by random motion when on straight courses are very much greater than in the case of a ship. The problem is complicated even further by the requirement that for use in aircraft the size and weight of the compass shall be at an absolute minimum.

In order that the magnet system may be as steady as possible under adverse conditions, its natural period of oscillation is made long and heavy damping is introduced; *e.g.*, by the immersion of the system in liquid.

The type of compass which will give the steadiest reading in an aircraft is one which is aperiodic.

A better solution of the problem of acceleration error is provided by the gyromagnetic compass (*see* above). Nevertheless, many aircraft use liquid-damped pivoted-needle compasses, and

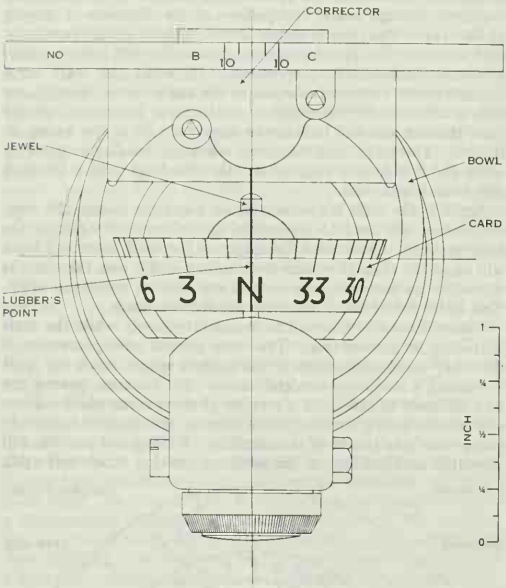

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FIG. 4.—EMERGENCY (E-TYPE) COMPASS FOR AIRCRAFT

it is customary to provide what is known as grid steering in order to facilitate the holding of a given course. A rotatable ring, carrying luminized grid wires in the form of a ⊥ (*see* fig. 3), is fitted to the compass bowl, the upright limb being directed to the zero mark of a circumferential scale of degrees on the ring. The magnet system has no card but, instead, luminous glass tubes which are fastened to the east-west and the northern half of the north-south damping filaments, the northern end being indicated by a cross. To steer a given course, the grid ring is turned until the desired course is indicated on the scale against a lubber's point in the bowl. The aircraft is then turned until the glass tubes on the magnet system lie within and parallel to the grid wires. It is then only necessary to steer the aircraft so that the glass tubes and grid wires are kept parallel to one another.

Vibration is a much greater problem in an aircraft than in a ship, and steps must be taken to ensure that the aircraft vibration is not transmitted to the compass bowl lest variable errors be introduced.

The importance of the liquid-damped compass in aircraft has been diminished by the advent of the gyromagnetic compass, and the modern tendency is to fit a far less refined type of liquid compass in aircraft for use in emergency. The bowl of one such type is roughly spherical, about two inches in diameter and made of polystyrene (*see* fig. 4). An edge reading card is supported at the centre of the bowl by the usual pivot and jewel. Silicone fluid is used as a damping medium. The aircraft's heading is ascertained by reading the card against a vertical lubber's line on the surface of the bowl facing the pilot. The temperature range throughout which it is necessary for an aircraft compass to function correctly is much greater than that for the functioning of a ship's compass, and the same compass liquid is not suitable for both. The liquids normally used in aircraft compasses are a mixture of 95% pure ethyl alcohol and 5% methyl alcohol (special care must be taken to ensure that the paint and other materials used inside the compass bowl are unaffected by the action of this compass liquid), a silicone fluid of an appropriate viscosity and various forms of kerosene or white spirit.

The correctors used to compensate for the effect of ferromagnetic material in the aircraft are usually of the scissors type. Errors due to soft iron in an aircraft are usually so small that no devices are required for their correction.

Vehicle Compasses.—Adaptations of aircraft compasses are sometimes used for land vehicles; the British North Greenland expedition (1952–54) and the Commonwealth Transantarctic expedition (1955–58) were so equipped. The electrical equipment in such vehicles is usually a serious source of compass deviation.

Surveying Instruments.—Compasses for both land- and seaborne surveys, the measurement of angles, the determination of variation and the like may be either liquid or dry instruments. The usual surveyor's compass is essentially an azimuth instrument and has a pivoted compass card and magnet at the centre of a bowl, adapted to be rotatably secured to the top of a tripod. The bowl carries a sighting device for training toward a given object.

The compass designed by the admiralty compass committee in 1842 is still regarded as a most reliable and useful surveying compass. It has a dry card with four magnets and an azimuth device which can be read by verniers to one minute of arc.

An instrument related to the surveying compass is the so-called datum compass. This is primarily used for ascertaining the magnetic heading of an aircraft during compass adjustment, and is capable of a high order of accuracy. It comprises a magnetic element with either a 360° card as in a conventional compass or a bearing plate that may be related to magnetic north by alignment with and reference to the magnetic element. The card or bearing plate is read with an optical magnifier and the line of sight is determined by viewing a suitable mark through a telescopic azimuth sight. These instruments are distinguished by the fact that they are refined and calibrated so that their errors do not exceed a few minutes of arc, and are ten times more accurate than the usual navigational compasses. Theodolite compasses, which are usually single-pivoted needles in a trough or tube and which are used to align the theodolite in the magnetic meridian, are included in the category of datum compasses.

A related group, though markedly less refined, are the prismatic marching compasses, which may be dry or liquid according to their quality, and which are used for map reading in the field, setting a line of march and similar purposes.

Inductor Compasses.—The pivoted-needle compass so far discussed indicates direction by virtue of the fact that a magnetic needle rests along the direction of the magnetic field of the earth. The inductor compass, also, determines direction by reference to the earth's magnetic field, but by measuring its strength. The earliest English patent for such a compass appears to be that of L. Dunoyer in 1907. In the simplest form a small coil with its axis horizontal is mounted on a vertical spindle. When the spindle is rotated the coil cuts the horizontal component of the earth's magnetic field and consequently acts as a dynamo, generating an electrical supply whose voltage may be measured. The direction and strength of this voltage will depend on the position of collector brushes relative to the direction of the earth's field. The brushes can be rotated by hand and their position indicated on a dial. The method of using the compass is to turn the brushes until the required course is indicated on the dial and then to alter the course of the craft until the voltmeter reads zero. There are many adaptations of this device, the sensitivity being enhanced in some cases by the addition of a highly permeable magnetic core

to the rotating coil. All these instruments are inclined to be bulky and of necessity use rapidly rotating parts. Mechanically they are unsuitable for modern ships and aircraft and have been superseded by what is known as the saturable inductor compass.

This measures the intensity of an ambient field, and is an entirely static device. Its operation depends on the readily saturable property of highly permeable alloys such as permalloy C and mumetal, and the consequent production of harmonic distortion in an alternating current supply to a solenoid wound about a core of such material. The rate of change of flux threading the solenoid (or back electromagnetic force) is abruptly changed as the

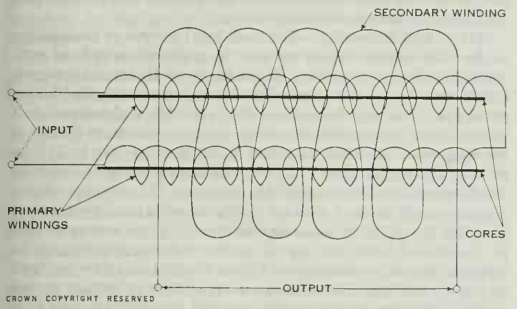

FIG. 5.—DIAGRAM OF SATURABLE INDUCTOR

alternating current drives the core material in and out of saturation twice in every cycle. When an ambient magnetic field exists along the core, the instants of saturating and unsaturating are different for the positive and negative half cycles of excitation and thus by suitable detecting instruments the presence and strength of a magnetic field may be determined. Two such inductors may be connected in a bridge circuit, in which case the fundamental excitation frequency may be canceled in each half of the bridge, leaving only the harmonic distortion which arises when an external magnetic field is present. This distortion gives rise to a back electromagnetic force predominantly second harmonic in nature but having a long series of higher even harmonics of smaller amplitude. Filters suppress all but the second harmonic, the magnitude of which is proportional to the applied field. This second harmonic mode is the most common in compass practice, though fundamental frequency systems have been proposed. Another technique, the measurement of the peak height of the voltage pulses produced in the bridge system, is more generally used in magnetometers and magnetic anomaly detector systems.

The second harmonic inductor for compass use (*see* fig. 5) is most conveniently constructed in the form of two adjacent parallel cores of highly permeable material, whose length is great compared with their diameter. Each has an axial winding, and these windings are connected in opposition and supplied from a source of alternating current. So far similar to the bridge circuit, the pair of wound cores is, however, enclosed in a secondary winding of a large number of turns and from the terminals of this a second harmonic voltage proportional to the axial magnetic field is obtained. Such an inductor may be used as a compass if provided with a follow-up mechanism devised to drive it to a null position—in which case the inductor would be directed east-west.

For accurate indication a card and gimbal system would be necessary, and it must be borne in mind that an inductor compass is subject to precisely the same kind of tilting and acceleration errors as a pivoted-needle compass. A compass of the type described still has the objections of bulk and weight, the presence of rotating parts, slip rings and the like. If, however, two or more inductors are used to measure the components of the horizontal field of the earth along several directions in a ship or in an aircraft, the relation of the fore-and-aft line to magnetic north can be found by combining the several voltages. For example, one inductor is in the fore-and-aft direction and another in the athwartship direction. The two vectors are combined in a two-phase resolver, the rotor of which may be adapted to seek a null position which is related to the direction of the earth's magnetic field with respect to the fore-and-aft line of the vessel. The detector system, except for its gimbal suspension, is stationary and has no moving parts. It is light and compact. The inductor compass can be combined with a pivoted-needle compass in order that it may operate in a stronger ambient field than that of the earth. By this arrangement certain tilt errors are avoided and a repeating system from a pivoted-needle compass is made available.

The Sun Compass is an instrument for obtaining an approximate direction from the direction of the sun. It is most easily considered as working in the reverse manner to a sundial. The sundial is carefully set up with its meridian accurately in the north-south direction and the shadow of its gnomon, or style, falling on the dial indicates the time. With the sun compass, on the other hand, the dial is turned until the shadow indicates the correct time and the meridian of the dial then indicates the true north-south line. The time set on the dial is the apparent time, *i.e.*, the time by the sun at the place of observation, and should not be confused with the time normally indicated by clocks which, for convenience, is mean time. Apparent time depends on the longitude, and the actual length of the apparent day varies slightly throughout the year.

In a simple type of sun compass the gnomon, or pin, is vertical and its shadow falls upon a horizontal dial plate. This plate is graduated to show the times at which the shadow will make definite angles with the north-south line.

Different dial plates must be used for different latitudes and for different declinations of the sun so that, to obtain a sufficient degree of accuracy, a set of 13 plates is required for each band of about 3° of latitude. If the gnomon is made adjustable so that it can be moved in a north-south direction to allow for the date, *i.e.*, the declination, one plate can be used in all latitudes and at all seasons. In this case the latitudes are indicated by a family of ellipses while the time lines become a family of hyperbolas. The meridian line indicates the true direction when the shadow of the gnomon falls on the intersection of the correct latitude and time curves. When the instrument is used in a vehicle to steer a predetermined course, the dial plate is set with its meridian line at the correct angle with the centre line of the vehicle, and the vehicle steered so that the shadow of the gnomon falls in the correct direction.

The astrocompass is a type of sun compass in which the dial plate is tilted about an east-west axis at an angle with the horizontal equal to the co-latitude. The gnomon and a target plate are rotated about the centre of the dial plate, their direction being indicated on a time scale. They are also tilted relatively to the dial plate by the angle of declination of the body being observed. Use of the compass involves keeping the time scale set and the shadow of the gnomon on the target. To observe stars, hour angle is used instead of time.

Several years before the outbreak of World War II in 1939 the value of a sun compass was recognized by officers serving in armoured fighting vehicles in the Egyptian desert. Various types were brought into use and proved of great value during the Libyan campaigns.

See GEOMAGNETISM; MAGNETISM; NAVIGATION; *see* also references under "Compass" in the Index volume.

BIBLIOGRAPHY.—On the magnetic compass *see* P. F. Mottelay (comp.), *Bibliographical History of Electricity and Magnetism* (1922); A. Schück, *Der Kompass*, vol. i (1911), vol. ii (1915), vol. iii (1918); H. L. Hitchins and W. E. May, *From Lodestone to Gyro-Compass* (1952). On marine magnetic compasses see *Admiralty Manual of Navigation* (1954); Sir F. J. O. Evans and A. Smith, *Admiralty Manual for . . . the Deviations of the Compass* (1862 to 7th ed., reprinted 1920); W. E. May, *Compass Adjustment* (1951). During the 19th century a number of important papers appeared in the *Philosophical Transactions of the Royal Society*, *Journal of the Royal United Service Institution*, *Transactions of the Institution of Naval Architects*, etc. On aircraft compasses *see* E. Brook Williams and W. J. V. Branch, *Air Navigation: Theory and Practice* (1952). (W. E. MY.; L. S. B.; AD. H.)

COMPASS PLANT, a common weed (*Silphium laciniatum*) of the interior of the North American prairies, which takes its name from the position assumed by the leaves. These turn their edges approximately to north and south, thus avoiding the exces-

sive midday heat while getting the full benefit of the milder morning and evening rays. The compass plant, also called pilotweed and rosinweed, belongs to the family Compositae.

Another member of the same family, *Lactuca scariola*, which has been regarded as the parent species of the cultivated lettuce (*L. sativa*), behaves in the same way when growing in dry exposed places; it is a native of Europe and northern Asia and has been widely introduced into North America.

COMPENSATION, a term applied in law to a number of different forms of legal reparation. It is due in England for improvements made by a lessee (*see* LANDLORD AND TENANT); it is due workmen for accidents occurring in the course of employment (*see* WORKMEN'S COMPENSATION); and it is due a person whose property or person is injured by the negligent conduct of another (*see* TORT). Compensation is also due an owner of property which is taken by the government or a public utility (*see* EMINENT DOMAIN; CONFISCATION AND EXPROPRIATION). For applicability of the doctrine to the property of nationals of one state seized by another, *see* NATIONALIZATION. *See* also references under "Compensation" in the Index volume. (A. DM.)

COMPENSATION INSURANCE: *see* WORKMEN'S COMPENSATION.

COMPÈRE, LOYSET (*c.* 1450–1518), one of the most charming among the Flemish contemporaries of Josquin Desprès. Probably a native of St. Omer, from 1474 to 1475 he was a member of the chapel of Galeazzo Sforza, duke of Milan. By 1486 he was in Paris as "singer in ordinary" to Charles VIII. He died, Aug. 16, 1518, at St. Quentin. Apparently a pupil of Jean d'Okeghem, Compère was a transitional figure, uniting the elegance of Guillaume Dufay with the humanism of Desprès. His most popular works were his chansons and motets. Two complete Masses survive, with 26 motets, 4 Magnificat, 52 chansons and 2 *frottole*.

BIBLIOGRAPHY.—Modern editions of chansons and motets in A. Smijers, *Van Ockeghem tot Sweelinck*, vol. iv (1942); H. Hewitt (ed.), *Harmonice Musices Odhecaton A* (1946). *See* also O. Gombosi, "Ghizeghem und Compère," in *Festschrift für Guido Adler* (1930). (B. L. TR.)

COMPETITION, ECONOMIC. In business and to the general public, competition in the market for any product or service means the absence of monopoly (*q.v.*) on either the selling or buying side, and likewise the absence of government intervention in the market process. To the economist competition means much more, especially when qualified by adjectives such as pure or perfect. It denotes a number of competitors who are well informed and who act independently of each other, the number being so large that no one of them can raise the market price of his output by restricting his sales, or lower the price of his input of resources by restricting his purchases. There must be free and relatively easy entry into and exit from the market or industry in question. The product should also be standardized and uniform so as to assure complete knowledge of its price and quality and guarantee against more than one price prevailing at any time in a single market.

Oligopoly and Monopolistic Competition.—Consider two hybrid forms, oligopoly and monopolistic competition. Each oligopolist is large enough to affect by his own sales or purchases the price of something which he sells or buys, but he still faces one or more business rivals. In monopolistic competition, the number of firms is large and there is free entry, but the product of each firm is differentiated either naturally or artificially (as by advertising), so that each firm may charge a different price from its rivals without forcing them out of business or being forced out itself. The business world and the general public consider oligopolistic and monopolistically competitive situations as being competitive, although competition usually concentrates in these cases on quality, on service, etc., rather than on price. There is usually more conscious competitive spirit between oligopolists (*e.g.*, the leading automobile manufacturers in the U.S.) or between monopolistic competitors (gasoline stations on opposite corners) than between pure competitors (wheat farmers on neighbouring farms). The economist usually lumps oligopoly and monopolistic competition together with monopoly under the head of imperfect competition.

On the other side of the market, buyers' monopoly is usually called monopsony. This term, corresponding to oligopoly, has not, however, become popular. The situation where monopolists and monopsonists face each other across the bargaining table is called bilateral monopoly. A group of ostensibly independent economic units acting collectively is called a cartel (*q.v.*) on either the buying or selling side of the market. A trade union, for example, is a labour cartel.

More than taxonomy or classification is involved here, because the traditional defense of competition applies almost entirely to the pure form. Furthermore, most of the so-called wastes of competition are more characteristic of oligopoly and monopolistic competition than of pure competition.

Merits and Demerits.—The traditional defense of competition in the 19th-century liberal tradition is made on grounds of optimum allocation of resources. It can be shown by formal economic theory that, given the population, tastes, resources, distribution of wealth, economic institutions and available technologies in a society, pure competition normally allocates resources ideally in the long run. By ideal is meant a situation in which: (1) no more of any product could be produced without using up resources worth more than the price of the product; (2) no more of any resource could be used without producing additional goods worth less than the price of the resources itself; (3) no resource could be transferred from one use to another without diminishing the value of the total product; and (4) no product could be produced at a lower average cost. Costs are taken here to include normal profits; *i.e.*, returns on resources supplied by the enterpriser himself.

This competitive ideal, never realized in competitive practice, has impressed a number of socialist writers to the point of being advocated as a policy aim for a planned economy. A socialist planning board could (it has been held) approximate the results of perfect competition more closely than an imperfectly competitive enterprise system.

On the negative side, the traditional liberal economists' case for competition claimed that it avoided the principal evils of monopoly on the one hand and governmental management on the other. The principal evil of monopoly (or imperfect competition) as they saw it was the profitability of raising prices in order to obtain greater gains by restricting output and violating the canons of ideal allocation of resources listed above. The principal evils of governmental management were held to be the lack of incentives to economic efficiency and progress and the danger of substituting dictatorial restrictions on civil liberty (not exclusively economic) for the operations of the market in fulfilling centralized economic plans.

Yet even at the zenith of laissez-faire economics (roughly the third quarter of the 19th century) there was always dissent from the competitive prescription by socialist and reformist writers. (Karl Marx's economic writing dates mainly from this period.) Certain of the grounds for dissatisfaction, including some developed much later, are the following:

The competitive system guarantees neither an equitable income distribution nor a "social minimum" income for all. If one starts from a distribution of wealth not in conformity with ethical ideals, the results of competitive economy will conform to the actual distribution rather than the ethical ideals. Bluntly, cream for the princess' cat will be produced ahead of milk for the beggar's baby. Price control, rationing and allocation are often advocated to offset the distribution of wealth and property, to assure the poor a larger share in consumption goods than the free market provides, even after the income distribution is modified by fiscal measures.

In speaking of cost in connection with competitive pricing or the competitive allocation of resources, one refers only to private costs actually borne by the enterpriser, not social costs which may be greater or less. The smoke nuisance is a common example of a social cost not usually reflected in the private cost of a smoky factory. Subsidization is suggested when the private costs exceed the social costs, and special taxes in the opposite case.

In industries with heavy fixed investments or sunk costs, like coal or steel, high-cost or inefficient firms do not in fact withdraw

from business or reduce their capitalization until they have been losing money for a prolonged period. Pure competition in these cases sometimes leads to chronically sick industries, with overproduction driving prices below the cost of even the efficient concerns. Workable competition, which usually involves some measure of price and output control by the industry or by a public agency, may offer a preferable outcome.

Similarly, in industries where demand fluctuates violently, and where capacity expands only slowly in response to increases in demand, it may be wise to stabilize prices and maintain excess capacity in operation during slack periods, which the competitive price mechanism will not do. Industries involved directly and indirectly in war production are specially subject to this consideration.

Technological development may be more rapid if financed in part by public funds, or by monopoly or oligopoly profits, or if the firm which takes the risk of introducing it is protected from imitative competition by its monopoly or oligopoly position. A patent system is itself a restriction on competition, but it is often an inadequate protection in cases of this kind, since many economic innovations are not patentable. It is not surprising to find many underdeveloped countries relying on government enterprises, public corporations or charters of monopoly in sectors critical to their rates of growth, even when their general economic philosophy is a competitive one.

In order to secure the maximum economies of large-scale production, plants must be large enough in some industries to lead to monopoly or oligopoly. Or, to put it in reverse, one can approximate pure competition in some industries only by sacrificing some of the benefits of technological progress.

Granted that real incomes have risen under economies which are primarily competitive, there is dissatisfaction with competition for failure to guarantee full employment and stability of the general price level at the same time. In modern economic thought, these problems are viewed as aggregative, that is, beyond the province of individual markets or industries, competitive or otherwise. Responsibility for the level of employment and prices is thought to rest primarily with the society's money, credit, fiscal and international trade policies, in all of which public control plays an important part.

The task of public monetary and fiscal authorities in maintaining full employment without inflation is easier when the economy is more freely competitive, since monopolistic pressure groups can sometimes force price increases which would not otherwise occur in periods of high employment or cut output in slack times when prices would have fallen under pure competition. On the other hand, direct governmental price and output controls are more effective in an oligopolistic or monopolistic economy, where similar controls exist on a private basis even in normal times.

Long-Term Trend.—As societies progress, an increasing proportion of the national income and product takes the form of publicly produced goods and services, particularly of government services, civilian and military. This seems to hold even in private-enterprise economies like that of the U.S., in which the federal government's economic role increased drastically after the turn of the 20th century and particularly after 1930, until the public sector came to account for from one-fourth to one-third of the national product. The obverse of this trend is a relative, although not an absolute, fall in the importance of the private economy, which includes the competitive sector.

Within the private economy itself there is much discussion of the relative importance of the competitive and the monopolistic elements. The classical economists treated *laissez faire* and free competition as largely synonymous because they regarded private monopoly, oligopoly included, as resulting primarily from public interference with free trade. They had in mind the royal charters of monopoly granted by the Tudor and Stuart kings of England, the protection of domestic monopolies by tariff legislation and so on. They foresaw the rapid demise of monopoly in a regime of *laissez faire* and of international free trade. Even in modern times it is possible to ascribe much of the persistence of monopoly and oligopoly to legislation encouraging trade unions and cartels, enlarging the scope and coverage of patents and trade-marks, legalizing resale-price maintenance and permitting corporations to hold each other's securities. Public regulations and purchasing policies are also accused of favouring large, well-established firms as against their small, less well-established competitors.

At the same time, it has become an article of faith among economic planners that, with the passage of time, competition becomes steadily more oligopolistic and steadily closer to monopoly. This principle was stated originally by Marx. The main reason for such a decline of competition is the heavy capital investment required to build a modern automobile factory or steelworks or to secure public acceptance for a new brand of soap or cigarettes. Entry, in other words, remains legally free to outsiders but becomes economically closed to them.

Statistical evidence, while inconclusive, supports neither of these extreme positions. In the American case, special effort has been made to preserve competition by the enactment and sporadic enforcement of antimonopoly legislation such as the Sherman, Clayton and Federal Trade Commission acts. Yet the relative importance of large-scale industry appears to be growing, as measured by the percentage of total manufacturing output or employment concentrated in the largest 50, 100 or 200 manufacturing corporations. But at the same time, the number of small independent firms is rising along with the size of the largest ones, and less than half of the 100 giants of 1900 are among the 100 giants of the 1960s. The largest corporations, constantly expanding into related fields, also find themselves competing (oligopolistically) with each other. Consider, for example, electrical home appliances, where there is competition between the large radio, electrical machinery, automobile and flour-milling companies, in addition to the large department stores and mail-order houses.

One authority speaks of countervailing power as arising in the form of the large merchandising companies (with monopoly power on the buying side) protecting the public from the exactions of large manufacturers with monopoly power on the selling side. The importance of interindustry competition is also great in many oligopolistic fields, as for example between motion-picture, radio and television entertainment, and likewise the competition of the used product in other oligopolistic fields, most notably automobiles. Figures taken exclusively from manufacturing, moreover, are somewhat misleading as to the course of concentration. Economies, in the process of development, appear to shift in relative emphasis from manufacturing industry to the (usually smaller-scale) service trades after a certain point in development is reached—in the U.S., after World War I. However, such service industries as telephones, radio and newspapers may also become both large and monopolistic.

Improvement in the means of transportation and communication affected the state of competition in a variety of ways. "People of the same trade seldom meet together, even for merriment and diversion," said Adam Smith, "but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices." In modern times it is much easier for "people of the same trade," ostensible competitors, to meet together or otherwise to communicate and collude against the public, even internationally, than it was in the 1770s when Adam Smith was writing. At the same time, improvements in transportation and communication widened markets enormously in terms of area and population. These improvements completely eliminated the monopoly power of many a petty local merchant or moneylender. As a result of these improvements, a few conspicuous giant concerns may be as competitive throughout a country or a continent, despite their size, as a great number of smaller firms used to be, taken a few at a time within individual towns or counties.

Another complex effect of development, particularly of communication, has been the rise of the new industries of advertising and selling. These are expensive industries, in which so much of the efforts of A go to cancel the efforts of B that a considerable amount of economic waste inevitably results. It cannot be estimated with any reliability what proportion of the increased information supplied to buyers by competing sellers (or to sellers by competing buyers) is actually both true and relevant. It is also

quite uncertain whether the net results of advertising and selling have been favourable or unfavourable to competition as against monopoly. That is to say, it is not known whether advertising and selling have operated primarily to open up a broader range of rational choices than existed before or to confirm consumers in set prejudices and forestall experimentation with competing products.

Trade advertising and selling, directed to informed businessmen as intermediate buyers, is predominantly true and relevant and does increase the degree of competition, but this is only a small fraction of the total advertising and selling industries. It is probably likewise true that, whatever may be the effects of advertising and selling on competition within single industries, they have intensified the scope and the severity of interindustry competition for the consumer's pound or dollar.

For legal aspects *see* MONOPOLY: *Legal Aspects;* FAIR TRADE LAWS; FEDERAL TRADE COMMISSION; INTERSTATE COMMERCE. *See* also BUSINESS CODES; CARTEL; and *see* references under "Competition, Economic" in the Index volume.

BIBLIOGRAPHY.—The classical case for competition in industry dates from Adam Smith, *Wealth of Nations,* book iv (1776). Its standard presentation is perhaps John Stuart Mill, *Principles of Political Economy,* book v (1848). A restatement, with significant modifications, makes up A. C. Pigou, *Economics of Welfare,* part ii, 3rd ed. (1929). Of recent works maintaining the beneficence of substantial degrees of monopoly in developing capitalist economies, three may be mentioned as influential: Joseph A. Schumpeter, *Capitalism, Socialism, and Democracy,* ch. v–vii (1942); J. Kenneth Galbraith, *American Capitalism: the Concept of Countervailing Power* (1952); and Sumner H. Slichter, *The American Economy* (1948).

On imperfect and monopolistic competition, the standard references are E. H. Chamberlin, *Theory of Monopolistic Competition* (1933); Mrs. Joan Robinson, *Economics of Imperfect Competition* (1933); and William Fellner, *Competition Among the Few* (1949). A recent development, following John von Neumann and Oskar Morgenstern's *Theory of Games and Economic Behavior* (1944), has been the analysis of oligopoly and bilateral monopoly using game-theoretical principles. An example is Martin Shubik, *Strategy and Market Structure* (1959). Applying competitive theory to socialist planning, *see* B. E. Lippincott (ed.), *Economic Theory of Socialism,* by Oskar Lange and Fred M. Taylor (1938); and A. P. Lerner, *Economics of Control* (1944).

The thesis that competition leads to monopoly is expounded or suggested in, *e.g.,* A. A. Berle and Gardiner C. Means, *The Modern Corporation and Private Property* (1933); Robert A. Brady, *Business as a System of Power* (1943); Arthur R. Burns, *The Decline of Competition* (1936); Thurman Arnold, *The Folklore of Capitalism* (1937); and Joseph Steindl, *Small and Big Business* (1946). A contrary view is maintained in George J. Stigler, *Five Lectures on Economic Problems,* ch. v (1949); and G. Warren Nutter, *Extent of Enterprise Monopoly in the United States, 1899–1939* (1951).

Antitrust legislation and its enforcement are advocated as controls over the imperfections of competition in Corwin D. Edwards, *Maintaining Competition* (1949); Henry C. Simons, *Economic Policy for a Free Society,* ch. ii–v (1948); Fritz Machlup, *Political Economy of Monopoly* (1952); and Donald Dewey, *Monopoly in Economics and Law* (1959). For the other point of view, in addition to the works of Schumpeter and Galbraith cited above, reference should be made to an influential essay by John Maurice Clark, "Toward a Concept of Workable Competition," reprinted in American Economic Association, *Readings in the Social Control of Industry* (1942).

A variety of studies are also available of competition and monopoly within individual industries, both national and international. For the United States, the Temporary National Economic Commission (1938–41) provides a particularly rich mine of source material, partially summarized in David Lynch, *Concentration of Economic Power* (1946). As a start on industry studies, with emphasis on the U.S., *see* Walter Adams (ed.), *Structure of American Industry,* 2nd ed. (1954); L. W. Weiss, *Economics and American Industry* (1961); William H. Nicholls, *Imperfect Competition Within Agricultural Industries* (1941); or Alfred R. Oxenfeldt, *Industrial Pricing and Market Practices* (1951). The problem of entry of new firms is discussed most fully in Joe S. Bain, *Barriers to New Competition* (1956). On the problem of advertising, which transcends individual industries, the standard work is Neil Borden, *Economic Effects of Advertising* (1942). (MN. B.)

COMPIÈGNE, a town in the Oise *département,* northern France, is situated on the left bank of the Oise, 76 km. (47 mi.) N.N.E. of Paris by road. Pop. (1954) 17,701. The centre of the town is the Place de l'Hôtel de Ville, which is connected with the bridge over the Oise (rebuilt 1949) by the Rue Solferino. The *hôtel de ville,* with its fine façade surmounted by an elegant belfry, is late Gothic. The church of St. Antoine (13th and 16th centuries) has fine Renaissance windows, and that of St. Jacques dates from the 13th and 15th centuries. A Gothic cloister, which houses the municipal library, is all that remains of the abbey of St. Corneille. For a long time prior to 1870 Compiègne was one of the French royal residences. The magnificent palace, at which *Son et Lumière* is presented, is a rich art museum. It was built mainly by Louis XV and was restored by Napoleon I. One façade looks toward the town while the other faces the beautiful park extending to the great forest of oak and beech which was formerly considered part of the defenses of Paris. Compiègne is situated on the main railway from Paris to Brussels and is an important tourist centre. There are foundries, machinery and a milk-bottling works, and the industries include oil and soapmaking, automobile tires and biscuitmaking.

Mentioned as Compendium for the first time in 557, but existing before that, Compiègne was the site of many assemblies and councils under the Merovingian kings. In 833 Louis the Pious was deposed there. Charles the Bald enlarged the town and founded the abbey of St. Corneille. Compiègne became a commune in 1153. Joan of Arc was made prisoner there by the Burgundians, and several treaties were signed at the palace. In 1814 Compiègne resisted the invading Prussian troops stubbornly. Under Napoleon III the palace was the residence of the court during the hunting season. The headquarters of the German army in 1870 and 1871, the town was occupied by the Germans again in World War I and bombarded in 1918. The Armistice was signed on Nov. 11, 1918, in Marshal Ferdinand Foch's private railway coach in the forest near Compiègne. During World War II Compiègne was occupied by the Germans on June 10, 1940, and on June 22 Hitler received the French surrender in the same railway coach, which had been preserved at the Carrefour de l'Armistice since 1918. It was subsequently taken to Berlin and put on display, but was destroyed in an Allied air raid in 1943. Compiègne was liberated by the Allies on Aug. 30, 1944. (M. DE LA M.-C.)

COMPLAINT, in law, the plaintiff's initial pleading, corresponding to the libel in admiralty, the bill in equity and the petition in civil law. The complaint, called a declaration at common law, consists of a title, a statement showing venue or jurisdiction, one or more counts containing a brief formal exposition of the facts giving rise to the claim asserted and a demand for relief. Thus it informs the defendant of the plaintiff's claim and initiates the pretrial process of narrowing the case to one or more sharply defined issues of law or fact. At common law and under early procedural codes the task of defining the issues was performed solely by the pleadings, but modern procedural systems have utilized pretrial conferences and deposition and discovery procedures as well for this purpose. *See* PRACTICE AND PROCEDURE. (C. E. CL.)

COMPLEMENT. In general the complement of an entity is that which with the given entity makes up a whole. In geometry the complement of an angle A is that angle which when added to A makes a right or 90° angle (*see* ANGLE; TRIGONOMETRY). In the theory of aggregates the complement of an aggregate S is the aggregate which remains when S is taken away from the aggregate U which forms the domain of discourse. *See* SET THEORY (THEORY OF AGGREGATES); LATTICE THEORY: *Complements.*

(L. M. G.)

COMPLEX IONS: *see* CO-ORDINATION COMPOUNDS.

COMPLEX NUMBERS. Since certain algebraic equations such as $x^2 + 1 = 0$ have no solutions in real numbers, early mathematicians were led to consider purely formal solutions involving square roots of negative numbers.

Thus Heron of Alexandria (*c.* A.D. 100) obtained the solution $\sqrt{-63}$, and Girolamo Cardan (1545) wrote $40 = (5 + \sqrt{-15})(5 - \sqrt{-15})$. These numbers were considered to be quite meaningless, and the term imaginary was applied to them. They have since become indispensable in several branches of modern mathematics and have applications in mechanics and electricity.

Geometric Representation.—If i is by definition a solution of the equation $x^2 + 1 = 0$, numbers of the form $a + bi$ where a and b are real are called complex (Carl Friedrich Gauss, 1832).

The modern development of complex numbers began with the discovery of a geometric interpretation for them. This

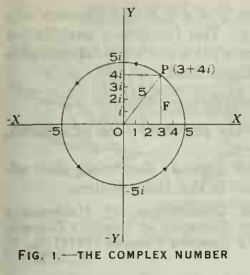

FIG. 1.—THE COMPLEX NUMBER

was indistinctly set forth by John Wallis (1685), and in completely satisfactory form by Caspar Wessel (1799).

Wessel's work received no attention, and the geometric interpretation was rediscovered by Jean Robert Argand (1806) and again by Gauss (1831). It is frequently called the Argand diagram (fig. 1).

Just as the real numbers represent points on a line, the complex numbers can be put into correspondence with the points on a plane. The multiples of i are called purely imaginary numbers and are plotted as points on the imaginary axis perpendicular to the axis of reals at the O-point. Then the number $a + bi$ corresponds to the point P where OP is the diagonal of the rectangle whose sides are a and bi. If $a + bi$ is multiplied by -1, its corresponding line or vector OP is rotated through 180°. Similarly if $a + bi$ is multiplied by i, its vector is rotated through 90°. Thus two successive multiplications by i produce the same effect as one multiplication by -1, so that in this sense $i^2 = -1$.

Logical Justification.—The first satisfactory introduction of the complex numbers was given by Sir William Rowan Hamilton (*Trans. Royal Irish Acad.*) in 1835, although Gauss afterward stated that the same idea had occurred to him in 1831.

Consider the set of all ordered couples $\alpha = (a_1, b_1)$, $\beta = (a_2, b_2)$, . . . of real numbers where $\alpha = \beta$ means that $a_1 = a_2$ and $b_1 = b_2$. Define the operations of addition and multiplication of couples by the equations

$$\alpha + \beta = (a_1 + a_2,\ b_1 + b_2),\ \alpha\beta = (a_1a_2 - b_1b_2,\ a_1b_2 + a_2b_1).$$

It can easily be shown that these couples combine according to the following rules:

$$\alpha + (\beta + \gamma) = (\alpha + \beta) + \gamma, \qquad \alpha(\beta\gamma) = (\alpha\beta)\gamma,$$
$$\alpha + \beta = \beta + \alpha, \qquad \alpha\beta = \beta\alpha,$$
$$\alpha(\beta + \gamma) = \alpha\beta + \alpha\gamma.$$

The couples of the form $(a,0)$ form a subset of the set of all couples which is abstractly identical with the set of real numbers. If $(a,0)$ corresponds to a, and $(b,0)$ corresponds to b, then $(a,0) + (b,0)$ corresponds to $a + b$, and $(a,0) \times (b,0)$ corresponds to ab. In this sense the real numbers are contained among these couples, and it may be written $(a,0) = a$. In particular, $(0,0) = 0$ and $(1,0) = 1$. If k is real, $k(a,b) = (ka,kb)$. For every couple α, $\alpha + 0 = \alpha$ and $\alpha \times 1 = \alpha$. For every $\alpha = (a,b)$ there is a couple $-\alpha = (-a, -b)$ such that $\alpha + (-\alpha) = 0$; and for every $\alpha \neq 0$ there is a couple $1/\alpha = (a/(a^2 + b^2), -b/(a^2 + b^2))$ such that $\alpha \times (1/\alpha) = 1$.

Thus the couples form a number field. All of the other rules of arithmetic which are valid for all fields are consequences of those enumerated. If one denotes the couple (0,1) by the letter i, then $i^2 = -1$ and

$$\alpha = (a,b) = a + bi.$$

These couples are precisely the complex numbers.

Another logical development of the complex field was given by Augustin Louis Cauchy (*Comptes Rendus*, Paris) in 1847. Consider the set of all polynomials

$$f(i) = c_0 + c_1i + c_2i^2 + \ldots + c_ni^n$$

with real coefficients in the indeterminate i. Two polynomials are defined to be equal if they give the same remainder upon division by $i^2 + 1$. Thus every polynomial is equal to a polynomial $c_0 + c_1i$ of the first degree in i. Addition and multiplication are defined in the usual way. That is,

$$(a_1 + b_1i)(a_2 + b_2i) = a_1a_2 + (a_1b_2 + a_2b_1)i + b_1b_2i^2.$$

Upon dividing this product by $i^2 + 1$, the remainder $a_1a_2 - b_1b_2 + (a_1b_2 + a_2b_1)\,i$ is obtained, which is therefore equal to the product. Since $i^2 + 1$ gives the remainder 0 upon division by $i^2 + 1$, it is true that i is a solution of the equation $x^2 + 1 = 0$. The laws of arithmetic are as readily provable as in Hamilton's approach.

It is significant that it is not possible to define a complex number separately from all other complex numbers. The complex field can be defined either by Hamilton's method or by Cauchy's method; a complex number is an element of the complex field.

Properties of the Complex Field.—Although the complex numbers appear to have been introduced to obtain a solution of the equation $x^2 + 1 = 0$, it is true that every equation with real coefficients, and indeed every equation with complex coefficients, has a complex root. This theorem, frequently called the Fundamental Theorem of Algebra, was proved by Gauss in his doctoral thesis (1799). It follows immediately that every equation of degree n has exactly n solutions, not necessarily distinct.

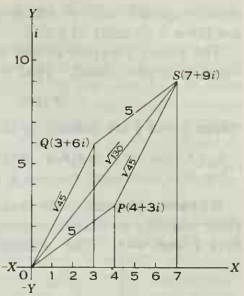

FIG. 2.—ADDITION OF COMPLEX NUMBERS

The Fundamental Operations.—Reference was made to the graphic representation of the complex numbers. The number $a + bi$ can be made to correspond to a point on the plane, or to the line segment or vector from the origin to this point. If the latter point of view is adopted, it is true that the sum of two complex numbers corresponds to the diagonal of the parallelogram whose edges are the summands. Since directed physical magnitudes such as forces and velocities add by the parallelogram rule, it is apparent that complex numbers are well suited for their computation.

Multiplication of complex numbers is best treated through their polar representation (Roger Cotes, 1710; Abraham de Moivre, 1730; Leonhard Euler, 1743). If r represents the distance OP from the origin to the point $a + bi$, and if θ is the angle from the positive x-axis to OP, then

$$a + bi = r(\cos\theta + i\sin\theta) = r\ \mathrm{cis}\theta.$$

The number r is called the absolute value (Karl Weierstrass) or modulus (Cauchy) of $a + bi$, and θ is called the argument or phase. Cis θ is an abbreviation for $\cos\theta + i\sin\theta$.

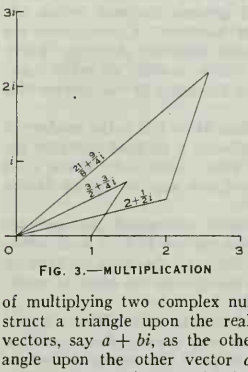

FIG. 3.—MULTIPLICATION

By the usual definition of multiplication,

$$r_1\ \mathrm{cis}\theta_1 \cdot r_2\ \mathrm{cis}\theta_2 = r_1r_2\ \mathrm{cis}(\theta_1 + \theta_2).$$

That is, the absolute value of a product is equal to the product of the absolute values of the factors, and the argument of the product is equal to the sum of the arguments of the factors. This leads to a simple graphic method of multiplying two complex numbers $a + bi$ and $c + di$. Construct a triangle upon the real unit segment with one of the vectors, say $a + bi$, as the other side. Construct a similar triangle upon the other vector $c + di$. The corresponding side to $a + bi$ of this second triangle will represent the product $(a + bi)(c + di)$.

Since every equation such as $x^i - (a + bi) = 0$ has n complex solutions, it follows that every complex number has n complex n-th roots. De Moivre's theorem states that

$$(r\ \mathrm{cis}\theta)^n = r^n \mathrm{cis}n\theta,\ r\ \mathrm{cis}\theta = (\sqrt[n]{r}\ \mathrm{cis}\frac{\theta + 2k\pi}{n})^n,$$

$$k = 0,1,2,\cdots,n-1.$$

Thus to find the n-th roots of $r\ \mathrm{cis}\theta$, draw a circle of radius $\sqrt[n]{r}$ and draw a radius whose argument is θ/n. This is one root. Divide the circumference into n equal parts, and draw the n

equally spaced radii of which the first root is one. These radii are the n n-th roots of $r \operatorname{cis}\theta$.

The power function in the complex field is, except in special cases, multiple-valued. That is,

$$(r \operatorname{cis}\theta)^{s\,\mathrm{cis}\varphi} = q \operatorname{cis}\xi$$

where q and ξ are defined by the equations

$$\xi = s \sin\varphi \cdot \log r + s(\theta + 2n\pi)\cos\varphi,$$
$$\log q = s \cos\varphi \cdot \log r - s(\theta + 2n\pi)\sin\varphi, \quad n = 0, \pm 1, \pm 2, \ldots$$

Automorphisms.—Mathematicians have been bothered by their inability to draw any genuine distinction between the numbers i and $-i$. The number $a - bi$ is called the conjugate (Cauchy) of the number $a + bi$.

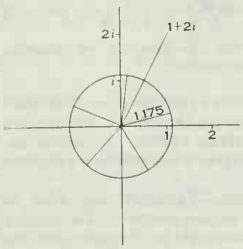

FIG. 4.—ROOTS OF A COMPLEX NUMBER

The conjugate of a sum is equal to the sum of the conjugates, and the conjugate of the product is equal to the product of the conjugates of the factors. In modern terminology, it is said that the correspondence between $a + bi$ and $a - bi$ is an automorphism of the complex field. The complex solutions of an equation with real coefficients occur in conjugate pairs.

Number Theory.—The numbers of the form $a + bi$ where a and b are rational constitute the Gaussian complex field. The numbers of this type where a and b are rational integers form an integral domain or ring very like the ring of ordinary rational integers or whole numbers.

The norm (Gauss) of $a + bi$ is $a^2 + b^2$, and the norm of a product is equal to the product of the norms of the factors. The numbers of norm 1 are the units, namely $1, -1, i$ and $-i$.

A number which is neither 0 nor a unit is called composite or prime according as it can or cannot be written as a product of two numbers neither of which is a unit. There exists a Euclid algorithm in this ring. That is, if $\beta \neq 0$ and α are two numbers of the ring, there exist two other numbers κ and ρ such that $\alpha = \beta\kappa + \rho$ where the norm of ρ is less than the norm of β. Then every two numbers have a greatest common divisor expressible linearly in terms of the numbers. Consequently the Fundamental Theorem of Arithmetic holds for this ring: Every number $\neq 0$ is factorable into a finite number of prime numbers and, save for unit factors and the order of the factors, this representation is unique.

If p is a rational prime of the form $4k + 1$, it is the product of two distinct conjugate complex primes; a rational prime of the form $4k + 3$ is a complex prime; and $2 = i(1 - i)^2$ where $1 - i$ is a complex prime. Much of ordinary number theory carries over to the complex integers.

Quaternions.—In 1843 Hamilton generalized the complex field to the algebra of real quaternions $a + bi + cj + dk$ where $i^2 = j^2 = k^2 = -1$, $ijk = -1$. Most of the ordinary laws of arithmetic hold for such numbers except that the order of multiplication is not usually immaterial.

In the hands of Josiah Willard Gibbs and Oliver Heaviside and others, the quaternion algebra has been developed into modern vector analysis, a method which is of great importance in mechanics, electricity and other branches of applied mathematics. (*See* NUMBER; NUMBER SEQUENCES.)

Hypercomplex Numbers.—This term is applied to numbers of the type $a_1e_1 + a_2e_2 + \ldots + a_ne_n$ where the a's are numbers of a field, the e's are linearly independent with respect to this field, and $e_ie_j = c_{ij1}e_1 + c_{ij2}e_2 + \ldots + c_{ijn}e_n$. Complex numbers and quaternions are special examples. The associative law of multiplication is usually assumed, but not the commutative law. (*See* ALGEBRAS [LINEAR].)

Functions of a Complex Variable.—One of the most extensive and useful branches of mathematics is the theory of functions of a complex variable. Let $z = x + iy$ where x and y are real variables and $i^2 = -1$. Then $w = u + iv$ is a function of z if u and v are functions of x and y. This function is analytic (or regular, or holomorphic or monogenic) if u and v are differentiable and if the Cauchy-Riemann conditions hold, viz.

$$\partial u/\partial x = \partial v/\partial y, \qquad \partial u/\partial y = -\partial v/\partial x.$$

This theory is considered extensively elsewhere (*see* FUNCTIONS, ANALYTIC).

See NUMBER: *Complex Number System;* ROOT; *see* also references under "Complex Numbers" in the Index volume.

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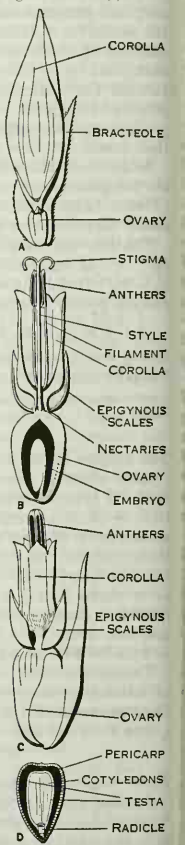
COMPLINE (Lat. *completorium*, "the completion"), in the Roman Catholic Church (and in Anglican religious orders), is the last hour of the divine office, said before retiring. *See* BREVIARY; HOURS, CANONICAL.

COMPOSITAE, the name given to the largest family of flowering plants. It includes more than 900 genera and over 14,000 species. In North America over 200 genera are represented by many species distributed over the whole country.

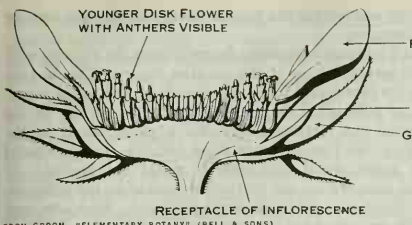
The family is characterized by crowding of the flowers or florets into heads. It is cosmopolitan, and the plants show considerable variety in habit. The great majority, including most British representatives, are herbaceous, but in the warmer parts of the world shrubs and arborescent forms also occur. In herbaceous plants the leaves are often arranged in a rosette on a much shortened stem, as in dandelion, daisy and others; when the stem is elongated the leaves are generally alternate. The root is usually thickened, sometimes, as in dahlia, tuberous; root and stem contain oil passages, or, as in lettuce and dandelion, a milky white latex. The flower heads (*capitula*) are surrounded by an involucre of green bracts—these protect the head flowers in the bud stage, performing the usual function of a calyx. The enlarged top of the axis, the receptacle, is flat, convex or conical, and the flowers open in centripetal succession, from the margin to the centre of the head. In many cases, as in the sunflower or daisy, the outer or ray florets are larger and more conspicuous than the inner, or disk florets; in other cases, as in dandelion, the florets are all alike. Ray florets when present are usually pistillate, but neuter in some genera (as *Centaurea*); the disk florets are hermaphrodite. The flower is borne atop the ovary (epigynous); the calyx is sometimes absent, or is represented by a rim on the top of the ovary, or takes the form of hairs or bristles that enlarge in the fruiting stage to form the pappus, by means of which the seed is dispersed. The corolla, of five united petals, is regular and tubular in shape in the disk florets, or irregular, when it is either strap-shaped (ligulate), as in the ray florets of daisy, etc., and all the florets of dandelion, or more rarely two lipped. The five stamens are attached to the interior of the corolla tube; the filaments are free; the anthers are joined (syngenesious) to form a tube around the single style, ending in a



FROM PERCY GROOM, "ELEMENTARY BOTANY" (BELL & SONS)

FIG. 1.—SUNFLOWER, SHOWING DETAILS OF STRUCTURE

A. Ray flower, which has no stamens, style, or stigma
B. Vertical section through an inner floret
C. Inner floret; regular, with tubular five-toothed corolla, stamens and pistil
D. Vertical section of the one-seeded fruit



FROM GROOM, "ELEMENTARY BOTANY" (BELL & SONS)

FIG. 2.—VERTICAL SECTION THROUGH THE FLOWER HEAD OF THE SUNFLOWER

pair of stigmas. The inferior ovary contains one ovule (attached to base of chamber), and ripens to form a dry one-seeded fruit, a typical achene; the seed is filled with the straight embryo.

The flower heads are an admirable example of an adaptation for pollination by insects. The crowding of the florets in heads ensures the pollination of a large number as the result of a single insect visit. Nectar is secreted at the base of the style, and is protected from rain or dew and the visits of short-lipped insects by the corolla tube, the length of which is correlated with the length of proboscis of the visiting insect. When the floret opens, the two stigmas are pressed together below the tube formed by the anthers, the latter split on the inside, and the pollen fills the tube; the style gradually lengthens and carries the pollen out of the anther tube, and finally the stigmas spread and expose the receptive surface, which has hitherto been hidden. Thus the flower is earlier a male and later a female. This favours cross-pollination as compared with self-pollination. In many cases there is a third stage, as in dandelion, where the stigmas finally curl back so that they touch any pollen grains that have been left on the style below, thus ensuring self-pollination if cross-pollination has not been effected.

Devices for distribution of the fruit are varied. Frequently there is a hairy or silky pappus, forming a tuft of hairs, as in thistle or coltsfoot, or a parachutelike structure, as in dandelion; these render the fruit sufficiently light to be carried by the wind. In *Bidens* the pappus consists of two or more stiff-barbed bristles by which the fruit clings to the coats of animals. Occasionally, as in sunflower or daisy, the fruits bear no special appendage and remain on the head until jerked off.

Composites are generally considered to represent the most highly developed family of flowering plants. As alluded to earlier, by the massing of the flowers in heads great economy is effected in the material required for one flower, as a large number of flowers are visited at one time by the pollinating insect.

A few members of the family are of economic value, *e.g.*, *Lactuca* (lettuce), *Cichorium* (chicory), *Cynara* (artichoke and cardoon), *Helianthus* (Jerusalem artichoke). Many are cultivated as garden or greenhouse plants, such as *Solidago* (goldenrod), *Ageratum*, *Aster*, *Helichrysum* (everlasting), *Zinnia*, *Rudbeckia*, *Helianthus* (sunflower), *Coreopsis*, *Dahlia*, *Tagetes* (French and African marigold), *Gaillardia*, *Achillea* (yarrow), *Chrysanthemum*, *Tanacetum* (tansy), *Arnica*, *Doronicum*, *Cineraria*, *Calendula*, *Echinops* (globe thistle), *Centaurea*. Some are of medicinal value, such as *Anthemis* (camomile), *Artemisia* (wormwood), *Tussilago* (coltsfoot), *Arnica*. Insect powder is prepared from species of *Pyrethrum* in the genus *Chrysanthemum*. A species of *Parthenium*, guayule, is a source of rubber.

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FIG. 3.—BLUEBOTTLE OR CORNFLOWER (CENTAUREA CYANUS)

The family is divided into two subfamilies: Tubuliflorae, characterized by absence of latex, and the florets of the disk being not ligulate, and Liguliflorae, characterized by the presence of latex and all the florets being ligulate. The first subfamily contains the majority of the genera, and is divided into a number of tribes.

The Compositae is well represented in Britain, in which about 40 genera are native. These include some of the commonest weeds, such as dandelion (*Taraxacum officinale*), daisy (*Bellis perennis*), groundsel (*Senecio vulgaris*) and ragwort (*S. jacobaea*); coltsfoot (*Tussilago farfara*) is one of the earliest plants to flower, and other genera are *Chrysanthemum* (oxeye daisy and corn marigold), *Arctium* (burdock), *Centaurea* (knapweed and cornflower), *Carduus* and *Cnicus* (thistles), *Hieracium* (hawkweed), *Sonchus* (sow thistle), *Achillea* (yarrow, or milfoil, and sneezewort), *Eupatorium* (hemp agrimony), *Gnaphalium* (cudweed), *Erigeron* (fleabane), *Solidago* (goldenrod), *Anthemis* (mayweed and camomile), *Cichorium* (chicory), *Lapsana* (nipplewort), *Crepis* (hawk's-beard), *Hypochaeris* (cat's-ear) and *Tragopogon* (goatsbeard).

See separate articles on the various composites; *see* also references under "Compositae" in the Index.

COMPOSITE ORDER: *see* ORDER.

COMPOUND, a chemical substance that can be prepared by the combination of simpler substances or that can be resolved by ordinary chemical methods into simpler constituents, as opposed to a chemical element.

See ELEMENTS, CHEMICAL; MOLECULE.

COMPRESSION. This word is applied to many industrial processes, including the reduction in volume of air and gases for use or storage purposes, that of loose substances for convenience of transport, fluid compression in steel ingot making to drive out gases and produce sound steel, the testing of materials by forces tending to crush them and the production of gasoline from natural gas. In steam-engine cylinders the steam is compressed at the end of the stroke, to exert a cushioning effect and to prevent sudden shock to the parts at reversal. Higher speeds and smoother working are thus possible. Compression of the charge in a cylinder of an internal-combustion engine occurs preparatory to combustion. The fuel is ignited in the diesel engine by compressing the air so highly in the cylinders that ignition temperature is attained. *See* INTERNAL-COMBUSTION ENGINE; STEAM; *see* also references under "Compression" in the Index.

COMPRESSOR, a device for mechanically decreasing the volume of a gas or vapour by increasing its pressure. Although the most frequently compressed gas is air, others often compressed are the various refrigerants, natural gas, oxygen, nitrogen, carbon dioxide, hydrocarbons and numerous other gases of industrial importance. Compressors may be classified into three general types: positive displacement, centrifugal and axial. These types are discussed in order and are followed by discussion of efficiency, booster compressors and compressed air.

Positive Displacement Compressors.—Nearly all compressors in this category are of the reciprocating piston type in which the gas is compressed in a cylinder in the manner illustrated in fig. 1. After having compressed and delivered a charge of gas at the pressure P_2 the piston is in the position represented by A in the diagram.

As it moves toward the right the air trapped in the clearance volume of the cylinder expands along the line AB. At B the pressure in the cylinder falls below that in the inlet line, forcing open the inlet valve. A new charge of air is thus drawn into the cylinder until the piston reaches the end of its stroke at point C. As the piston begins its return stroke the inlet valve is forced shut and the charge of air is compressed along the line CD. At the point D the pressure in the cylinder reaches a value sufficient to force the spring loaded discharge valve open, thus permitting the volume of air represented between points D and A to be discharged at the pressure P_2.

Compressors in which the entire pressure increase is accomplished in a single step as in fig. 1 are called single-stage compres-

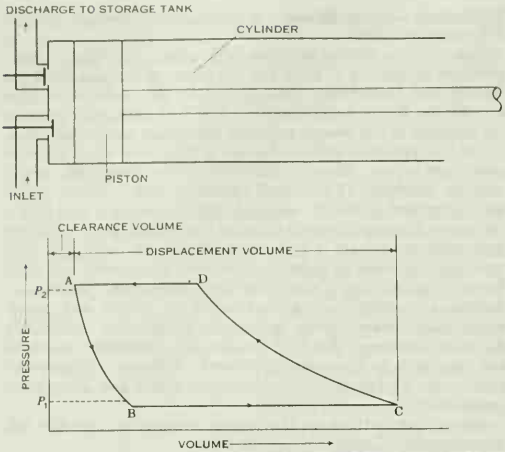


FIG. 1.—DIAGRAM SHOWING THE PRINCIPLE OF OPERATION OF A RECIPROCATING COMPRESSOR

sors. If a second stage of compression is employed, the discharge from the first-stage cylinder is delivered to the intake of a second-stage cylinder in which the gas is further compressed to a higher pressure. During the compression process the gas tends to increase in temperature so that some form of cooling is necessary. In small low-pressure designs, fins on the outside of the cylinders are sufficient. In larger compressors, water-jacketed cylinders are commonly employed. In two-stage machines, intercoolers may be used in which the air is reduced in temperature between stages by means of a water-cooled heat exchanger.

Reciprocating compressors are widely employed for the compression of air and refrigerant gases. They range in size from small single-cylinder units to large multicylinder installations capable of compressing thousands of cubic feet of gas per minute. Reciprocating compressors are the only type suited for compressing air and other gases to extremely high pressures.

Centrifugal Compressors.—Centrifugal compressors operate on the principle of increasing the kinetic energy of the gas with a high-speed impeller and subsequently converting this kinetic energy into increased pressure in a divergent outlet passage called the diffuser. The principle of operation of a centrifugal compressor is illustrated in fig. 2. Air enters the impeller eye with a low velocity and leaves the impeller at the periphery with a much higher velocity V which is the resultant of the tangential velocity V_t and the velocity of the impeller blade V_r. In the diffuser the velocity V is reduced to a low value at discharge causing the pressure to rise by converting the kinetic energy of the gas into an increase in pressure.

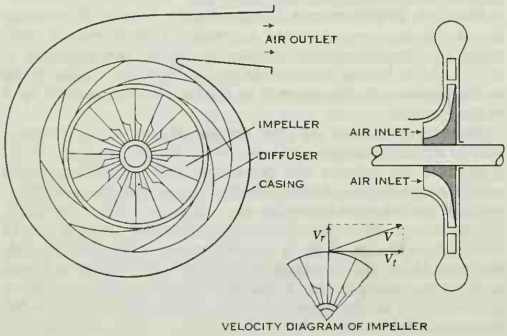


FIG. 2.—DIAGRAM OF IMPELLER, DIFFUSER AND CASING FOR A CENTRIFUGAL COMPRESSOR

The pressure increase obtainable depends upon the velocity with which the air leaves the tip of the impeller blades. This in turn is limited by the centrifugal force that the blades can safely stand. Another factor influencing the pressure rise is the density of the gas. In general the increase obtainable is proportional to the density, making the heavier gases more suitable for centrifugal compression, especially if high-pressure ratios are desired.

Centrifugal compressors are particularly suited to the compression of large volumes of gas to moderate pressures. Such compressors are widely employed for the compression of Freon refrigerant vapours in large refrigeration and air-conditioning installations. They have also been used in stationary gas turbines as well as in jet engines. In the latter application the centrifugal compressor has the disadvantage of offering a larger frontal area than does the axial compressor (*see* below) and has therefore been largely abandoned for that application. However, some of the earlier jet engines employed compressors of this type.

Axial Compressors.—This design derives its name from the fact that the flow through the compressor is in the axial direction; that is, parallel to the axis of rotation as in a common household fan. Axial-flow compressors differ from fans in that they are designed to increase the pressure of the gas by a substantial amount whereas fans are usually employed simply to move air. The most common application of axial compressors is in jet aircraft engines and in gas turbines.

The basic principle of operation of the axial-flow compressor

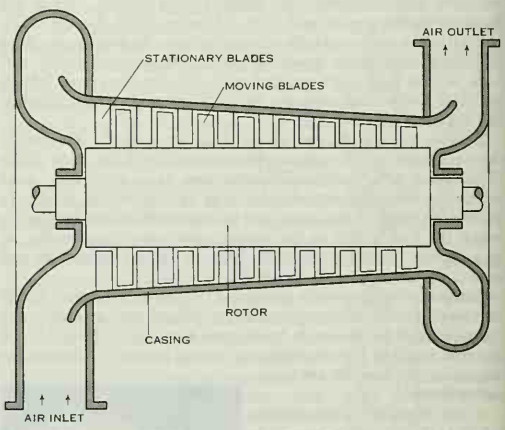


FIG. 3.—CROSS SECTION OF AN AXIAL-FLOW COMPRESSOR

is alternately to increase and decrease the velocity of the gas flowing through the compressor. During each increase in velocity the kinetic energy of the gas is increased and during each decrease in velocity this kinetic energy is converted into an increase in pressure.

The process is accomplished by means of a large drum-type rotor having many rows of aerodynamically shaped blades extending outward from it in a radial direction. This rotor is surrounded by a stationary casing, which also contains a similar number of rows of blades that extend inward and fit between the rows of blades on the rotor.

When assembled the two halves of the casing fit together around the rotor to form an annular passage into which the blades extend and through which the gas flows as it is compressed. A cross-sectional drawing of a typical axial compressor is illustrated in fig. 3.

Various blade designs accomplish different objectives with respect to the flow pattern through the compressor. A typical one that will illustrate the principle of operation of axial compressors is represented in fig. 4. The row of moving blades attached

to the rotor and the row of stationary blades attached to the casing may be taken as typical for a single stage of compression. The moving blades travel to the right with the velocity V_b and the entering gas travels in the direction shown with the velocity V_1. The moving blades catch this entering gas and give it a whirl in the direction of rotation so that it leaves the moving blades with a relative velocity V_{r2} but with an actual velocity relative to the next row of stationary blades equal to V_2. Thus, in passing through the moving row of blades the gas has been given an increase in velocity from V_1 to V_2. This requires an addition of energy to the rotor that must be supplied by some outside source such as an electric motor or turbine. The gas with the velocity V_2 next enters the stationary row of blades. In passing through these the gas is turned somewhat in the axial direction and leaves the stationary blades with the velocity V_1. In passing through the stationary blades, therefore, the gas has suffered a decrease in velocity from V_2 to V_1. This results in the desired increase in pressure across the stage. Since the velocity change is small the pressure rise is also small. By employing a number of stages in series, however, the desired over-all pressure increase can be obtained.

As already indicated this type of compressor is used principally for jet aircraft engines and gas turbines. For a discussion of the role of the compressor in jet engines and gas turbines, *see* TURBINE: GAS.

Efficiency of Compressors.—The efficiency of compressors is defined as the ratio of the work required to compress the gas isentropically, *i.e.*, at constant entropy, to the work actually delivered to the rotor, impeller or crankshaft. In well-designed axial and centrifugal compressors this ranges between 0.80 and 0.90 with typical values being approximately 0.85. About the same efficiency may be expected with large reciprocating machines.

Booster Compressors.—In the transportation of natural gas by pipeline, booster compressor stations are employed at regular intervals along the lines in order to restore pressure loss between stations. These compressors are high-capacity, low-pressure ratio machines of either the centrifugal or reciprocating type. They may be driven in a number of ways: with gas engines, gas turbines, steam turbines or electric motors. The pressure in the pipelines is usually maintained between about 500 and 1,200 lb. per square inch. Pressure ratios across the machines may be anywhere from about 1.1 to 1.8 depending on the distance between stations and other factors.

Compressed Air.—No other power agent with the possible exception of electricity has such a varied range of uses as compressed air. In the category of free action it is employed in jets of all kinds, such as, for example, sandblasting, the cleaning of machinery and fabrics, the spraying of paints and other similar applications. There also are numerous methods in which air, expanding in a cylinder or small turbine, can be used for operating portable pneumatic tools and other devices. In addition, compressed air is used for brakes on trains and heavy vehicles, for pressurizing aircraft passenger compartments, for the operation of hoists and in many thousands of filling stations and garages for the inflation of tires and other applications.

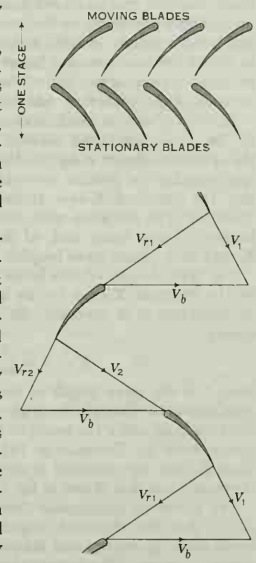


FIG. 4.—DIAGRAM SHOWING THE BLADE ARRANGEMENT FOR A SYMMETRICAL-TYPE AXIAL-FLOW COMPRESSOR (ABOVE) AND VELOCITY DIAGRAM SHOWING THE VELOCITIES OF GAS AT INLET AND OUTLET OF TYPICAL BLADE ROWS (BELOW)

BIBLIOGRAPHY.—Compressed Air and Gas Institute, *Compressed Air Handbook*, 2nd ed. (1954); British Compressed Air Society, *Technical Reference Book of Compressed Air Terms and Standards* (1956); V. M. Faires, *Thermodynamics*, 3rd ed. (1957); D. G. Shepherd, *Principles of Turbomachinery* (1956). (RD. A. BR.)

COMPROMISE OF 1850, a term referring to the series of five measures passed by the U.S. congress in Sept. 1850 in an effort to settle outstanding issues involving slavery and to avert the threat of disunion.

When the 31st congress met on Dec. 3, 1849, it was faced with a request from California for admission to the union with a constitution excluding slavery. The question of the extension of slavery into the territory ceded by Mexico in 1848 had created severe tension, both in congress and in the country generally. The request of California compelled congress to take a stand on the larger question, for failure to admit California with the constitution of its own choice would certainly have led to separatist movements on the west coast. Northern antislavery groups supported California vigorously, but southern leaders generally were as determined in their opposition, partly because the admission of California would upset the traditional numerical balance between free and slave states. (There were then 15 slave states and 15 free states.) This southern opposition became more determined when Pres. Zachary Taylor, himself a slaveholder, unexpectedly supported California and gave some encouragement to a move to establish a free state in New Mexico. Southern extremists countered by calling a convention of the southern states to meet in Nashville, Tenn., in June 1850, to discuss ways of defending southern interests against what they asserted was a continuing denial of justice to their section. It appeared that only some compromise acceptable to moderates in all sections could prevent a sectional schism.

At the close of Jan. 1850, Sen. Henry Clay of Kentucky had initiated the first major effort at compromise when he introduced five bills which, he hoped, would give some satisfaction to both the slavery and the antislavery groups. These bills provided for the admission of California with the constitution it had already adopted, the organization of the remaining part of the Mexican cession into the territories of New Mexico and Utah without any provision concerning slavery, a new and more rigorous law for the return of fugitive slaves, the prohibition of the slave trade in the District of Columbia, and the assignment to New Mexico of the territory in dispute with Texas, giving the latter compensation in the form of the assumption by the federal government of Texan debts to the amount of $10,000,000.

These proposals precipitated one of the great senate debates of the 19th century. Clay, Thomas Hart Benton of Missouri, Daniel Webster of Massachusetts and John C. Calhoun of South Carolina were among the participants. Webster supported Clay, arguing that legislation offensive to the south was unnecessary because slavery could not prosper in the territories of the far west. Calhoun defended the extreme southern position, alleging that the northern majority was systematically infringing the rights of his section. A younger senator, William H. Seward of New York, presented the antislavery position in asserting that there was a moral law more sacred than the constitution. The measures were referred to a special committee, which reported them as a single bill, known as the omnibus bill. It was defeated, however, partly because it was opposed by President Taylor, who declared that the admission of California should not be contingent upon action on any other measure. The crisis had reached an ominous impasse.

On July 9, President Taylor died after a brief illness. His successor, Millard Fillmore, favoured the compromise proposals. The five measures included in the omnibus bill were brought forward by Stephen A. Douglas of Illinois, and after a brief debate they were passed by the senate as separate bills. Before the end of September they had passed the house of representatives and had become law.

The outcome was accepted by moderates in all sections, and the secession of the southern states had been postponed for a decade. The compromise, however, contained the seeds of future discord. The opening of New Mexico and Utah to slavery led to the de-

mand, in 1854, for similar action in Kansas, while the new fugitive slave law contained provisions so obnoxious to moderate anti-slavery elements that they became determined opponents of any further extension of the area open to slavery. By its very nature, the compromise could be only a temporary expedient. *See* also UNITED STATES OF AMERICA: *History*. (H. W. BY.)

COMPTON, ARTHUR HOLLY (1892–1962), U.S. physicist who in 1923 discovered the change in the wave length of X-rays when scattered by matter, the phenomenon known as the Compton effect (*q.v.*). He was born in Wooster, O., Sept. 10, 1892. In recognition of his achievements in research he was awarded in 1927, jointly with C. T. R. Wilson of England, the Nobel prize for physics. From 1942 to 1945 he served as director of the metallurgical laboratory at The University of Chicago which developed the first self-sustaining atomic chain reaction, paving the way for the controlled release of nuclear energy.

He was educated at the College of Wooster (Wooster, O.) and at Princeton university where he received the Ph.D. in 1916. Following teaching and industrial research experience and a year of advanced study in England he was made professor and head of the department of physics in Washington university, St. Louis, Mo. In 1923 he was appointed professor of physics at The University of Chicago and later served as chairman of the department of physics and dean of the division of the physical sciences. He returned to Washington university as chancellor in 1945 and served until 1953, at which time he became distinguished service professor of natural philosophy. He resigned this post in 1961 and died at Berkeley, Calif., on March 15, 1962.

In addition to many scientific articles Compton wrote *Secondary Radiations Produced by X-rays* (1922), *X-rays and Electrons* (1926), *Freedom of Man* (1935), *X-rays in Theory and Experiment* (with S. K. Allison, 1935), *Human Meaning of Science* (1940) and *Atomic Quest* (1956). (E. T. F.)

COMPTON, HENRY (1632–1713), bishop of London who played a leading part in English politics during the crisis of James II's reign, was born at Compton Wynyates, Warwickshire, and educated at Queen's college, Oxford. Ordained in 1666, he became bishop of Oxford in 1674 and of London in 1675. His staunch Protestantism brought him into disfavour with James II, who in 1685 deprived him of his seat in the privy council. Next year, for refusing to suspend John Sharp, rector of St. Giles-in-the-Fields, whose antipapal sermons had offended the king, Compton was himself suspended. He gave his support to the seven bishops who made a petition against the king's Declaration of Indulgence (1687) and was the only ecclesiastic to sign the invitation to William of Orange to come to England. When John Tillotson was preferred to him as archbishop of Canterbury (1691), Compton therefore suffered a bitter disappointment. Under Queen Anne, Compton gave full support to the Tories, and Francis Atterbury, bishop of Rochester, was his protégé. As bishop of London Compton gave every encouragement to the newly founded Society for the Propagation of the Gospel and to missionary work in America. He died at Fulham, July 7, 1713.

See E. F. Carpenter, *The Protestant Bishop* (1956). (G. HU.)

COMPTON EFFECT, the increase in wave length, or the reduction in frequency, of X-rays and gamma rays that have been scattered by electrons. This change in quality of the radiation depends markedly on the angle through which the rays are scattered, the change being greater for larger angles. When discovered by Arthur H. Compton in 1923, this phenomenon posed crucial problems for physics. The explanation provided by Compton required that radiation have a corpuscular nature in which each quantum or photon carries directed momentum as well as energy. However, these corpuscular properties of radiation were entirely inconsistent with its long-established wave properties, and to preserve these physicists wondered whether the Compton effect might not require the abandonment of the basic laws of conservation of energy and momentum in atomic processes. However, with the discovery and development of quantum mechanics (*q.v.*) it was shown that not only radiation, but matter as well, possesses both wave and corpuscular properties, and thus the Compton effect became one of the basic phenomena of physics.

Discovery of Compton Effect.—Soon after the discovery of X-rays (*q.v.*) by W. C. Röntgen it was realized that this radiation would be a powerful source for investigating the nature of matter. One of the most important uses was found by J. J. Thomson, who investigated the process of X-ray scattering by matter on the theory that electrons bound in atoms oscillate under the action of the X-rays and thus reradiate energy. In this process X-rays are scattered without change in wave length or frequency exactly as visible light is scattered by the earth's atmosphere. However, in 1912, C. A. Sadler and P. Mesham conducted scattering experiments with X-rays of short wave length produced by X-ray tubes operated at high voltages, and showed that these X-rays after being scattered by light elements are of longer wave length than before being scattered. Similar results were found in 1920 by J. A. Gray for scattered gamma rays. Gray also found that the increase in wave length of the scattered gamma rays, as revealed by their greater absorption, increases with the angle of scattering. Compton had also observed the increased wave length of scattered gamma rays in experiments conducted at Cambridge university, as early as 1919, and continued a systematic investigation of this phenomenon.

In 1923 Compton published a full discussion of the secondary radiations produced by X-rays, including the changes produced in X-rays by scattering. At the same time he proposed an entirely new theoretical explanation, suggesting that when an X-ray is scattered, it shares its energy and momentum with a single electron. *See* ELECTRON.

Photons and Recoil Electrons.—The Compton theory of X-ray scattering considered X-rays to be corpuscular photons or quanta similar to those introduced by Einstein in 1905 to explain the photoelectric effect (*see* PHOTOELECTRICITY). The important new idea introduced by Compton was that momentum as well as energy must be considered as being carried by individual corpuscles, or photons, of radiation. The Compton theory of X-ray scattering from electrons predicted the reduced frequency of the scattered radiation, and explained it as being caused by electrons whose recoil took up the difference in energy and momentum between incident and scattered X-ray photons. This effect becomes increasingly prominent as the frequency of the X-rays is increased, and is most clearly evident with scatterers of low atomic number in which the electrons are loosely bound. The Compton theory of X-ray scattering was one of the first atomic theories to take full account of the theory of relativity.

In 1923 Compton made accurate spectrographic measurements of the X-ray scattering through an angle ϕ from carbon, using the apparatus shown in fig. 1. He employed a Bragg X-ray crystal spectrometer for precise wave-length determinations and showed that the scattered X-rays contain radiations of two kinds: the Thomson type radiation with wave length identical to that in the incident X-ray beam and, of far greater significance, modified X-rays with longer wave lengths.

The wave length of this latter type radiation differs from that of the incident X-rays by an amount depending on the angle of scattering ϕ in precisely the way predicted by the Compton theory.

$$\lambda' - \lambda = \frac{h}{mc}(1 - \cos\phi)$$

Here λ is the wave length of the incident X-rays, λ' that of the rays scattered through the angle ϕ, h is Planck's constant, m the electron mass and c the speed of light. Fig. 2 shows the measurements made by Compton in 1923 of the change in wave length when X-rays are scattered at several different angles. The apparatus used was that shown in fig. 1.

The Compton corpuscular theory of X-ray scattering also predicted that the electrons responsible for the scattering should recoil with the energy and momentum necessary to balance each scattering event. The energy thus gained by an electron recoiling at an angle θ is

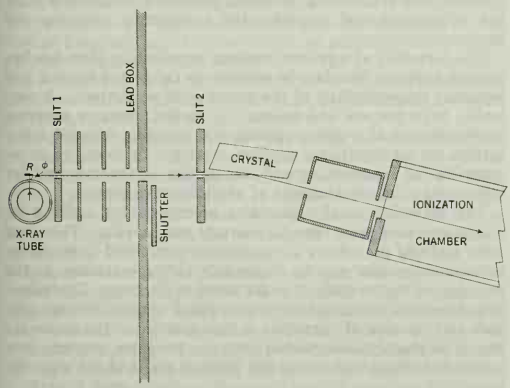
$$E = \frac{hc}{\lambda}\,\frac{2\alpha\cos^2\theta}{(1+\alpha)^2 - \alpha^2\cos^2\theta}, \text{ where } \alpha \equiv \frac{h}{\lambda mc}$$

Such recoil electrons were observed in cloud-chamber photographs

taken by C. T. R. Wilson at Cambridge, Eng., in 1923, and their observed energies were shown by Compton and J. C. Hubbard to be consistent with the established theory.

As soon as the basic phenomena of the Compton effect were established, they raised very serious problems concerning the foundations of atomic physics. Since the Compton theory explained the phenomena by wholly corpuscular properties of radiation and electrons, it first seemed that either the wave theory of light or the basic principles of conservation of energy and momentum in individual scattering events must be abandoned. In an effort to reconcile the wave nature of X-rays with the Compton effect, N. Bohr, H. A. Kramers and J. C. Slater proposed in 1924 a statistical theory for the phenomenon. In this they abandoned the conservation of energy and momentum for individual scattering events between X-rays and electrons, and considered these conservation laws as holding only for the statistical average of a large number of such interactions. This compromise was not needed, for in the years following its discovery, the Compton effect proved to be one of the most important cornerstones of quantum mechanics, which requires both wave and corpuscular properties for matter as well as for radiation.

Simultaneity.—A crucial experimental test was soon proposed for deciding between the Bohr, Kramers and Slater view and the Compton scattering theory. A basic requirement of the Compton theory is that the scattered X-ray photon and recoil electron should appear at the same instant of time, while according to the Bohr, Kramers and Slater hypothesis, these events would occur at random. An experiment using two Geiger counters was carried out in 1925 by W. Böthe and H. Geiger; this demonstrated that in many cases the scattered photon which actuated one counter and the recoil electron which discharged the other counter appeared within 10^{-2} sec. of each other. Although this is not high resolution, it was nevertheless concluded that the number of such coincidences observed was very much larger than the number which could be expected on a purely random basis. The Böthe-Geiger type of experiment has been repeated by several experimenters, and any possible time interval between the appearance of recoil electron and scattered photon has been steadily reduced. In 1936 R. S. Shankland showed that this time interval is less than 10^{-4} sec., a result also found in experiments by W. E. Burcham and W. B. Lewis. Much faster electronic techniques and scintillation counters were available by 1950, and they were employed by R. Hofstadter and J. A. McIntyre to show that any possible time lag is less than 10^{-8} sec.; in 1952 R. E. Bell further reduced the interval to 10^{-10} sec. By the mid-1950s there was not the slightest doubt regarding this aspect of the Compton theory. It should be mentioned that the quantum theory of Compton scattering permits a time lag of about 10^{-19} sec., an interval far shorter than any possible experimental observation.



FROM A. H. COMPTON, "X-RAYS AND ELECTRONS"; COPYRIGHT D. VAN NOSTRAND CO., INC., PRINCETON, N.J. (1926)

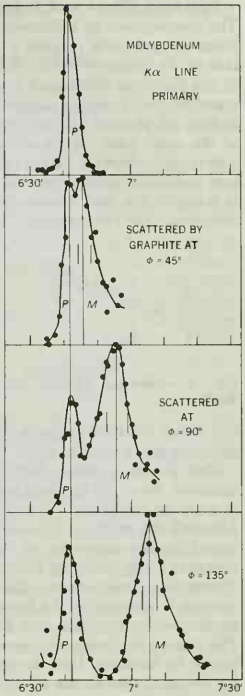
FIG. 1.—APPARATUS USED BY A. H. COMPTON IN 1923 TO PROVE THAT X-RAYS OF A SINGLE WAVE LENGTH SCATTERED THROUGH AN ANGLE ϕ FROM GRAPHITE SCATTERER R CONTAIN A MODIFIED COMPONENT AT A LONGER WAVE LENGTH AS ANALYZED BY A BRAGG X-RAY CRYSTAL SPECTROMETER

Conservation of Energy and Momentum.—A much more stringent test for the quantum theory of the Compton effect is to observe the angles at which recoil electron and scattered photon pairs travel out from the point of scattering. The Compton theory predicts that

$$\cot \theta = -(1 + \alpha) \tan \frac{\phi}{2}$$

This angular relationship as shown in fig. 3 was first tested by Compton and A. W. Simon in cloud-chamber observations of the scattering of high-energy X-rays. They could establish the initial direction of motion of the recoil electron track and in certain cases found at another point in the cloud chamber the track of a second electron ejected from an atom by the scattered X-ray photon. The momentum vectors for the incident X-ray photon, the scattered X-ray photon and the recoil electron satisfied the conservation laws for energy and momentum. The number of cases in which these related pairs of electrons were observed at the expected angles was not large, but seemed sufficient to confirm the theoretical predictions.

A test of both the angular relationship and the time coincidence was made by Shankland in 1936. These experiments employed Geiger counters placed at the predicted angles ϕ and θ of fig. 3, in a circuit which recorded time coincidences between the counter discharges. The observations proved that the angular relationship is confirmed to an accuracy of $\pm 10^0$, and that no time lag as great as 10^{-4} sec. occurs between the counter discharges. Similar experiments giving confirmation of both the angular relationship and simultaneity were performed by J. C. Jacobson, by G. Bernardini and S. Franchetti, and by W. Böthe and H. Maier-Leibnitz. In 1950 W. G. Cross and N. F. Ramsey, using the much faster coincidence counting methods and more efficient scintillation detectors then available, confirmed the angular relationship to within $\pm 1^0$, and reduced any possible time lag to 10^{-8} sec. They also confirmed that the three vectors shown in fig. 3 are in the same plane, as they must be for momentum to be conserved. Fig. 4 shows the apparatus used by Cross and Ramsey in these experiments, in which gamma rays are scattered by electrons in a beryllium foil. The electrons recoiling to the electron counter are accompanied by modified gamma rays traveling to the gamma-ray counter. The recoil electron and scattered photon pairs discharge these counters simultaneously when the counters are set at the angles predicted by the Compton theory. The experimental proof of the angular predictions of the Compton theory and of simultaneity in the scattering events is a conclusive proof that both energy and momentum are conserved in individual Compton scattering events between X-rays and electrons. These results constituted an essential step beyond the mere demonstration of simultaneity as provided by the Böthe-Geiger type of experiment.



FROM A. H. COMPTON, "X-RAYS AND ELECTRONS"; COPYRIGHT D. VAN NOSTRAND CO., INC., PRINCETON, N.J. (1926)

FIG. 2.—X-RAY SPECTRA OBTAINED BY A. H. COMPTON WITH THE APPARATUS SHOWN IN FIG. 1, PROVING THE PROGRESSIVE CHANGE IN WAVE LENGTH OF THE COMPTON-MODIFIED LINE M FOR VARIOUS SCATTERING ANGLES ϕ. P INDICATES THE UNMODIFIED SCATTERED LINE

Compton Effect and Relativistic Quantum Mechanics.—The development of relativistic quantum mechanics by P. A. M. Dirac in 1928 made possible a very basic description and explanation of the Compton effect. While the original corpuscular theory of the Compton effect gave great impetus to the development of quantum theory, and in particular to the view that radiation travels in directed photons having discrete energy and momentum, it had at the same time raised serious questions about the seemingly well-established wave nature of light. However, relativistic quantum mechanics gives a general description of Compton scattering in terms of the dual wave-corpuscle nature of both radiation and electrons. The Dirac theory of the Compton effect predicts results identical with those of the early corpuscular theory as regards change in wave length with scattering angle, energy of the recoil electrons, simultaneity and the angular relationship between recoil electron and scattered photon. In addition it predicts the intensity of scattered X-rays as a function of scattering angle, a result which has been confirmed by experiment and which was not correctly given by the earlier theory.

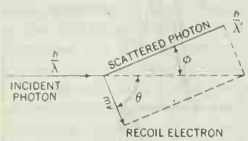


FIG. 3.—COMPTON EFFECT (*see* TEXT)

This situation arises from the fact that Dirac's relativistic quantum theory of the electron incorporates a most unusual feature in its prediction of negative energy states for electrons. Although the reality of these negative energy states was later confirmed by the discovery of the positron (*see* PARTICLES, ELEMENTARY), the Compton effect provided the first crucial test for the negative energy states. The theoretical prediction was incorporated in a formula for the intensity of Compton-scattered X-rays as derived by O. Klein and Y. Nishina using the Dirac theory. The photon scattering is a second-order process described in the theory by assuming that the primary photon is first absorbed by the electron, leaving the latter in an intermediate state, and then when the photon is actually scattered, its emission leaves the electron in a final energy state. The essential point, however, is that the intermediate states can include those in which the electron has negative energy, and the contribution of these states to the total scattering of photons by the Compton process is essential. Of course, both before and after scattering a photon, the electron is in states of positive energy, but intermediate states of either positive or negative energy are possible. Experiments designed to test this point were in close agreement with the predictions of the Klein-Nishina formula and thus proved decisively the reality of Dirac's negative energy states for the electron, a theory now basic for the understanding of the properties of all elementary particles.

By the mid-1950s all aspects of the Compton-Dirac theory had been accurately confirmed by numerous experiments using X-rays and gamma rays over an extremely wide energy range. Compton's original data on the intensity of gamma-ray scattering at various angles obtained at Cambridge university in 1919 were explained, and the 1950 precision experiments of Hofstadter and McIntyre proved to be in excellent agreement with theory. Other important intensity measurements include those of W. H. Voelker in 1952 using 15-Mev (million electron volts) gamma rays from a betatron, and measurements by F. H. Coensgen made with the Berkeley electron-synchrotron operating at 250 Mev. The confirmation of Compton's theory of scattering at the highest X-ray energies provided a sensitive and important test for the understanding of the interaction of radiation with matter.

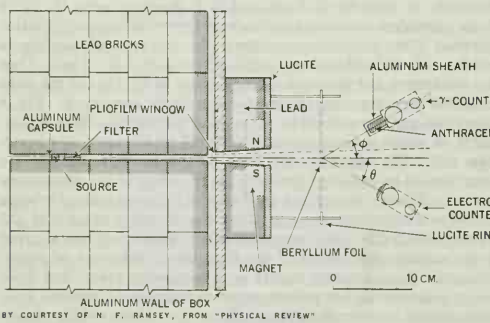


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FIG. 4.—EXPERIMENT TO PROVE THE LAWS OF CONSERVATION OF ENERGY AND MOMENTUM IN INDIVIDUAL COMPTON SCATTERING EVENTS

Although the usual Compton event results in a single scattered photon, it is also possible on rare occasions for two scattered photons to appear. The occurrence of this double Compton effect was also predicted by relativistic quantum mechanics, and experiments provide confirmation of the predicted details of this process.

The Compton effect occupies a position of primary importance in the development of physics in the 20th century, first, because at the outset it stimulated the development of quantum mechanics by providing very basic experimental findings which classical theories were powerless to explain; moreover, during the entire development of quantum mechanics, the Compton effect has been one of the central phenomena with which the theory could be tested by experiment at many crucial points. It is probable that in the near future it will provide another decisive test for one of the basic facts of quantum electrodynamics related to ultra-high-energy phenomena (*see* QUANTUM MECHANICS: *Quantum Electrodynamics*). It is expected that at very high energies modification of the theory may be necessary. This involves the question of a fundamental length in the interactions of elementary particles which is presumably the smallest length that can be measured. If this length is found to be a fundamental feature in nature, it is probable that its existence will be established by observations on the Compton effect in the scattering of very high energy photons. It would be revealed by departures from predictions of the present theory of quantum electrodynamics in the energy range above 10^{12} electron volts. Thus, the Compton effect may again help point the way for new developments in theoretical physics.

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COMPTROLLER (CONTROLLER), the title sometimes given to the official whose primary responsibility is to furnish an organization with accounting records and reports. He is responsible for instituting and maintaining documents and records for safeguarding assets, disclosing liabilities, presenting income and other tax information, and preparing and interpreting operating and financial reports.

The controller of a private business organization often has important advisory functions in addition to the record-keeping and reporting responsibilities of the earlier chief accountant. A controller helps prepare and enforce the budget, measure expected profitability of alternate proposals, and assemble relevant information for administrative decision making. In short, he is responsible for accumulating and interpreting information and for translating it into instruments of administrative control.

The controller usually maintains procedures for auditing invoices, vouchers, plant records, warrants and payrolls. These and other auditing procedures are sometimes centralized under an internal auditor who may be responsible to the controller, to the president of the company or to the board of directors. Controllership functions are occasionally distributed among different officials and the title of controller is then omitted. The controller should be sharply distinguished from the treasurer, property custodian and others who handle the physical assets of the organization.

Units of government traditionally give greater emphasis to auditing and safeguarding features and less emphasis to advisory functions. Branches of the U.S. government make use of numerous controllers including the comptroller of the currency, an office created by the National Bank act of 1863 to supervise all national

banks and approve the creation of new national banks. The British government has an official designated as the comptroller and auditor general. He holds a permanent appointment as an officer of parliament and is responsible for ensuring that all government expenditures are properly made. (C. T. D.)

COMPUTING MACHINES, ELECTRONIC. Electronic computers, which were first used in the 1940s in a few research laboratories, have now become commonplace tools in data processing for government, business, and industry; in scheduling and control of manufacturing operations; in military systems of all types; and in scientific activities. Manufacture of computers has reached the status of a major industry, and a whole new profession has arisen—the art of using and applying computers to problems of all types. Most college and university students now receive some training in the design or use of computers, and science and mathematics curricula are being revised in the secondary (and even in the elementary) schools to introduce the new concepts required. Perhaps no other single development has had such an impact on human endeavours in such a brief period of time, and it is probable that in the future computers will affect the lives of everyone in some way.

Classes of Computers.—Electronic computers can be broadly divided into two classes, analogue (or analog) and digital. In the former, a variable quantity that is to be studied or manipulated is represented by an electrical quantity, usually an electrical potential. The machine quantities are said to be analogous to the actual quantities—hence the name "analogue." In the digital computer, the variable quantities are represented by numerical codes, usually in the binary number system. The two classes of computers use such different techniques and are put to such different uses that they will be treated separately. First, however, it will be well to compare the techniques and point out the advantages and disadvantages of each.

Accuracy.—Since an analogue computer represents or simulates quantities with electrical potentials whose values are proportional to the quantities represented, its accuracy is limited by such practical circuit problems as linearity of amplifiers, stability of the value of circuit components, background noise that changes with time, etc. Stability of the value of the circuit components has a direct effect on output; a change of 1% in the value of the output resistor of a multiplier will change the multiplying factor by 1%.

For many applications an accuracy of 1% is adequate and can be easily obtained. If, however, a number of operations have to be cascaded, an acceptable overall accuracy may require a much better accuracy in each stage; this is particularly so if one of the operations involves the subtraction of one quantity from another almost equal to it. (For instance, if a quantity of 19 units is subtracted from another of 20 units, then an accuracy of 1% in the difference requires an accuracy of 0.05% in each of the quantities.) Accuracies of 0.1% can be obtained without much difficulty, but to get and maintain accuracies much better than this requires careful design and very good components.

In a digital computer, on the other hand, the numerical codes that represent quantities require only the reliable recognition of two states of a circuit or device, as will be discussed below. Wide tolerances (up to 20%) can be placed on individual components without causing errors. Also, since the numerical codes can be made as large as desired, the accuracy in calculations is virtually unlimited.

Speed.—For certain problems, analogue computers can be faster than digital computers. This is because a digital computer, despite its very high speed of performing individual operations, must proceed one step at a time. In an analogue computer, a separate computing element is provided for each operation, and all are at work simultaneously and continuously.

Hybrid Techniques.—Since each type of computer has limitations as well as advantages, there is a growing interest in hybrid techniques, partly analogue, partly digital. In many applications, hybrid techniques have been able to exploit the best features of both classes and yield a better result (faster computation with a given accuracy level, less equipment, or some other criteria) than either the completely analogue or the completely digital techniques.

ANALOGUE COMPUTERS

As mentioned above, most analogue computers operate by manipulating electrical potentials, or, more usually, potential differences. The basic unit of an analogue computer is the operational amplifier, which is a device whose output current is proportional to its input potential difference. By causing this output current to flow through suitable components, further potential differences are obtained that can be made to bear any one of a wide range of relationships to the input.

If the input is applied to such an amplifier and the output circuit consists of a resistor, the potential difference across this resistor will be proportional to the output current and hence to the input potential difference. The amplifier will therefore act as a multiplier, the multiplying factor being proportional to the value of the output resistor, which can be varied over a wide range. If a number of such amplifiers are connected with their outputs in parallel, the current through the common resistor will be the sum of all the individual output currents and will be proportional to the sum of the individual input potential differences. The amplifier will therefore behave as an adder. If the output current is caused to flow into a capacitor, a charge will build up that is proportional to the product of the current and the time during which it flows; in this case the amplifier will act as an integrator.

By various circuit artifices, a wide variety of mathematical operations can be carried out on the potential differences. Since the output of each of these amplifying stages is also a potential difference and can be made of the same order of magnitude as the input, it can therefore serve as an input to a further operational stage. Most practical analogue computers consist of a number of such operational units, which can be connected so as to build up a mathematical expression, sometimes of great complexity and with many variables.

Although these amplifiers generally operate at frequencies up to 10,000 cycles per second, they must retain amplification at zero frequency in order to handle the constant terms of the inputs. Analogue computers may be used to simulate time-varying quantities, either in "real time" (a speed sufficient to provide an answer to a problem within the actual time it must be solved) or at a greater speed than in actuality, the latter being limited by the high-frequency cutoff of the amplifiers. Until the late 1950s, all electrical analogue computers used vacuum tubes, but newer designs, using transistors, are much smaller, consume less power, and are less expensive. In the mid-1960s desk-top units with 40–80 operation amplifiers cost from $20,000 to $50,000, and large installations sometimes exceeded $500,000.

Applications.—The original electronic analogue computers arose from the needs of antiaircraft artillery "predictors." In these, the variables were the latitude, longitude, and height of the target and the projectile respectively, all of these varying with another variable, time. A number of fixed or slowly varying data were also fed into the predictor, such as the muzzle velocity and ballistic characteristics of the projectile, the characteristics of the atmosphere, etc.; the computer had to solve two simultaneous equations so that the target and the projectile, each moving along its own course, would arrive at the point of intersection at the same time.

One interesting application of analogue computers is in aerodynamics. The equations relating air flow and the attitude of, and forces on, the lifting surfaces are complex, and their solutions by conventional methods were so difficult and tedious that many designers preferred to ignore theory and rely on experiment. Analogue computers became available at a time when the experimental approach was becoming impossibly expensive and dangerous, and difficult equations involving such problems as flutter are now within their capability.

The following application illustrates how these machines can be used as an experimental tool. An aerodynamicist may from prior experience, from simple theory, or even from intuition have a rough idea of the relationship between the various quantities in-

volved; he can set up the relationship on an analogue computer and can produce curves giving the variation of lift (for example) with any combination of the other variables. He now seeks experimental data for some of these combinations and compares these experimental results with those of his computer; if his original assumptions were not correct, his experimental results will not "fit." He next varies his original assumptions, repeating his attempt to fit his experimental points to the computed curves. As this fit improves, the equations set up in the computer are more and more descriptive of the true relationship between the variables. As this relationship is thus more accurately reproduced, it can be used to replace the original assumed relationships, and the aerodynamicist can confidently use his computer for other combinations of variables.

Such a computer can so completely describe the relationships of speed, attitude, lift, etc., of an aircraft that it can simulate the complete behaviour of an actual aircraft. If the multiplying, integrating, and other factors of the various units are brought out to controls similar to aircraft controls, and the outputs to suitable actuators, a pupil can be made to experience all the operations of flying an aircraft; with such a "simulator" he can be taught all that he needs to know to fly the aircraft under normal, faulty, or even emergency conditions without the expense and danger of learning by actually flying.

General- and Special-Purpose Machines.—Many analogue computers are general-purpose machines, adapted for solving a wide range of problems. There are, however, many special-purpose analogue computers merging into types that carry out functions similar to those of normal analogue computers but which are not considered to be computers at all. Examples are process controllers in chemical manufacturing plants and automatic pilots in aircraft. In such special-purpose machines, the outputs of transducers operated by physical parameters (temperature, fluid flow, pressure, etc., in the chemical example; aircraft attitude, speed, altitude, etc., in the automatic-pilot example) are fed into a device that combines them by arithmetical processes effected by methods commonly used in analogue computers.

DIGITAL COMPUTERS

The familiar office adding machines and desk calculators are rudimentary examples of digital computers in that they work with numerical representations of quantities that are to be manipulated. The three distinguishing characteristics of the modern digital computer are (1) an addressable memory to hold a stored sequence of operations to be carried out automatically (a program), the necessary data, and intermediate results; (2) the concept of logical decision making, *i.e.*, the ability to automatically take specified alternate courses of action depending on the outcome of a particular operation; and (3) extremely high speed, up to 1,000,000 or more operations per second. Actually, a man with a desk calculator, using pencil and paper for memory and tables for data, could carry out the same sequence of operations as that performed by an electronic digital computer on a particular problem, make the same decisions, and find the same answers. Because of the great difference in speed, however, it would take him several years to do what the electronic digital computer can do in a matter of minutes. Similarly, a digital computer can rapidly find a desired item out of many millions of items stored in its memory, update it, refile it, etc., vastly speeding up routine clerical tasks in such fields as banking, insurance records, and airline reservations.

The functional elements of the digital computer may be grouped into four major categories: (1) the arithmetical unit, which performs tasks such as addition, multiplication, logical comparison, etc.; (2) the memory, in which data words and sequences of instructions are stored; (3) the input-output system, which permits the entry of programs and data and the output of results; and (4) the instruction control unit, which interprets the sequence of operations (program) stored in the memory and controls the other functional units appropriately. Digital computers are constructed in a wide range of sizes, with prices in the mid-1960s ranging from about $20,000 for desk-top units to $10,000,000 for large computers that fill a large room. Despite this wide range in size and cost, all digital computers have the same functional elements; the cost and size differences come in the degree of sophistication employed and in the size of the problems to be solved or the files to be maintained. For example, the arithmetic unit of a small computer may be capable of performing only a few simple operations, such as adding and shifting numbers. More complex operations, such as multiplication and division, can be performed on such machines by programming sequences of these basic operations, but such programmed operations are slow and take up valuable memory space. The larger machines provide more "built-in" automatic operations, such as multiplication and division, to save time and reduce the memory space needed for programs. Similarly, the amount and type of memory employed are chosen to meet the needs of the intended usage, as are the characteristics of the input-output devices.

Binary Code.—Most digital computers use the binary code, which has only two digits, 0 and 1, and which can be represented electrically by a variety of two-state (switching) devices; a switch can be "on" for 1 and "off" for 0. It is much easier to design two-state devices than the ten-state devices that would be required for decimal code. Also, the arithmetical processes are much simpler in binary code than in decimal code. In the normal decimal notation, each digit represents successive powers of ten. Thus the number 251 means $2 \times 10^2 + 5 \times 10 + 1$; the corresponding binary code for this number is 11111011, meaning $2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2 + 1$. The binary equivalents of some decimal integers are written as follows:

1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
20	10100
100	1100100

In normal decimal numbers, multiplication by ten is performed by shifting the number one place to the left and adding a zero; the above list shows that in binary arithmetic this operation results in a multiplication by two. The list also shows that binary numbers have more, sometimes many more, digits than the corresponding decimal numbers; the binary number for 100 has the same number of digits as the decimal number for 1,000,000. The most common number length in binary machines is 36 "bits" (binary digits), but current machines vary from 12 to 72 or more.

To understand the basis of binary arithmetic, the decimal process of adding 1 to 9 may be considered; there is no higher digit than 9, so that the result of the addition must be written 10. But in binary arithmetic there is no digit higher than 1, so that when 1 is added to 1 a two-digit number must be written, thus: $1 + 1 = 10$.

The rules of multiplication and addition shown by tables of conventional decimal arithmetic, which have nearly 200 items, are reduced in binary arithmetic to a few simple rules. Two examples should make this clear. The rule for binary addition is:

$$0 + 0 = 0$$
$$0 + 1 = 1$$
$$1 + 0 = 1$$
$$1 + 1 = 10$$

In other words, two different digits added together produce 1, and two similar digits added together produce 0, but if they are both 1s the machine must carry 1. The corresponding rule for binary multiplication is:

$$0 \times 0 = 0$$
$$0 \times 1 = 0$$
$$1 \times 0 = 0$$
$$1 \times 1 = 1$$

Thus, if either digit is 0, the result is 0, but if neither digit is 0, the result is 1. These rules are very easy to implement in a computer. (*See* BINARY NUMBERS.)

Switching Devices.—Early digital computers used electrical relays as their two-state devices; such machines, some of them quite large, were made in the United States during the early 1940s for military needs. Although they appear grotesque by modern standards, they served a useful purpose in establishing the fundamentals of this technique of computing. These relay machines suffered from unreliability, because of the known uncertainties of the relay contacts, and from low speed (only a few tens of operations per second). Much of the subsequent development of digital machines was devoted to attacking the twin problems of speed and reliability; present speeds of many millions of operations per second are attained, so that the need for reliability is still more imperative. A fault rate of 1 in 1,000,000,000 would in most contexts be regarded as superlatively accurate, but in a computer performing 1,000,000 operations per second it would result in a risk of a mistake every 17 minutes, which most users would find completely unacceptable. Modern computers run many days without a mistake.

The relays, with their slow speeds, moving parts, and vulnerable contacts, were followed in the early 1950s by vacuum tubes, usually in pairs connected so that the current in one turned off the current in the other until the pair was pulsed into the other state. Early computers of this type, using tubes based on those in commercial radio receivers, were unreliable, but improvements in tubes and circuits soon made possible reliable computers with speeds up to 100,000 operations per second. Several thousand tube machines were constructed and put to use, in essence starting the computer age. The main limitations of tube machines are that they are large (up to 30,000 tubes) and costly to operate (as much as 20 to 50 kw. of electrical power for circuit operation and cooling).

In the late 1950s, transistor development had reached a stage where types suitable for computer use became available. Transistors have permitted construction of much smaller and less costly computers that have higher operating speeds (up to 50,000,000 operations per second), much greater reliability, and much less operating expense (a reduction of 30 to 1 in one comparison of tube and transistor machines with similar capabilities). With all newer designs using transistors, the existing tube machines will gradually disappear.

Storage Devices.—For use in a binary machine, a device to store one bit must be able to be placed in one of two stable states, corresponding to 1 and 0; must be able to maintain this state indefinitely until changed; must be able to be read or changed at very high speed (up to 1,000,000 times a second); and, because millions of bits may have to be stored, must be very inexpensive. Actually, since not all of these requirements can be met at present by a single type of device, most computers have several types of memories, as discussed below. Although many devices and techniques have been tried, the most successful ones have been based on the principle of magnetic recording. The differences between the different types of storage devices in present use reside in the type and disposition of the magnetic material.

Memories that can be addressed at random at high speed are essential for high speed of computer operation and are found in almost all machines of current design. They are commonly built up of small cores shaped like doughnuts, usually $\frac{1}{16}$ in. in diameter, which are made of a hard magnetic material and which can be magnetized in either of two directions by currents in wires passing through the hole. Such a core is "read" to discover which state it was in by trying to magnetize it in a fixed direction, usually that corresponding to the state chosen to represent "0." If the core was in the "1" state prior to the read operations, the resulting magnetic flux reversal will cause an electrical pulse to be generated on a sense wire that threads the hole. However, if the core was already in the "0" state, no flux reversal will occur and no pulse will appear on the sense wire. Since the above readout method sets all cores to the "0" state, the stored information is destroyed and must be rewritten after reading if it is to be remembered. This technique, called "destructive read," is used most often because it is the least expensive. For certain applications, particularly military or industrial control operations, where loss of stored information could be disastrous, nondestructive memory-reading techniques have been developed.

The size of core memories has progressed from a maximum of 4,096 (2^{12}) words of 36 bits each (a total of 147,456 cores) in the early 1950s to as much as 131,072 words of 48 bits each (a total of 6,291,456 cores) in the mid-1960s. At the same time, speed has increased from 100,000 read-write cycles per second to more than 1,000,000, and the cost per bit of storage capacity has decreased from more than $1 to about 20 cents. New techniques involving thin evaporated magnetic films have demonstrated speeds of 10,000,000 read-write cycles per second and offer hope of eventually reducing costs to 1 or 2 cents per bit. Because present costs of film memories are higher than those of core memories, they are now used only as small "scratch-pad" memories to speed up computer operations.

Despite the progress in the random-access memories cited above, they will probably never be large enough (and inexpensive enough) to hold the tens of millions of words needed in many problems. Data infrequently referred to can be stored in slower, less expensive types of memory and transferred to the high-speed memory only when needed. Slow-access stores are typified by magnetic tapes; they use a wide (one-inch) tape similar in many ways to tape used on commercial magnetic-tape recorders. The digits to be stored are recorded as dots of magnetism. There are commonly up to 16 separate tracks, laid parallel across the tape. Although there are often as many as 1,000 bits per linear inch, the number of bits to be recorded and read is so high that tape speeds of 200 in. per sec. are common. To read any particular entry on the tape it is necessary to be able to start and stop the tape in a few thousandths of a second, and the mechanical design of the tape-handling equipment is thus a major problem. The capacity of such a store is virtually unlimited (up to 10,000,000 words per tape reel), and tapes of data or programs may be removed when not in use, freeing the tape mechanisms for other work. The main problem with tapes is the access time, since it may be necessary to traverse the whole tape (requiring a minute or more) to find a desired stored item. Tape stores are generally used only for information that can be processed as it arises or for information that has been prestored in logical order, so that the tape-handling unit does not spend most of its time searching for the required item.

Intermediate between these two types of storage are the magnetic drum and the magnetic disc. A drum can be considered as a wide magnetic tape, carrying from 1 to 200 tracks, wrapped around a drum rotating at about 3,000 rpm. Each digit recorded comes around to the reading point every fiftieth of a second (which is the maximum access time), but the capacity of the store is limited to several tens of thousands of words, except on a few very large and expensive units. The magnetic disc has proved to be a less expensive way of providing the very large, medium-speed stores needed in many applications (*e.g.*, airline seat reservations). A magnetic-disc store in a way resembles the familiar "juke-box" automatic record changer. Up to 20 discs, coated on both sides with magnetic material, are rotated on a common shaft, and a servocontrolled reading head is positioned to read a desired track. Because of this positioning, access time is somewhat longer than that of the drum, but capacities of up to 10,000,000 words per unit are available. Removable discs are also available.

Even larger capacities than those economically provided by discs are desired in some applications (*e.g.*, storing multilanguage dictionaries for language translation), and new types of stores based on photographically recorded spots read with light beams are now appearing. These "read-only" stores (the computer cannot change the recorded data) have access times similar to magnetic discs, and capacities up to 10,000,000,000 words.

Programming.—The operations carried out by a digital computer are generally very simple, so that a problem of any complexity must be broken down into a program, which consists of a series of instructions usually expressed in a code very similar to that used for numbers and other data. Breaking down a logical problem into component parts, each of which is within the scope of a particular computer, is a skilled trade, and much of the suc-

cess of early digital machines depended on the ability of individual programmers, since few scientists or businessmen were able to prepare their own programs. Later, with more versatile machines, it became possible and indeed common to devote a part of the machine's capacity to preparing its own detailed program from general instructions fed into it. Automatic coding techniques that relieve the programmer of most of the drudgery allow him to concentrate on the logical problems involved and express his resulting instructions in (almost) plain language. Great progress is being made in the development of computer "languages" for scientific, engineering, and business use that approach natural language and will permit individuals to easily prepare their own programs.

Scientific v. Business Machines.—The amount and nature of storage provided depends on the purpose for which the machine is intended; this constitutes one of the main differences between scientific and business machines. In scientific machines the units that carry out arithmetical and logical operations are most important, while the storage capacity is not particularly large. In business machines the provision for arithmetic and logic need not be so generous, but the storage, at all levels, must be copious. The entire documentation of an office, such as ledgers and similar records, the lists of customers' names and addresses with the trade conditions appropriate to each, and the catalogue information referring to the firm's products must be stored. Those data that are applicable repeatedly during a run will be in an integral store such as a core store; other information, applicable to individual customers only, will be on magnetic tapes or discs.

Business machines are also differentiated by the bulk of data fed into and out of them. Computers have been much used to extend the scope of punched-card systems and similar office machinery, and they accept information from card readers capable of reading up to 500 cards (each carrying up to 960 binary digits) per minute. In banking, customer account numbers are commonly recorded on checks with a magnetic ink that can be read directly by the computer. Also used are optical scanners that can read standard printed matter at a rate of a fraction of a second per page by coding each letter and number for the computer. The output of the computer may actuate punches to produce cards for further mechanical handling, or it may produce a typescript output. A high-speed printer suitable for handling the output of a computer will type about 1200 lines of script per minute, all the characters (up to 100 or more) in each line being typed simultaneously. Bills, checks, and address labels can thus be automatically prepared at extremely high speed.

For scientific machines, cathode-ray tube displays (similar to television screens) and graphical plotters are now used to automatically draw plots and graphs, showing the results of calculations, that formerly had to be prepared by hand from numerical data printed out by the computer. In the future, this technique will also be widely applied in industry to automate the process of preparing engineering drawings, particularly as more and more of the work-load of design and engineering is handled by computers.

Future Trends.—The advent of new technologies, particularly microelectronics (*see* INTEGRATED CIRCUIT), promises a continuation of the rapid advancement that has occurred in the computer art. For military and space use, digital computers the size of shoe boxes were constructed in the 1960s that had capabilities comparable to those of computers that filled an entire room only a decade earlier.

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COMSTOCK, ANNA BOTSFORD (1854–1930), U.S. naturalist and artist, a wood engraver of nature subjects, and an influential advocate of nature study in education, was born on Sept. 1, 1854, at Otto, N.Y. She was a graduate of Chamberlain institute, Randolph, N.Y., and Cornell university, Ithaca, N.Y., and studied art at Cooper union, New York city. In 1913 she was made assistant professor and in 1920 professor of nature study at Cornell university. Among her published works are *Ways of the Six-Footed* (1903), *How to Know the Butterflies,* with J. H. Comstock (1904), *Handbook of Nature Study* (1st ed., 1911), *The Pet Book* (1914), *Bird, Animal, Tree, and Plant Notebooks* (1914) and *Trees of Leisure* (1916). Mrs. Comstock died on Aug. 24, 1930, in Ithaca. (H. Es.)

COMSTOCK, ANTHONY (1844–1915), professional U.S. reformer, was born in New Canaan, Conn., on March 7, 1844. For more than 40 years he was the most eminent U.S. crusader against obscene literature and his name came to be loosely used as a synonym for moralistic censorship. He was also active in the suppression of fraudulent banking schemes, mail swindlers, lotteries and medical charlatans. In general Comstock did not concern himself with serious literature but directed his energies against commercial pornography. Occasionally, however, he took action against established writers and the classics on the principle of "morals, not art or literature." He received a public-school education, served in the Union army during the American Civil War and became in 1872 an active worker with the Young Men's Christian association in New York city. He lobbied successfully in 1873 for passage of more stringent laws (called "Comstock laws") against the transportation of obscene matter in the mails. He was also an organizer and chief special agent of the New York Society for the Suppression of Vice. He died in New York city on Sept. 21, 1915. Among his published works were *Frauds Exposed* (1880), *Traps for the Young* (1883) and *Morals Versus Art* (1888).

See Heywood Broun and Margaret Leech, *Anthony Comstock, Roundsman of the Lord* (1927). (H. Ca.)

COMSTOCK, JOHN HENRY (1849–1931), U.S. entomologist and author of popular handbooks on that subject, was born in Janesville, Wis., on Feb. 24, 1849. After his graduation from Cornell university, Ithaca, N.Y., in 1874, he pursued further study at Yale university in 1874–75 and at the University of Leipzig in 1888–89. He was instructor and assistant professor of entomology in 1875–78 at Cornell, and, after serving as U.S. entomologist at Washington in 1879–81, was made professor of entomology at Cornell and continued in that chair until 1914 when he became professor emeritus. By his influential work as a teacher and by his researches and writings, he contributed notably to the advancement of entomological science and rose to foremost rank among American entomologists. Besides numerous articles in scientific journals his published writings include: *A Manual on the Study of Insects,* with Anna Botsford Comstock (1895, 1904, 1907); *Insect Life* (1897, 1891); *Introduction to Entomology* (1888, 1920, 1924); *How to Know the Butterflies,* with Anna B. Comstock (1904); *The Spider Book* (1912); and *The Wings of Insects* (1918).

COMTAT-VENAISSIN, a former enclave of territory in southeastern France, corresponding to the southwesternmost quarter of the modern *département* of Vaucluse (*q.v.*). Bounded on the west by the Rhône, which separated it from Languedoc, it was half encircled from the east by Dauphiné and Provence, the lower course of the Durance river forming its southern frontier. It took its name from the countship of Venasque, southeast of Carpentras. Carpentras, however, was the chief town.

In ancient times the country was inhabited by the Gallic tribe of the Cavarii. Later the countship was part of the kingdom of Burgundy or Provence (*see* BURGUNDY; ARLES, KINGDOM OF) and passed with it under the distant suzerainty of the Holy Roman emperors, from whom the counts of Toulouse held it as a fief.

Raymond VII of Toulouse ceded it in 1229 to Pope Gregory IX, who left its administration to the French king's representatives. In 1273 Philip III of France decided to give it up to Pope Gregory X. From 1274 it was under a legate till 1791, when it was annexed to France. Avignon (*q.v.*) was not added to the papal territory till 1348.

See J. Fornery, *Histoire du Comtat-Venaissin et de la ville d'Avignon,* 3 vol. (1909–12).

COMTE, AUGUSTE (ISIDORE AUGUSTE MARIE FRANÇOIS XAVIER COMTE) (1798–1857), French positivist philosopher, gave

the basic social science of sociology its name and established the new subject in a systematic fashion. He was born at Montpellier on Jan. 19, 1798. His father was a tax official. In 1814, Comte entered the École Polytechnique at Paris, but the institution was temporarily closed in 1816. Comte remained in Paris as a teacher of mathematics, and in 1818 made the acquaintance of Count Henri de Saint-Simon, who contributed many of the concepts that Comte later embodied in his writings. In 1826, Comte started a course of lectures in Paris to expound his ideas as they were developed at this time, but he suffered a serious nervous breakdown and was compelled to abandon them.

From 1832 to 1842 Comte was a tutor and then an examiner at the revived École Polytechnique. In the latter year he quarreled with the directors of the institution and lost his post along with much of his income. During the remainder of his life he was supported in part by such English admirers as John Stuart Mill and by French followers, especially the philologist and lexicographer Maximilien Littré. Comte married Caroline Massin in 1825, but the marriage was unhappy and they separated in 1842. In 1845 Comte had a profound romantic and emotional experience with Clotilde de Vaux, who died in the following year. He idealized this sentimental episode and it exerted a considerable influence upon his later thought and writings, notably in regard to the role of women in the positivist society he planned to establish. Comte was a rather somber, ungrateful, self-centred and egocentric personality, but he compensated for this by his zeal for the welfare of humanity, his intellectual determination and his strenuous application to his life's work. He devoted himself unflaggingly to the promotion and systematization of his ideas and to their application in the cause of human betterment. He died in Paris on Sept. 5, 1857.

Main Writings.—In 1822, Comte published his first work, *A Plan for the Scientific Works Necessary to Reorganize Society*, which roughly forecast his intellectual career. It described the intellectual trends of the time and suggested the needed reforms in ideology and social planning. In 1826 he brought out *Considerations on the Spiritual Power*, which was inspired in large part by Saint-Simon and by leading Catholic writers such as Joseph de Maistre and L. G. de Bonald. It foreshadowed some phases of his later religion of humanity. Shortly after this he began work on his first major treatise, *Course of Positive Philosophy*, the first volume of which appeared in 1830 and the sixth and final volume in 1842. He then turned immediately to an even more ambitious project, *System of Positive Polity;* the first volume was published in 1851 and the fourth and final one in 1854. This work both developed his sociological theories and set forth his plan for an ideal society.

Comte published a number of lesser works: *Discourse on the Positive Spirit* (1844); *Positivist Calendar* (1849); *Positivist Library* (1852); *Positivist Catechism* (1852); *Appeal to Conservatives* (1855); *Subjective Synthesis* (1856); and *System of Positive Logic* (1856). Comte's material was well organized and its exposition proceeded in impressively orderly fashion for the most part, but his style was heavy, laboured and rather monotonous. His chief works are notable mainly because of the scope, magnitude and importance of his project and the conscientious persistence with which he developed and expressed his ideas.

Sources of Comte's Ideas.—Comte drew many of his basic ideas from earlier writers, going back as far as Plato and Aristotle, but he took them mainly from thinkers of the 18th and early 19th centuries. From David Hume, Immanuel Kant and F. J. Gall he derived his conception of positivism in method and his notions about psychology. Catholic writers like Bonald and De Maistre impressed him with their views concerning a religious framework for social organization. The repudiation of Christianity and the installation of the worship of the Goddess of Reason in the French Revolution stimulated his idea that the religious order should be of a secular nature. From Hume, Kant and Turgot, Comte took over the idea of historical determinism, which was somewhat paradoxically tempered by the notion of a providential order of human development which he adopted from Bossuet, Vico, Bonald and De Maistre. Through Turgot, Condorcet, Burdin and Saint-Simon he conceived his idea of progress and the law of the three stages (theological, metaphysical and scientific) in the intellectual development of mankind. From the abbé de Saint-Pierre, Montesquieu and Saint-Simon he appropriated the conception of the need for a basic and unifying social science which would both explain the existing social organization and guide social planning for a better future. This social science he called "sociology" for the first time.

Although he later quarreled with him, Comte was most indebted to Saint-Simon who had emphasized the three stages of intellectual development, the need for a new and secularized spiritual order to replace supernaturalism, the belief that social phenomena can be reduced to laws, the conviction that the purpose of the new and fundamental social science should be ameliorative, and that the outcome of all this ideological novelty and systematization should be the guidance of sound social planning.

Comte synthesized these previous ideas with differing emphasis in his various works and in different periods of his career, and added not a few important conceptions of his own in rounding out his system of social philosophy, social planning and sociology. But his main personal contribution consisted in his resolute adoption of the positive or scientific method, from which he strayed at times, and in his impressive achievements in synthesis and systematization.

If Comte relied widely on writers from the past, he paid little attention to what was being produced while he was composing his own works. Once he had worked out his system of thought and social science and had assembled the data and ideas which he regarded as essential for his task, he read virtually nothing more. To an even greater extent than Herbert Spencer, he depended upon his learned friends for such information as he received as to the intellectual achievements of his age but, unlike Spencer, he made very little use of the information he casually obtained in this manner.

The Positivist Philosophy.—The main contributions of Comte's positive philosophy fall into five parts: the rigorous adoption of the positive or scientific method; the law of the three states or stages of intellectual development; the classification of the sciences; the conception of the special and incomplete philosophy of each of the sciences anterior to sociology; and the synthesis of the positivist social philosophy which completes, clarifies and unites all the lesser and subordinate philosophies.

Developing further the ideas of Turgot, Burdin and Saint-Simon, Comte held that the evolution of human thought and knowledge passes through the three main stages: the theological, the metaphysical and the scientific, and divided each of these into several substages; but these need not be of concern here. A major imperative of the positivist program is to place the study of society in the third or scientific stage. This Comte attempted to do on a grand scale. But he realized that it would be a slow process, for the theological and metaphysical vestiges inevitably linger on longest in the realm of social science.

Comte's classification of the sciences was based upon the hypothesis that the sciences must inevitably develop in the order of decreasing generality and increasing complexity. Hence, they appeared in the following genetic series: mathematics, astronomy, physics, chemistry, biology and sociology. Each of these sciences draws from and depends upon those which precede it in the series. Sociology not only completes the series but also reduces social facts to laws and synthesizes the whole of human knowledge, thus rendering it equipped to guide the reconstruction of society.

Comte devoted much of the first three volumes of the *Positive Philosophy* to an exposition of the special philosophy of each of the five sciences which precede sociology. But this has been regarded as one of his least successful intellectual achievements, lacking in originality and precision and excessively dogmatic. It did not compare with his broader treatment of the positivist philosophy in general or his elucidation of the province and principles of sociology.

In addition to his system of positivism as such, Comte made important contributions to philosophy in general. His philosophical writings were probably the most powerful inspiration to the development of a scientific orientation in philosophical thought in con-

temporary times. The evolutionism of Herbert Spencer gave this trend a more dynamic pattern. Comte's thinking also had some influence upon the assumptions of the 20th-century philosophical position known as logical positivism (*q.v.*).

Social Planning and Utopia.—In his plan for social reorganization Comte proved his own thesis that theological concepts survive longest in sociology. John Stuart Mill and Comte's rationalistic admirers were astonished and shocked when Comte's conception of the ideal positivist society was revealed in his *System of Positive Polity* as a religious utopia. But he had foreshadowed this in his earlier writings. His relations with Saint-Simon had given him a spiritual frame of reference with respect to social reconstruction. His 1826 volume, *Considerations on the Spiritual Power*, indicated that he believed that the organization of the Catholic Church, divorced from its supernaturalism, might well provide an ideal structural and symbolic model for the new positivist society. His episode with Clotilde de Vaux stimulated his mysticism and developed a cult of sentimental womanhood. It had been a cardinal tenet of Comte that any desirable and permanent social improvement must be preceded by an appropriate moral transformation. For the Catholic God, Comte substituted the worship of the Great Being, namely, humanity past, present and future. He called his new faith "the religion of humanity." It was more truly a system of social ethics. The spiritual power of the priesthood was to be independent of and superior to the temporal authority. Comte even worked out a positivist catechism, hierarchy of the sacraments, calendar of the saints, and the like (see *Main Writings* above), but beneath or within this fantastic symbolism there was much realism and substance.

Comte himself was the supreme social planner of the new social system based on the worship of the Great Being. But, he said, his original planning would require detailed guidance and interpretation, constant exhortation, and continuity. To assure these would be the responsibility of the spiritual power lodged in the priesthood with headquarters in Paris. But the priesthood was actually to be made up of secular sociologists, who would work out the details of the new social order, preach the positivist gospel, give advice and counsel, control education and public morality, and arbitrate disputes, although devoid of any material power to enforce their decisions and recommendations.

The actual administration of the temporal power Comte would hand over to the economic leaders, especially the captains of industry—businessmen and bankers. It would be their task to establish and maintain social control and to assure political, social and economic justice, thus making certain that public morality would be upheld. The maintenance of private morality was the province and responsibility of womanhood, which was to be given dignity, discipline and austerity through the monogamous family, indissoluble marriage and perpetual widowhood. But women were to be excluded entirely from public or political life although given special educational advantages. Universal education stressing positivist principles was to be introduced as a cornerstone of the new social order.

Comte's Contributions to Sociology.—Comte's extensive contributions to sociology can only be briefly summarized here. He gave this basic social science its name, even though he did not originate the concept or the province of the subject which had already been clearly discerned by his immediate predecessors. But he did greatly extend and elaborate the field of sociology and systematized its content. He anticipated the organismic school of sociologists by regarding society as a "collective organism." Here he anticipated Herbert Spencer by holding that social progress is characterized by an increasing specialization of functions and a more perfect adaptation of organs (institutions). He thoroughly established the theory of social causation by showing how individual acts and motives are determined or conditioned by their institutional setting.

Comte divided sociology into two main fields or branches; social statics, or the study of social organization; and social dynamics, or the general theory of social progress. He held that the underlying principles of social organization are the distribution of functions and the combination of efforts. The former is achieved through the social division of labour, and the latter by means of the state and government. In its most general sense, social progress is manifested or exhibited through three inevitable stages of social evolution, comparable to those of intellectual development. These are the military-theological, the critical-metaphysical, and the industrial-scientific, thus emphasizing the interrelation of intellectual trends and social change. Material progress also takes place through three stages in which the main activities and interests are, in sequence, conquest, defense and industry. In the realm of moral progress man's social nature had found satisfaction first in the family, then in the state, and finally in the race.

Comte's Influence on Later Thought and Policies.—Comte's chief service to philosophy consisted in his comprehensive effort to establish the priority of the positive or scientific method, his law of the three stages of intellectual evolution, his classification of the sciences, and his encouragement of a scientific perspective in thought and literature as represented by H. A. Taine, Ernest Renan and Marcelin Berthelot in France, John Stuart Mill in England, and Theodor Gomperz in Germany.

In sociology, his main contribution was to christen the new science and to be its first systematizer. He divided the subject into its two traditional fields of social statics and social dynamics. Next to these should be placed his emphasis on the dominant role of sociology in social planning, a point of view later accepted and promulgated by Lester F. Ward, Ludwig Stein, Leonard T. Hobhouse, Charles A. Ellwood and others. In a special field of sociology, criminology, he promoted the trend toward a secular and social interpretation of crime and its treatment which repudiated the existing savagery.

In the realm of history, Comte left his mark through his law of the three stages of intellectual development which inspired Karl Lamprecht and other students of intellectual history. He laid the basis for social history through his emphasis on the social conditioning of human actions and motives. He greatly stimulated the search for possible laws and stages of historical development. In the area of economics, while he refused to recognize either economics or political science as a separate science, Comte encouraged what came to be known as institutional economics in the hands of Simonde de Sismondi, J. A. Hobson, Werner Sombart, Max Weber, and Thorstein Veblen and his disciples. In political science, Comte anticipated the sociological interpretation of politics which was later cultivated by Hobhouse, Robert Michels, Graham Wallas, and the students of group activities and interests within the state, notably Ludwig Gumplowicz, Gustav Ratzenhofer, Albion Small and A. F. Bentley.

Comte had a considerable influence on social reform movements, especially in England through the work of John Stuart Mill who was more deeply influenced by Comte than by any other French thinker. His religion of humanity not only encouraged reform tendencies in liberal Christian circles but stimulated the rise of secular religious movements such as humanism. Comte has been esteemed in antidemocratic circles from his time to our own as a result of his opinion that the ideal government is one of the intellectually elite, thus foreshadowing Gaetano Mosca and Vilfredo Pareto. He anticipated the managerial system involving the assumption of power by administrators (bureaucrats) in business and government, elucidated a century later by James Burnham and now in operation in different degrees throughout the world (*see* BUREAUCRACY). His insistence upon universal education aided the educational reformers.

See POSITIVISM; SOCIOLOGY; *see* also references under "Comte, Auguste" in the Index volume.

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COMYN, JOHN, the name of four Scottish barons of Norman descent who figured prominently in the troubled history of Scotland during the late 13th and early 14th centuries. John Comyn (d. 1274) was justiciar of Galloway and nephew of Alexander Comyn (d. 1290), earl of Buchan, and of Walter Comyn (d. 1258), earl of Menteith, in whose days the family dominated Scotland. The justiciar's son John (d. *c.* 1300), called "the Black Comyn," was one of the six guardians of Scotland after the death of Alexander III (1286). When Alexander's granddaughter Margaret the Maid of Norway died in 1290, John was one of the 13 claimants to the throne, but he supported his brother-in-law John de Balliol, whom the English king Edward I confirmed as king of Scotland (1292). He joined Balliol's rising against Edward (1295) but was soon forced to submit.

John (d. 1306), called "the Red Comyn," was the only son of the Black Comyn. He also supported the rebellion (1295) of his uncle, John de Balliol, and he raided England in 1296 and was held by Edward as a hostage (1296–97). On his release he became guardian of Scotland and headed resistance to the English after their defeat of Sir William Wallace at the battle of Falkirk (1298). Despite Comyn's victory at Roslin (1303), Scotland was overrun and he submitted to Edward in 1304. Subsequent rivalry with Robert the Bruce (afterward Robert I) ended with Comyn's murder at Dumfries on Feb. 10, 1306.

John Comyn (d. 1308), earl of Buchan and hereditary constable of Scotland, was cousin to his namesake the justiciar and son of Alexander Comyn. He took part in the negotiations which led to Balliol's establishment as king, and with him surrendered to Edward after the rising of 1295. Having helped to crush Wallace, he again changed sides and did not finally submit to the English until 1304. The murder of his kinsman the Red Comyn confirmed his support of the English and enmity to Bruce. (R. G. Ni.)

CONAKRY, capital and principal port of the Republic of Guinea, Africa, is situated on the small island of Tombo, which is linked to the Kaloum peninsula by a causeway 328 yd. long, and extended by the Los Islands (*q.v.*). Pop. (1961 est.) 56,000. The town's development dates from World War II. It is a handsome place of wide, parallel avenues with large buildings and bordered with mango trees, and is surrounded by a coastal promenade lined with villas. There are several distinct quarters: the Centre, with the chief stores; the administrative quarter; Boulbinet quarter to the south, with its picturesque fishing harbour and old streets; Hospital quarter; and Corinthie quarter, a slum of huts with corrugated iron roofs. A suburb has grown up outside the island, residential on the peninsula and industrial along the road to the airport (9½ mi. distant). Conakry is the seat of the Guinea government and the commercial, industrial and intellectual centre of the country. It is the railhead of the Conakry-Niger line, and has an excellent modern port with quays, warehouses and oil storage tanks. The port's progress is the result of the development of agriculture and of the mining industry (iron at Kaloum and bauxite on the Los). (J. D.)

CONANT, JAMES BRYANT (1893–), U.S. educator and scientist, president of Harvard university and U.S. high commissioner for western Germany following World War II, was born in Dorchester, Mass., March 26, 1893. He received his A.B. and Ph.D. (1916) degrees from Harvard university and, after spending a year in the research division of the chemical warfare service during World War I, returned to Harvard as instructor in chemistry. He was advanced in rank to professor of organic chemistry, winning recognition as a brilliant organic chemist. He specialized in research into free radicals, the chemical structure of chlorophyll and the quantitative study of organic reactions. On May 8, 1933, he was elected president of Harvard, succeeding A. Lawrence Lowell; as president he led the university toward a broadening of the social and geographical make-up of the student bodies of the undergraduate college and the professional schools. An early advocate of aid to the Allies in the late 1930s, Conant became a central figure in organizing United States science for World War II, including the development of the atomic bomb. After the war he served as a senior adviser to the National Science foundation and to the Atomic Energy commission. In 1953 he was appointed United States high commissioner for western Germany and in 1955 ambassador. He became known as a defender of the democratic spirit in the new Germany. Returning to the United States in 1957, he took up an earlier interest in public education and conducted studies of the comprehensive high school and the junior high school, on which he reported to both the general public and his fellow educators.

Conant's publications include two textbooks, *Practical Chemistry*, written with N. H. Black (1920), and *Chemistry of Organic Compounds* (1933). He was particularly successful in writing about science for the nonscientifically trained person, as in *On Understanding Science* (1947).

Among his books on educational policy may be mentioned *Education and Liberty* (1953), *The American High School Today* (1959) and *Suburbs and Slums* (1961). (F. Kl.)

CONCA, SEBASTIANO (*c.* 1680–1764), Italian baroque painter, created great, animated compositions, superficial but dazzling in colour and brilliant in execution. He was born at Gaeta, and studied at Naples under Francesco Solimena. In 1706, along with his brother Giovanni, who acted as his assistant, he settled at Rome, where for several years he worked in chalk only, to improve his drawing.

He was patronized by Pietro Cardinal Ottoboni, who introduced him to Pope Clement XI; and a "Jeremiah" painted in the church of St. John Lateran was rewarded by the pope with a knighthood and by the cardinal with a diamond cross. "Pool of Siloam" is considered his finest picture.

CONCENTRATION CAMPS are internment centres, established outside the ordinary detention system, in which persons are confined for reasons of military or political security, and for punishment or exploitation. Imprisonment usually is by executive decree or military order and frequently includes groups or classes of persons without regard to individual culpability. Concentration camps are thus to be distinguished from prisons in which persons convicted of crimes under civil law are confined, and from prisoner-of-war camps in which captured military personnel are held under the laws of war. They are to be distinguished, as well, from many other camps or centres in which large numbers of persons may be temporarily confined, such as refugee camps, detention stations and relocation centres.

Military Concentration Camps.—In periods of hostility, civilian populations sometimes have been concentrated in camps to prevent them from engaging in guerrilla warfare or providing aid to enemy forces, or simply as a means of terrorizing the populace into submission. Upon the failure of Arsenio Martínez de Campos to put down the Cuban rebellion of 1895, the Spanish government sent Valeriano Weyler y Nicolau to Cuba to command the Spanish troops. As a part of his efforts to pacify the country Weyler instituted his "concentration" policy by a decree of Oct. 21, 1896. Under the decree Cuban men, women and children living in rural areas were forced from their homes and "concentrated" in large camps enclosed by barbed wire and guarded by Spanish soldiers. The prisoners were held in deplorable conditions, with little food and inadequate shelter. Protests in the United States and Spain over this inhumane waging of war against civilians led to Weyler's recall. His successor, Gen. Ramón Blanco y Erenas, found that *reconcentrados* were dying by the thousands, and he ordered the concentration camps abolished.

During the 1901–02 period of the South African War the British, under Horatio Herbert Kitchener, adopted similar measures of repression against the Boers. Having withdrawn his garrisons to major centres, Kitchener established concentration camps for the confinement of noncombatants of the republics of Transvaal and Cape Colony. By July 1901 the camps were filled to overflowing, and at the end of the war they contained about 200,000 persons. Although the concentration policy was criticized in England, the system was not abandoned until the cessation of hostilities in March 1902.

While reprisals against noncombatants for hostile acts against occupying military forces are not expressly prohibited by international law, they must be reasonably related to acts of provocation. The concentration camps established by military authority in Cuba and South Africa were excessive measures for military control and were not supportable in law. Even so, confinement was solely for the period of hostilities, and was not characterized by the deliberate mistreatment inflicted upon the inmates of political concentration camps. (*See* Laws of War.)

Political Concentration Camps.—Concentration camps for political control have been used chiefly in police states in which punitive power may be exercised outside the ordinary judicial system. To a considerable extent the camps have served as the special prisons of the secret police. Persons suspected of opposition to the totalitarian regime have been summarily arrested by the secret police and placed under long or indefinite terms of confinement in the camps. The principal purpose of the political concentration camp thus has been the maintenance of totalitarian control. A secondary purpose has been the utilization of inmates for forced labour. Prisoners have been required to work for wages in food. Those unable to work usually died from starvation, and those who did not starve frequently died from overwork. While political concentration camps have been established, under various forms, in many totalitarian regimes, they have been used most extensively in the Soviet Union and Nazi Germany. Millions of persons have been confined, punished and exploited in such concentration camps.

Corrective Labour Camps of the Soviet Union.—During the first years of the Soviet regime the Cheka (All-Russian Extraordinary Commission for Repression of Counterrevolution and Sabotage) was the primary repressive instrumentality of the state. The Cheka was given the power to exile persons to concentration camps without judicial trial. It was replaced in 1922 by the O.G.P.U. (United General Political administration). At that time there were 23 concentration camps in various locations in Russia.

Although its powers were not absolute, the O.G.P.U. could arrest and send to concentration camps, without trial, persons accused of political offenses, such as espionage and counterrevolution, as well as those accused of certain criminal offenses, such as looting and illegal border crossing. In 1923 the O.G.P.U. established a concentration camp on Solovetski Island in the White sea in which prisoners were first used extensively for forced labour. Thereafter the Soviet concentration camp system became a gigantic organization for the exploitation of inmates through work.

The O.G.P.U. established many corrective labour camps in northern Russia and Siberia, especially during the first five-year plan, 1928–32, when thousands of rich peasants (kulaks) were driven from their farms under the collectivization program. The inmates of the camps in northern Russia were used principally in the lumbering and fishing industries and on large public-works projects, such as the construction of the White sea–Baltic sea canal. The inmates of the Siberian camps were used principally in lumbering and mining. In 1932 the O.G.P.U. set up corrective labour camps for gold mining in the arctic taiga along the Kolyma river in far eastern Siberia.

The O.G.P.U. was replaced by the N.K.V.D. (people's commissariat of internal affairs) in 1934. Thereafter the corrective labour camp system was administered by the N.K.V.D. which had its own para-military force. The Stalinist purges of 1936–38 brought additional thousands of political "unreliables" into the camps. By 1939 a vast system of concentration camps, utilized primarily for forced labour, existed across the northern reaches of European Russia and Siberia. These camps were said to be essentially institutions of slavery. Inmates were housed in rough barracks and were inadequately clothed for the severe arctic climate. The standard rations of bread and soup were scarcely adequate to maintain life. Camp commandants were credited with the amount of work produced against the amount of food consumed. As a consequence the prisoners were driven to, and beyond, the limits of human endurance.

The occupation of eastern Poland in 1939 and the incorporation of the Baltic states into the Soviet Union in 1940 led to incarceration in concentration camps of large numbers of non-Soviet citizens from those areas. Following the outbreak of war with Germany in 1941 the camps received prisoners of war and Soviet nationals accused of collaboration with the enemy. After the war, Russian soldiers who had allowed themselves to be captured were sent to the camps. The powers of the N.K.V.D. were transferred to the M.V.D. (ministry of internal affairs) in 1946. Under the M.V.D. corrective labour camps continued to serve as primary instruments for political control over the peoples of the Soviet Union and of the Soviet satellite states.

Concentration Camps of Nazi Germany.—In Nazi Germany the concentration camps (*Konzentrationslager*) were first established for the confinement of opponents of the Nazi party. *Reichsmarshal* Hermann Göring, who was responsible for the institution of the concentration-camp system, stated that the camps had been created for the confinement of thousands of leaders of the Communist and Social Democratic parties. But political opposition soon was enlarged to include individuals who opposed the methods of the Nazis and persecuted minority groups, particularly the Jews. In the anti-Jewish pogrom of 1938, 20,000 Jews were taken into "protective custody" by the Gestapo and sent to the concentration camps. By 1939 six major camps had been established: Dachau, Sachsenhausen, Buchenwald, Mauthausen, Flossenbürg and Ravensbrück.

The outbreak of World War II created a tremendous demand for labour in Germany, and Nazi authorities turned to the concentration-camp population to augment the labour supply. From 1940 to 1942 nine new camps were established: Auschwitz, Neuengamme, Gusen, Natzweiler, Gross Rosen, Lublin, Niederhagen, Stutthof and Arbeitsdorf. Thousands of forced labourers from countries occupied by Germany were placed in concentration camps and auxiliary labour camps. Under the "night and fog decree" (*Nacht und Nebel Erlass*), a terrorist measure, prominent citizens of occupied territories were spirited away by the Gestapo under cover of "night and fog" and secretly imprisoned in concentration camps. Escaped Soviet officer prisoners of war who were recaptured were sent to Mauthausen where they were executed under the "bullet decree" (*Kugel Erlass*).

The concentration camps were under the administration of the W.V.H.A. (Economic Administration Main office) of the SS. (*Schutzstaffel*). They were guarded by special units of the SS. known as the death's-head battalions (*Totenkopfverbände*). While severity of treatment depended upon the categories of prisoners confined, conditions in general were degrading and brutal.

Prisoners were used for medical experiments, in the course of which many were maimed, tortured and killed. Housing was so deplorable, rations were so meagre and work was so excessive that few persons could survive long internment. Crematoriums were established in the camps to dispose of the bodies of the dead. Toward the end of the war, when food and fuel supplies became exhausted, thousands died of starvation and disease. The Allied forces found the quick and the dead lying side by side in the barracks. Camp after camp presented a scene of horror.

The most shocking extension of the concentration-camp system in Nazi Germany was the establishment of extermination centres under cover of the war by order of *Reichsführer* SS. Heinrich Himmler. These centres, located principally in Poland, were for the primary purpose of the mass murder of unwanted populations, particularly the Jews. The elimination of such populations was part of the Nazi plan to develop a "master race." Victims were shipped to the camps in freight trains. Those who were not fit for heavy manual labour were sent at once to gas chambers which were usually disguised as bathhouses. Children as well as adult men and women were exterminated in the gas chambers. Bodies of the dead were removed by special details of prisoners and were burned on the ground or in the crematoriums. Everything of value was taken from the victims, including even the gold fillings extracted from the teeth of corpses. The most notorious of the extermination centres was the concentration camp at Auschwitz (Oświęcim), Pol. Rudolf Hoess, the commandant of Auschwitz, confessed to the extermination of 2,500,000 people in that camp alone.

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(W. R. Hs.)

CONCEPCIÓN, province of south central Chile lying almost entirely within the coastal mountains, is bounded by the province of Ñuble on the north and east, Bío-Bío and Cautín on the south and the Pacific on the west. It is approximately bisected by latitude 37° S. One of eight provinces created in 1826, Concepción was reduced to 2,201 sq.mi. by the segregation of territory to form Ñuble, Bío-Bío, Malleco, Cautín and Arauco provinces. Concepción is the third province in population (537,711 in 1960) and in population density. The city of Concepción (*q.v.*) is the provincial and departmental capital. Lesser administrative centres are Talcahuano, site of a major naval base, Coronel (*q.v.*), a coal-mining centre, Tomé and Yumbel.

For many years Chile's third industrial centre, Concepción produced in the 1950s 10% of the manufactured goods, 7% of the mineral wealth (value) and about 8% of the timber (volume). Iron and steel, textiles and food products are major manufactures in the diversified industry. Coal (about 80% of the national output) and glass and ceramics raw materials are the chief mineral products. Tree farms (pine and eucalyptus) yield most of the timber. Although the climate is temperate and humid, the soils are among the least productive in Chile. Only the vineyard acreage is significant. Nevertheless, a variety of food crops and livestock is raised for the markets of Coronel, Lota, Concepción, Talcahuano-San Vicente and Penco-Tomé. The cities are joined by rail and highways. Double rail communication with the Santiago-Puerto Montt railway is made by way of the Bío-Bío valley or by the more northerly Itata and San Rafael valleys. (J. T.)

CONCEPCIÓN, third largest city of Chile, provincial and departmental capital and a major educational and manufacturing centre, is located in latitude 36° 50′ S., longitude 73° 06′ W. Pop. 167,468 (mun.). The city is an episcopal see, and the seat of an appellate court and of the University of Concepción. The city's commercial and industrial prominence may be related to a number of geographic assets. Concepción bay, to the north, is large and protected; the Bío-Bío river, which enters the sea just below the city, provides a corridor through the coastal mountains to a valley region where agricultural and forest industries are well developed. The river's volume and hydroelectric potential are ample to meet foreseeable regional industrial and domestic requirements. Over 90% of Chile's coal is mined within 55 mi. of the city. The railway serving the major mines ends in Concepción, as do the railways which follow the Bío-Bío and Itata rivers into the interior. The Itata railway links the east-shore Concepción bay industrial and resort towns of Lirquén, Penco and Tomé (textiles, sugar and wine processing, glass and ceramics, coal mining). A local railway serving the southwestern side of the bay joins Talcahuano, Huachipato and San Vicente with Concepción. Talcahuano is a major naval base, a commercial port for the region from Talca to Temuco and, like San Vicente, a source of Santiago's fresh and preserved sea food. Huachipato, a planned industrial town, is the site of a modern steel mill, built in the late 1940s. Concepción's industries include textiles, food processing, woodworking and brewing; across the Bío-Bío is a paper factory and upstream is the Chiguayante cotton mill. The city has an attractive university campus and adjacent residential area. Concepción, founded on the present site of Penco in 1550, was twice burned by the Araucanians (in the 1550s) and struck by several earthquakes, two of them followed by tidal waves (1730, 1751). In 1754 the city was transferred to the present site. Serious earthquakes have continued (1835, 1898, 1922, 1939, 1960). (J. T.)

CONCEPCIÓN, a department of north central Paraguay, lies between the Apa river on the north and Ypané on the south, and is bounded on the west by the Paraguay mainstream. The terrain is swampy lowland in the west, rising eastward into hilly country. Area 6,970 sq.mi. Economic activities centre around lumbering, cattle raising and subsistence agriculture. The principal settlements are Concepción, the capital, Horqueta, Loreto and Belén, all in the southwest of the department. Of the estimated population of 80,174 (1960), 90% live south of the Aquidabán river, in the districts served by these towns. A road links Concepción to Brazilian centres and a narrow-gauge railway serves Horqueta. (G. J. B.)

CONCEPCIÓN (VILLA CONCEPCIÓN), the principal town and river port of northern Paraguay, lies on the Paraguay river near the mouth of the Ypané river. Pop. (1960 est.) 20,642, including many with an admixture of Indian blood. It is an export point for cattle, lumber and yerba maté, and a distributing centre for merchandise brought up the Paraguay river from Argentina and from Asunción, the national capital, which lies 134 mi. to the south. It has a considerable trade with the Brazilian province of Mato Grosso, to the north, as well as with the quebracho ports of Casado and Pinasco. It is also linked by internal air services with the capital. Founded in 1773, it was an important logistic point during the Chaco war, 1932–35, and has remained a garrison city. It is the headquarters of the bishop of the Chaco. A metre-gauge railway eastward to Horqueta serves a cattle-raising and lumbering area. (G. J. B.)

CONCEPT AND CONCEPTION. In philosophy the word "concept" (of which "conception" is an older equivalent) is very frequently employed: it is indeed so convenient as to be almost indispensable, though its use has sometimes been thought to raise difficulties. A typical instance of its use is in the title of Gilbert Ryle's book *The Concept of Mind*, where it implies that the purpose of the author is not to investigate empirically (*e.g.*, by the methods of psychology) the mind itself, but to investigate the salient logical features, or in the author's phrase the "logical geography," of the language in which we speak of the human mind. Similarly, investigations of the logical features of discourse about pleasure or duty or remembering would be said to be concerned with the concepts of pleasure or duty or memory. Derivatively, to use, or to be able to use, the linguistic expressions in question would be said to be to apply, or to possess, those concepts. The convenience of the word "concept" is that it supplies a brief mode of referring to the interest of philosophers in logical, or linguistic, problems, as distinct from the interest of other inquirers in empirical (nonlinguistic) matters of fact. Its use has, however, been occasionally deplored, on the ground that it might suggest that philosophers are concerned with nonsensible entities, "objects of thought" or "mental contents," and thus might actually obscure the essentially linguistic, or logical, character of philosophical problems. It need not be denied that the use

of this expression might, as indeed might the use of any other, prove sometimes misleading; however, the danger of this is an insufficient reason for renouncing altogether the use of so convenient a term. *See* also ABSTRACT AND ABSTRACTION; CONCEPTUALISM; UNIVERSAL. (G. J. WE.)

CONCEPT FORMATION, PSYCHOLOGY OF. A prominent aspect of the human thought process is the utilization of abstraction, in which generalized categories are used to represent a diversity of particular objects and events. The "general ideas" which are used for classes of items are called concepts (*see* CONCEPT AND CONCEPTION), and the process by which the person comes to give a common response (usually a name) to a general class of objects which despite differing details have certain characteristics in common is called concept formation. The relationship between universals and particulars has been discussed by philosophers since the time of Plato, but not until the 20th century was the problem given experimental study.

Concepts develop slowly through experience. They are usually derived from a series of concrete examples, or instances, some of which are found to be members of the class being derived and others of which are not. The first type of example is commonly referred to as a positive instance (a member of the class) and the latter as a negative instance (not a member of the class). Thus the child is told on many occasions that the animal he sees *is* a dog, but on other occasions he is told that his teddy bear or the family cat is *not* a dog. Depending on its nature, positive and negative instances have varying utility in conveying a concept. In general, positive instances seem to be more effective in learning, although with complex concepts negative instances are essential to limit appropriately the possible range of generalization.

Observation of and interviews with children in the process of learning concepts at successive ages have had an important influence in the study of how concepts are acquired. Jean Piaget analyzed into four general stages the development of concepts in children. During the first stage the child shows discrimination of objects by a characteristic reaction to particular objects. In the next stage he employs words to stand for particular objects but not for classes of them. In the third stage the child responds symbolically to a class of objects but is unable to give an adequate verbal formulation of the concept. During the fourth stage the child is able to give an acceptable definition of the concept. These stages are not, of course, perfectly clear-cut, and there is considerable overlapping between them.

A pioneer study by C. L. Hull involved the learning of nonsense syllables to various symbols drawn to resemble Chinese characters and devised to have certain common characteristics imbedded in them. Hull found that the appropriate nonsense syllable was learned to each class of stimulus on the basis of the hidden characteristics, although in many cases the learners were not able to verbalize the basis on which they did this. Extensive further study was undertaken by E. Heidbreder, who believes that concepts involving concrete objects are more readily learned than those involving spatial forms or abstract numbers.

Appropriate concept formation is dependent upon the functioning of the nervous system and brain. Studies of the effects of brain damage, particularly among wounded soldiers, indicated that injury to the frontal cortex of the brain impairs the person's ability to utilize abstract concepts but has much less effect on his dealing concretely with particular objects. For example, one of the patients studied by K. Goldstein and M. Scheerer could readily drink out of a glass filled with water but was unable to demonstrate how to drink when the glass was empty. Another patient could use a generic term like flower in a particular way (as, "I grow flowers in my garden") but could not deal with the abstract concept of flower.

Somewhat related phenomena are found in studies of mental patients, particularly those with schizophrenia (*q.v.*). L. S. Vigotsky, a physiologist, who devised an important clinical test used in the study of conceptual capacity, advanced the thesis that thinking in schizophrenics is a regression to childlike thinking. Significant studies of thinking in schizophrenia were carried out by E. Hanfmann and J. Kasanin, who found marked deterioration in the pattern of concepts utilized by schizophrenics. There was, however, considerable variability, the lowest levels of conceptual functioning occurring consistently only among patients also having organic damage. Since schizophrenic patients typically have severe emotional difficulties, it is not clear to what extent the deteriorated performance is attributable to personality disturbances rather than to changes in intellectual functioning.

Most of the concepts the child learns and the adult uses in his everyday thinking exist ready made in the culture in which he is brought up. The task of the individual is not to form them but to acquire them by means of his relations with others. The invention of entirely new concepts is a much rarer and much more difficult task. This is, of course, particularly characteristic of scientific activity. Here, in addition to the inductive type of concept attainment which has been discussed, there is need for inference of the type classically labeled deduction and also for creativity to develop novel combinations not formerly considered. Concepts involving relationships where there are long time lapses between an event and its consequences, or concepts involving contingencies and interdependence, are particularly difficult to develop. There are also frequently motivational resistances to the acceptance of new concepts which have to supplant those derived from earlier experiences. *See* also CHILD PSYCHOLOGY AND DEVELOPMENT; THINKING AND PROBLEM SOLVING, PSYCHOLOGY OF.

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CONCEPTUALISM (from "concept"), in philosophy, a term applied by modern writers to a scholastic theory of the nature of universals, to distinguish it from the two extremes of nominalism and realism. The scholastic philosophers took up the old Greek problem as to the nature of true reality, whether the general idea or the particular object is more truly real. Between realism which asserts that the *genus* is more real than the *species*, and that particulars have no reality, and nominalism according to which *genus* and *species* are merely names (*nomina, flatus vocis*), conceptualism takes a mean position. The conceptualist holds that universals have a real existence, but only in the mind, as the concepts which unite the individual things; *e.g.*, there is in the mind a general notion or idea of boats, by reference to which the mind can decide whether a given object is, or is not, a boat. On the one hand "boat" is something more than a mere sound with a purely arbitrary conventional significance; on the other it has, apart from particular things to which it applies, no reality; its reality is purely abstract or conceptual. This was enunciated by Abélard in opposition to Roscelin (nominalist) and Guillaume de Champeaux (realist). Abélard held that it is only by becoming a predicate that the class-notion or general term acquires reality. Thus similarity (*conformitas*) is observed to exist between a number of objects in respect of a particular quality or qualities. This quality becomes real as a mental concept when it is predicated of all the objects possessing it. Hence Abélard's theory is alternatively known as sermonism (*sermo*, "predicate"). His statement of this position oscillates markedly, inclining sometimes toward the nominalist, sometimes toward the realist statement, using the arguments of the one against the other. Hence he is described by some as a realist, by others as a nominalist. When he comes to explain that objective similarity in things which is represented by the class concept or general term, he adopts the theological Platonic view that the ideas which are the archetypes of the qualities exist in the mind of God. They are, therefore, *ante rem, in re* and *post rem*, or, as Avicenna stated it, *universalia ante multiplicitatem, in multiplicitate, post multiplicitatem* ("universals exist before, in, and after the multiplicity of their particulars"). The whole controversy suffers from a tendency to confuse "idea" in the sense of a concept or notion in the mind with "idea" in the Platonic sense of an ultimate archetype of phenomenal objects. (A. Wo.)

CONCERT. The concert is a social institution for the performance of absolute, as distinct from religious or dramatic, music which developed to its present form from the informal music-making of the 17th century. The social influences affecting the concert also affected the music conceived for it, and the evolution in music from Mozart to Beethoven has a counterpart in the aristocratic, as opposed to the democratic, patronage of the concert. Similarly, cosmopolitan aspects of music in the second half of the 20th century are associated with the increasingly international outlook of concert audiences.

Early forms of the concert were associated with university activities. In the first half of the 18th century many German universities maintained a Collegium Musicum for the performance of chamber music, and "music meetings" were regularly held at Oxford and Cambridge. Gatherings of amateurs to hear music had been a feature of the Italian academies of the Renaissance, notably those at Bologna and Milan founded in the 15th century. Like the French academies that succeeded them, they fostered music as one of the humanities and anticipated in this respect the function of 18th-century concert patrons. The more important Italian and French academies were, however, principally concerned with exploring the borderlands of music and poetry, and these opened a way to the opera rather than to the concert.

The first public concerts for which admission was charged were given in London by the violinist John Banister at his home in Whitefriars in 1672. In 1678 Thomas Britton, a charcoal seller, established weekly concerts in a loft in Clerkenwell at the subscription rate of 10*s.* a year. Handel and Pepusch were among the performers at these humble but historic concerts which were the forerunners of several other London series, particularly in the neighbourhood of Covent Garden.

Concerts of instrumental and vocal music were frequently given at the homes of the nobility in France in the 17th century. The first public concerts in France were the Concerts Spirituels, organized by the composer Anne Danican Philidor on days of religious festivals when the Opéra was closed. These flourished in Paris from 1725 to 1791. Closely associated with the development of the symphony and bringing the 18th-century repertory to a wide public, the Concert Spirituel served as a model for similar concert societies in other countries.

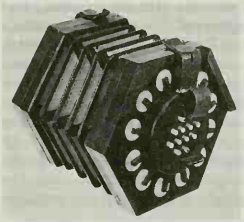
In the second half of the 18th century the symphonies of Haydn and Mozart were introduced in England at the professional concerts, and Haydn wrote a famous set of 12 symphonies for performance in London at the Salomon concerts. Earlier, concerts reflecting the social elegance of 18th-century London were given in elaborate settings at the gardens of Vauxhall, Ranelagh and Marylebone. An English equivalent of a *fête galante* was suggested by the masquerades and Handelian opera singers at these pleasure gardens where the programs ranged from works by the seven-year-old Mozart to popular songs of the day. Something of the spirit of the London garden concerts was revived at the end of the 19th century at the Crystal Palace concerts in London. Among the numerous 18th-century concert societies in Germany and Austria the Gewandhaus concerts at Leipzig, dating from 1781, and the Tonkünstlersocietät (Musicians' society), founded in 1771 in Vienna, were later to be associated with the great figures of romantic music. The court concerts given by the orchestra of the elector palatine between 1743 and 1778 at Mannheim, described by Charles Burney as "an orchestra of generals," reached the highest standard of orchestral playing in Europe at that time.

A change came at the beginning of the 19th century when concerts attracted audiences drawn from a wider social range. New concert societies were formed to meet the demands of a growing democratic spirit. Many societies, formed when the symphonies of Beethoven and the romantic works of Berlioz were first heard, exist to the present day, notably the Philharmonic society (later, Royal Philharmonic society) in London, the Concerts du Conservatoire in Paris and the Gesellschaft der Musikfreunde in Vienna.

So far concert giving had been mainly confined to England, France, Germany and Italy. With the growth of nationalism concert societies were formed for the promotion of national music in many European countries, notably the Russian Music society founded in 1859. In the United States concerts had been given in the 18th century at New York, Philadelphia and Boston, and also at Charleston, S.C., where a St. Cecilia society was founded in 1762 and where, five years later, concerts were inaugurated under the title "New Vauxhall," on the model of the London garden concerts. But the main U.S. contribution to concert activity came with the foundation in the 19th century of symphony orchestras in several towns. Prosperity attracted European artists and enabled high standards to be reached by U.S. musicians. From the early 20th century, concert activity in the larger U.S. cities attained at least the level of that in European centres.

In the 20th century, and particularly after World War II, concert activity was greatly stimulated by the radio and the phonograph. Larger concert halls were built and orchestral and chamber-music concerts became one of the main attractions at music festivals. Concert societies were established in countries of the British Commonwealth and South America. Others sprang up in India and Japan. With the world-wide popularization of music concert repertories were, however, marked by a new trend. Well-established works of the classical and romantic periods were generally more favoured than contemporary works. On the other hand, standards of execution at concerts, particularly of instrumental works, were noticeably higher. Orchestras, as well as soloists, traveled freely from one country to another, and concerts even in provincial towns, sometimes the scene of a music festival, reached a standard which must have been unknown in the main centres of concert activity in the 19th century. (E. Lr.)

CONCERTINA, a musical instrument of the free-reed class (*see* Wind Instruments), patented by Sir Charles Wheatstone in London, 1829. Hexagonal hand bellows are fastened between two sets of boards that carry the reeds in fraised sockets, and also the pallet valves and finger buttons by which air is selectively admitted to the reeds. The reed tongues, of steel or brass, are attached to their individual brass frames by screwed plates. The concertina employs "double action" (*see* Accordion), each note being given by a pair of reeds, one to sound on the press of the bellows, the other on the draw. In the original and subsequently the most usual model, the chromatic scale is divided between the two hands; in some later models, as the duet-system concertina, a chromatic scale is provided for each hand.



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EARLY CONCERTINA MADE OF ROSEWOOD AND LEATHER WITH IVORY KEYS AND MOTHER-OF-PEARL PALLETS; BY SIR CHARLES WHEATSTONE; *c.* 1829

Wheatstone's other invention in this field, patented in 1829, was the Symphonium. This was a chromatic mouth organ with reeds contained in a small nickel-silver box and controlled by finger buttons at the sides. The blowing hole was at the back of the box, and the reeds (one for each note) were all sprung to be sounded on the blow, none on the draw. The patent also describes a bellows attachment for the Symphonium.

After the great days of the concertina virtuoso in the 19th century, from Giulio Regondi to Alexander Prince, the instrument gradually became superseded from *c.* 1910 by the improved continental accordion. *See* also Harmonium. (A. C. Ba.)

CONCERTO, in music, a term used since about 1700 as the title for compositions in which the skill of a single virtuoso instrumentalist is set into relief against an orchestral background. The word has two, apparently contradictory, meanings: first, it describes music played in consort, *i.e.*, together; second, it describes music characterized by a conflict between separate groups of instruments with different tonal qualities.

The Early Concerto.—The early history of the concerto is not easy to trace because of this confusion in meaning and because of the inexact application of the term—a difficulty that is also encountered with the sonata and the symphony. The word "concerto" first makes its appearance in late 16th-century Italian

sources: in anthologies of music by Andrea and Giovanni Gabrieli (1587), Cristofano Malvezzi and Luca Marenzio (1591) and Adriano Banchieri (1596); and in the title of a treatise on instrumentation by Ercole Bottrigari, *Il desiderio, overo de' concerti di varij strumenti musicali* (1594). In these books, as in dozens of others published during the first 40 years of the 17th century, the Italian term "concerto" is exactly synonymous with the Latin *concentus*, the English "consort" or the French "ensemble." A concerto of this time was a comparatively short piece of polyphonic music for a relatively small number of singers and players, or players alone, each performing an individual part of no particular technical difficulty. The ensemble was usually welded together by the accompaniment of an organ, harpsichord or lute, and the performers were expected to improvise their own embellishments to their written parts. Such a style could only arise in cities like Venice, where there was a long tradition for elaborate ensemble music on great church and state occasions, or at the courts of wealthy art-loving despots (*e.g.*, the Medici of Florence); all the early concertos are associated with such surroundings. In many early concertos the players were arrayed in two or more groups so that the music formed an antiphonal dialogue. In others—notably the very influential *Concerti ecclesiastici* of Ludovico Viadana (1602)—the music is what now would be termed a motet or, more rarely, a madrigal for one or more solo voices, accompanied by the organ and sometimes by other instruments as well.

Throughout the first 40 years of the 17th century the concerto remained an Italian form, practised almost exclusively by Italian composers, and it retained its connotations of ceremony, the church and court, and improvised embellishment. Between *c.* 1640 and 1680 the word disappeared altogether, for reasons that are far from clear, in favour of sonata or sinfonia (for instruments) and cantata (for voices). When it reappeared (Giovanni Bononcini's *Concerti da camera*, 1685; Giuseppe Torelli's *Sinfonia e concerti*, 1692; Giulio Taglietti's *Concerti e sinfonie*, 1696) its meaning had become restricted to instrumental music, and it has remained so ever since. Concertos of this date are distinguishable from the trio-sonata (for two violins, cello and keyboard) only in that the composers appear to have envisaged several players to a part. An attempt also seems to have been made at distinguishing between the church concerto—solemn, pompous, contrapuntal—and the chamber concerto, which was more light hearted and less intricate (*see* CHAMBER MUSIC).

The Concerto Grosso.—By 1700 or so the viola had become an integral part of the ensemble and each violin part had forked into two, one for an accomplished soloist and the other for his less proficient colleagues. This orchestral ensemble of strings and keyboards was usually handled by composers as a double body: a *concertino* ("little concerto") consisting of the old trio-sonata combination of two violins, cello and keyboard; and a *ripieno* ("filling out") of strings in four or five parts, with a second keyboard. Music for such an ensemble was called a *concerto grosso* (a term first encountered in 1698), and the style was perfected by Torelli (1698), Tommaso Albinoni (1700), Arcangelo Corelli (published posthumously in 1714) and Antonio Vivaldi (1710–20). Most of this music was composed in Rome, Bologna or Venice during the years from 1680 to 1720; it was widely disseminated, above all by the enterprising though piratical music publishers Estienne Roger of Amsterdam and his rival John Walsh of London; and it was widely imitated, by Handel and Bach among many others.

Soon the *concerto grosso* broke into two diverging forms: the solo concerto for a single soloist, and the orchestral concerto for an ensemble of strings, woodwind and accompanying keyboard. Vivaldi took the lead in the development of both these forms, and he also established the pattern of an animated rhythmic first movement, an expressively singing slow movement, and a high-spirited brilliant finale. His hundreds of concertos include 71 (printed) violin concertos, 27 cello concertos, 37 bassoon concertos and three oboe concertos, as well as many orchestral concertos for highly diversified ensembles. Bach and Handel were the first to write concertos for a solo keyboard instrument—they were renowned as virtuosi on the harpsichord and organ, just as Vivaldi was on the violin—and they also carried the development of the orchestral concerto a stage further, notably in Bach's set of six Brandenburg concertos composed between 1716 and 1721. Each of the Brandenburg concertos displays a different combination of soloists, but at least three of them belong to the repertory of chamber music rather than to that of the symphony orchestra since all the parts are for single players.

By 1730 Vivaldi's three-movement form (quick, slow, quick) had become standard throughout Europe. Its dramatic elements of contrast and display appealed instantly to an age that was mad about opera; Bach's *Italian concerto* for unaccompanied two-manual harpsichord is not only a perfect example of the genre but also demonstrates how it could be transferred intact to a single instrument. Such a work as this is very close to the classical sonata, concerto or symphony of the next generation, lacking only the minuet and trio, and the new structure of sonata form. With the concertos of Bach's sons Carl Philipp Emanuel and Johann Christian, the bridge between the two styles is crossed into the familiar territory of Mozart, Haydn and Beethoven. In their music the violin at last yielded its supremacy as a solo instrument, and the newly perfected pianoforte took over instead. Mozart composed six concertos for violin, but nine for piano; Haydn nine for violin, 20 for piano; Beethoven one for violin, five for piano.

The Classical Concerto.—During the classical period the concerto steadily increased in length, brilliance and emotional content; the listener found it ever easier to identify himself with the soloist's problems and triumphs, as an analogue with his own attempts to make his way in the world, and the concerto soon became the favourite among all forms of concert music. The piano's increasing power permitted an ever richer and louder orchestral accompaniment; its keyboard was extended to higher and lower notes until its range exceeded that of all other orchestral instruments put together; and the piano concerto became more and more an adventure in contest and endurance, rather than an essay in contrast and elegance. Small wonder that the great romantic composers of the 19th century chose it with such unanimity: two piano concertos each by Weber, Mendelssohn, Chopin, Liszt, Brahms; one each by Schumann and Grieg; three by Tchaikovsky. The array of violin concertos by the same composers makes a striking comparison: one each by Mendelssohn, Schumann, Brahms and Tchaikovsky.

Some special developments in the concerto during the classical and romantic periods are worth noting: (1) the appearance of concertos for almost every instrument of the symphony orchestra (*e.g.*, Haydn's for trumpet, and cello; Mozart's for horn, bassoon, clarinet, oboe, flute and harp; Domenico Dragonetti's for double bass; Rimsky-Korsakov's for trombone); (2) the growth of the accompanied cadenza, finally reducing the soloist's improvisatory freedom to nil; (3) the cyclic form adopted by Liszt for his concertos, in which the three movements become welded together into one long fantasia; (4) the single-movement concerto or *Konzertstück;* (5) the introduction of new concerto forms (*e.g.*, César Franck's symphonic variations for piano and orchestra); (6) the return of the multiple concerto (concertos for two or three soloists are usually known as double or triple concertos, *e.g.*, those by Beethoven, Schumann, Brahms, but the term *sinfonia concertante* is preferred for a work in which these players have a less dominating part, *e.g.*, Mozart's beautiful *sinfonia concertante* for violin, viola and orchestra, K. 364); (7) the ever increasing technical difficulty of the solo parts.

The Concerto in the 20th Century.—By 1900, as the result of more than a century of development, the concerto had lost all contact with the form perfected by Mozart; 20th-century composers have worked new veins. Some composers have tried to revive the ideals in style or sound of the early 18th-century concerto, occasionally by using single instruments for every part of the texture (Ernest Bloch, Gustav Holst, Vincent d'Indy, Henk Badings, Goffredo Petrassi, Paul Hindemith, Igor Stravinsky, Manuel de Falla, Francis Poulenc). Others have sought to even out the disparity in technique between soloist and accompaniment by writing concertos for virtuoso orchestra (Hindemith, Béla Bartók). A third group has continued to ride the tiger of virtuosity in solo concertos, not for its own sake but as a means of

personal expression (Sergei Rachmaninoff, Edward Elgar, Sergei Prokofiev, Dimitri Shostakovich, Arnold Schönberg, Alban Berg, Michael Tippett, William Walton). A fourth group has endeavoured to cure the elephantiasis afflicting the late 19th-century concerto by writing much shorter works, reviving for this purpose the diminutive term *concertino*, which first appeared on a title page of 1687 and already had been adopted by Weber for his clarinet concertino, opus 26; among them are John Carpenter and Walter Leigh.

Such new developments as these show that the concept of the concerto is far from outworn. Audiences will always enjoy a contest, provided its rules are comprehensible; they will always enjoy a musical debate, provided the language is neither abuse nor gibberish; and they will always enjoy observing a virtuoso in action, for it is the most exciting of all musical experiences.

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CONCESSIONS, a term embracing grants by a state to citizens, aliens or another state. A concession may signify a grant by one state to another of political rights in its territory; also a grant, franchise, contract, charter or licence by a state to an individual, a corporation or another state to carry on a specified economic enterprise in its territory. Before World War I the economic concession was used to bring economically undeveloped countries into an expanding international economy.

Origin and History.—In the middle ages the term "concession" apparently meant a grant, usually of land, from a ruler. After the Europeans' discovery of distant lands, concessions took the form of charters granting lands and some measure of sovereignty to companies, such as the Massachusetts company and the British and Dutch East India companies, and to individuals such as William Penn and Lord Baltimore.. The more recent history of concessions has paralleled the expansion of industry. The 19th century saw the establishment both of economic concessions by agreement with the rulers of economically undeveloped regions and of political concessions as a substitute for the outright acquisition of a colony or to provide a transportation link such as a canal or a railroad. Economic and political concessions were not always easily differentiated. Economic concessions sometimes served as indirect means of political control of weak states. The rise of Asian and African nationalism, particularly after World War II, gave a new prominence to the concession as a means of making capital and technical skills available to undeveloped states.

Political Concessions.—Political concessions, usually set forth in treaties between governments, often embrace grants of partial or total sovereignty, perhaps over a commercial port or a military, naval or air base. Examples of Chinese concessions include railways and such ports as Macao (to Portugal in 1557), Kiaochow (to Germany in 1898), Port Arthur (to Russia in 1898), Weihai-wei (to Great Britain in 1898) and part of Tientsin (to Belgium in 1902). Similar was Cuba's concession of Guantánamo bay to the United States in 1903. Although a concession generally takes the form of a lease, the extent to which sovereignty could be effectively transferred is seen in the manner in which Port Arthur was shuttled back and forth between Russia and Japan, with China a powerless bystander. *See* also IMPERIALISM.

Also of a political nature were grants of sovereign rights such as that by the sultan of Borneo to Sir James Brooke (*q.v.*). "Concessions within concessions" occurred in the late 19th century when chartered companies such as the Royal Niger company gained concessions from native chiefs and in turn granted them for development of industries and natural resources.

The Suez canal involved investment both for profit and for political purposes. The canal was constructed and operated in accordance with concession agreements made by Ferdinand de Lesseps and the khedive of Egypt in 1854 and 1856 and confirmed by the sultan of Turkey in 1866. These agreements, together with the declaration of 1873 and the nine-power treaty of 1888, established the principle of unhampered navigation for merchantmen and warships of all nations in peace and war, subject to regulations concerning tolls, pilotage dues, etc. The concession agreements provided that a Universal Suez Maritime Canal company should be established for a period of 99 years from the opening of the canal, which occurred in 1869. This joint-stock company was financed by Egypt and by private investors, chiefly French. In 1875 for political and commercial reasons Great Britain purchased the khedive's holdings, amounting to nearly 44% of the shares. In 1949 the subvention to Egypt was increased to 7% of gross profits. On July 26, 1956, Pres. Gamal Abdel Nasser of Egypt announced nationalization of the canal. Western opposition and efforts by users of the canal to establish an international operating authority proved futile. In 1958 the shareholders agreed to settle for retention of external assets and liabilities and payment by Nasser's government of £28,300,000, at least 40% in sterling and the remainder in French francs, payment to be completed on Jan. 1, 1964.

Amid considerable political and diplomatic maneuvering, the Panama canal concession, originally acquired by L. N. Bonaparte-Wyse and associates from Colombia in 1878, passed to a French corporation and finally to the United States. By the treaty of Nov. 18, 1903, the United States guaranteed the independence of the new republic of Panamá in exchange for a grant in perpetuity of the use of a zone ten miles wide, exclusive control therein for sanitation, police, judicial and other purposes, the right to fortify and defend the canal and the right to intervene when necessary to preserve order in the cities of Colón and Panamá. Panamá received an immediate payment of $10,000,000 plus an annuity of $250,000 beginning after nine years. In 1921 Colombia was accorded $25,000,000 in compensation for losses suffered.

The Nature of Economic Concessions.—Economic concessions fall into two major categories: (1) public utilities; and (2) exploration for and exploitation of natural resources. Among the public utilities embraced have been cables, telegraphs, shipping, lighthouses, roads, sewers, hospitals and air transportation. Natural resources exploited have included petroleum and other hydrocarbons, minerals, rubber, timber and agricultural products. The instrument of concession is usually an agreement or contract in which both the granting state and the concessionaire accept mutual obligations toward each other. Unless economic concession agreements are between states, they are not treaties.

Mining Concessions.—Mining has been conducted by concession since the middle ages. Today in much of the world concession is the necessary method for mineral and oil extraction because either constitution or statute vests the subsoil in the state. Elsewhere the concession method can serve the interests of conservation. Where the subsoil is owned by the state the government concedes the privilege of working government property. Otherwise, the privilege of mining depends upon both agreement with the surface owner and contractual permission or licence from the state. International mining concessions provide the conceding state with both income and a basis for industrial development, while the concessionaire's state acquires more certain access to industrial and strategical minerals, including fissionable materials, which distribution governments try to control.

Oil Concessions.—Development of the internal-combustion engine rendered petroleum and competition for access thereto matters of increasingly vital concern both to economic and to military policy makers. Competition increased the royalties of conceding states. Wherever the concessionaire's return depends upon finding oil, the risks may be considerable. The 1958 contract between Pan American Petroleum corporation (wholly owned by Standard Oil Company [Indiana]), Iran and the government-owned National Iranian Oil company required a bonus of $25,000,000, deductible in ten equal installments, in determining taxable net profits after the start of production. Additional requirements were an annual rental of $400–$600 per square kilometre, an expenditure of a minimum of $82,000,000 for exploration during the first 12 years, an income tax of 50% of net profits and an equal division of the other 50% with the National Iranian Oil company.

Venezuela's petroleum mineral law of 1943, based on state

ownership of the subsoil traceable to statutes of 1783, allowed concessions for exploration, exploitation, transportation and refining of petroleum. An exploration concession granted the exclusive right to explore for three years a specified area of approximately 10,000 ha. One-half the plot could be sold for exploitation; the remainder was to revert to the state. The exploitation concession extended for 40 years and was granted on the basis of sealed bids for specified plots. The Venezuelan arrangements led by 1952 to foreign-exchange earnings from oil of about $500,000,000, which at that time amounted to about 50% of the country's foreign-exchange earnings and 60% of the government's revenue.

The Nature of Concession Contracts.—A concession contract is not made under legal compulsion but at the absolute discretion of the conceding state. Without the element of discretion the grant is not in the strict sense a concession. Employment of political and other indirect pressures need not invalidate a concession, provided that the requirements of the laws of the conceding state have been met. The concession contract grants economic rights, usually short of ownership, either for a specified time or in perpetuity. The grantor may be a unitary state or a subordinate unit such as a municipality or a native chief. The rights granted need not include a monopoly. They may include auxiliary rights such as those granted by Liberia to the Firestone Tire and Rubber company in 1926: (1) to build and use roads, bridges, airfields, pipelines, telephone lines, railroad stations, hydroelectric facilities and power lines; (2) to use public highways, public transportation and harbour facilities; (3) to import supplies and equipment duty free; (4) to construct and operate a transatlantic radio transmitter.

The concessionaire takes upon itself obligations to provide stipulated facilities such as housing or perhaps a complete village for employees. The Burmah-Shell agreement of 1951 with India for the construction of a refinery at Bombay called for a payment of $800,000 to Bombay state for housing. Concession agreements often impose an obligation to employ citizens of the conceding state and limit the number of aliens employable. The Iranian consortium agreement of 1954 between the government of Iran, the National Iranian Oil company and eight international oil companies, including the Anglo-Iranian Oil company, required the training and education of local personnel. The concessionaire may also undertake to promote local private enterprise in the manner of the Arabian American Oil company's industrial development division, which reported a steady increase in payments to Arab contractors. As in the 1951 agreement between Standard-Vacuum Oil company and India, provisions may be made for investment by citizens of the conceding state.

A concession agreement may declare the company's insulation from domestic politics in return for abstention from participation in local politics. Provision is generally made for arbitration of disputes by a tribunal specified in the contract. Arbitration aids in adjusting a contract to changed conditions such as the extension of national jurisdiction over the continental shelf.

The concession contract declares what law governs it. For example, under the Suez concession agreement, questions of the status and internal affairs of the company were to be governed by French law applicable to joint-stock companies and to be submitted to arbitrators in France subject to appeal "to the imperial court in Paris." Disputes in Egypt between the company and third parties and those between the company and the Egyptian government were to be governed by local law applied by local tribunals. Where all parties were foreigners, litigation was to be conducted "according to established rules." Latin-American contracts regularly contain a Calvo clause impressing upon the concessionaire the capacity of a citizen or local corporation in respect to disputes. The Iranian consortium agreement declared the agreement to be governed by the principles of law common to Iran and the companies' home states and by "principles of law recognized by civilized nations in general."

Royalties.—Older royalty arrangements often required a fixed payment per barrel or ton produced or a lower percentage of profits than was customary after 1945. The Anglo-Persian Oil company once paid Iran 16% of net profits plus £3,000 per annum. Fixed royalty payments often disappointed the conceding state when increased prices spelled increased corporate profits. More satisfying was the 50–50 arrangement that became common after World War II, particularly in respect to oil concessions. This arrangement allowed the state to impose a tax on the net income in such amount as would give the state 50% of the profits when added to fixed payments, if any.

A 75–25 allocation was initiated in 1957 when Ente Nazionale Idrocarburi, an Italian government corporation, undertook to pay exploration expenses over 8,800 sq.mi. in Iran, subject to 50% retroactive reimbursement after commercial quantities of oil were found, and to accord 50% of the profits to the Iranian government and 25% to the National Iranian Oil company, which shared exploitation expenses. There was no bonus as in the Pan American Petroleum corporation contract previously mentioned. In 1958 the Japanese Arabia Oil company contracted with Kuwait for exploration and development of the area in the neutral zone between Kuwait and Saudi Arabia lying between six miles beyond low-water mark and the international boundary in the Persian gulf. Kuwait was accorded a $1,500,000 annual rental, an additional $1,000,000 annually from the time oil might be struck, a bonus of $5,000,000 when production reached 50,000 bbl. daily and 57% of net profits down to the retailer. A corresponding agreement according Saudi Arabia 56% of the profits had been concluded late in 1957.

Termination of Concessions.—Concessions not in perpetuity end at the time set in the contract. India's agreement of 1951 with Standard-Vacuum for construction and operation of a Bombay refinery included a 25-year guarantee against nationalization.

The conceding state may, according to the terms of the concession itself, legally terminate a concession before its expiration date or, unless under treaty obligation to the concessionaire's state, by proper exercise of the right of eminent domain involving adequate compensation. Several international arbitral decisions have declared that the arbitrary employment of sovereign power, either by legislative or executive act, to annul a concession constitutes a "denial of justice" and creates an international liability to the concessionaire's state. Refusal to submit the validity of such termination to arbitration in violation of an arbitration clause has been held to create liability to make reparation. Failure to realize expected profits is not sufficient reason for releasing a state from its contractual obligations. Nor is the fact that a new state has succeeded the grantor of the concession sufficient ground for annulment by the successor state. The principle of unjust enrichment may be pleaded against the action of a successor state that ignores an expenditure of capital and labour from which the successor derives benefits.

Similarly, the principle of unjust enrichment opposes nationalization of concessionary enterprises without compensation. Nationalization of the Suez Canal company included an undertaking to compensate. The requirement of just compensation was also recognized in Mexico's settlements with the United States and the United Kingdom for its expropriation of oil lands. Even such Communist countries as Czechoslovakia, Poland and Yugoslavia conceded the necessity of compensation in their agreements with such states as France, Switzerland and the United Kingdom. In short, a concession contract involves mutual obligations not to be avoided by unilateral action.

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CONCILIATION IN INDUSTRIAL RELATIONS: *see* INDUSTRIAL RELATIONS.

CONCLAVE (from Lat. *cum*, "together," and *clavis*, "key"), originally meaning a room or apartment locked with a key, in the

Roman Catholic Church is the specific name for the assembly of cardinals met to elect a new pope and for the system of strict seclusion to which they are submitted.

In early times, the method of episcopal election at Rome was the same as in other towns; the Roman clergy and people and the neighbouring bishops each took part in it in their several capacities. The people would signify their approbation or disapprobation of the candidates more or less tumultuously, while the clergy were, in a strict sense, the electoral body, met to elect for themselves a new head, with the bishops acting as presidents of the assembly and judges of the election. In such an assembly, the various functions were not very distinct, and persons of importance, whether clerical or lay, were bound to influence the result, sometimes decisively. Moreover, this form of election lent itself to cabals and to disputes, sometimes involving bloodshed and schisms through the election of antipopes. The remedy for this abuse was found in recourse to the support of the civil power.

It thus soon came to be accepted that the elected candidate should not receive episcopal consecration until he had obtained the confirmation of the emperor; and this state of affairs lasted almost without interruption till the middle of the 11th century. When the emperors were at Rome, they presided over the elections; when they were away, rival factions of barons struggled for the spiritual power as they did for the temporal. Cases were seen of popes imposed by a faction rather than elected and then deposed, poisoned or thrown into prison, sometimes to be restored by force of arms. After Clement II's death delegates of the Roman clergy actually asked the emperor Henry III to give them a pope, and similar steps were taken after the death of Damasus II. Fortunately on this occasion Henry appointed a man of high character, his cousin Bruno, bishop of Toul, who presented himself in Rome in company with Hildebrand (later pope as Gregory VII).

From this time began the reform. Hildebrand had the election of Victor II (1055), of Stephen X (IX) (1057) and of Nicholas II (1058) carried out according to the canonical form, including the imperial ratification. Then Nicholas issued his celebrated bull of April 13, 1059, to determine the electoral procedure. The election was reserved to the members of the higher clergy, that is, to the cardinals (*see* CARDINAL), among whom the cardinal bishops had the preponderating position. The consent of the rest of the clergy and the people was now only a formality, and the emperor was reckoned to have no rights save those he had received as a concession from the Holy See. Further, in the event of disturbances at Rome preventing the election from being carried out freely there, the cardinal bishops, together with a small number of the clergy and of the laity, were empowered to hold the election where they should think fit; and should difficulties of any sort prevent the enthronement of the new pope, he was empowered immediately to act as if he were actually pope. This legislation was accepted by the emperor Henry V by the concordat of Worms (1122).

Two other points were established by Alexander III at the Lateran council of 1179: the constitution *Licet de vitanda discordia* makes all the cardinals equally electors, omits to mention the lower clergy or the people, and requires a majority of two-thirds of the votes to decide an election.

Institution of the Conclave.—Abuses nevertheless arose. An electoral college too small in numbers, which no higher power has the right of forcing to haste, can prolong disagreements and draw out the course of the election. When, after the death of Clement IV in 1268, the 17 cardinals assembled at Viterbo had allowed two years to pass without coming to an agreement, the local magistrates had recourse to the method of seclusion, shutting up the electors in the episcopal palace and blocking all outlets; and when the election still delayed, the people removed the roof of the palace and allowed nothing but bread and water to be sent in. Under such pressure, the cardinals finally elected Gregory X, after an interregnum of two years, nine months and two days.

Taught by experience, the new pope considered how to prevent the recurrence of such abuses. In 1274, at the council of Lyons, he promulgated the constitution *Ubi periculum*, the substance of which was as follows: at the death of the pope, the cardinals present are to await their absent colleagues for ten days. They are then to meet in one of the papal palaces in a closed conclave; none of them is to have more than one servant to wait on him, or two at most if he is ill. In the conclave they are to lead a life in common, not even having separate cells. They are to have no communication with the outer world; food is to be supplied to them through a window that must be under guard. The election is to be the sole business of the conclave, the magistrates of the town where it is held being required to see that these provisions are observed. Adrian V and John XXI were weak enough to suspend the constitution *Ubi periculum*, whereupon abuses at once reappeared; then Celestine V, who was elected after a vacancy of more than two years, revived it before abdicating the pontificate, and it was inserted in the decretals.

Later Legislation.—Pius IV's bull *In eligendis* (Oct. 1, 1562), signed by all the cardinals, is particularly notable for its regulation of the method of voting. Every day there is to be a scrutiny, or solemn voting, at which the cardinals are to use special papers (concealing the name of the voter, which is to be read only when some candidate has the required majority). This is to be followed by the *accessit*, or a second voting, at which the cardinals may transfer their suffrage to the candidates who won most votes in the scrutiny. The same bull also reaffirmed earlier measures on the question of seclusion and provided that the functionaries of the conclave were to be elected by secret ballot of the Sacred College and that the cardinals' cells were to be assigned by lot.

Something must be said about the so-called right of veto or exclusion, whereby the rulers of the various Catholic countries eventually claimed to be able to exclude from eligibility to the papacy any candidate to whom they objected. It had of course long been their practice to instruct the cardinals of their nation to do their utmost to eliminate distasteful candidatures; and they might even make public their desire to exclude certain candidates. In the course of the 16th century, however, they advanced a claim to an actual right of formal and direct exclusion, which should be notified in the conclave in their name by a cardinal charged with this mission and should have a decisive effect; and this was tacitly admitted by the Sacred College. It was a right based on custom and not supported by any written concession, but it was straightforward and definite. During the 19th century Austria exercised, or tried to exercise, the right of veto at all the conclaves, except that which elected Leo XIII (1878). Finally, in 1903, on Aug. 2, when Cardinal Rampolla had received 29 votes, Cardinal Puzyna, bishop of Cracow, declared that Austria opposed his election; whereupon the Sacred College yielded and, on Aug. 4, elected Cardinal Sarto (Pius X). Then, by the bull *Commissum nobis* (Jan. 20, 1904), Pius X suppressed all right of exclusion on the part of the secular governments and forbade, under pain of excommunication reserved to the future pope, any cardinal or conclavist to accept from his government the charge of proposing a veto, or to exhibit it to the conclave under any form.

Meanwhile Leo XIII's constitution *Praedecessores nostri* (May 24, 1882) had authorized occasional derogations from established order in circumstances of difficulty, such as the death of a pope elsewhere than in Rome or attempts to interfere with the liberty of the cardinals. This constitution was left untouched when Pius X issued his constitution *Vacante sede apostolica* (Dec. 25, 1904), which superseded all other legislation on the conclave. *Vacante sede apostolica* was a codification rather than a reform, its principal innovation being the abolition of the *accessit* and the substitution of a second ordinary scrutiny during the same session. Pius XII's constitution *Vacantis apostolicae sedis* (Dec. 8, 1945) modified the effect both of *Praedecessores nostri* and of *Vacante sede apostolica* and increased the requisite majority for the election of a pope from two-thirds of the votes cast to two-thirds plus one.

Procedure.—On the death of the pope, the cardinal camerlengo of the Holy Roman Church, who is the personal representative of the Sacred College in the ordinary administration, takes up residence in the Vatican palace; and wherever he goes in the palace he is escorted by the Swiss guards. Every morning, from the death of the pope to the beginning of the conclave, all the cardinals meet

in the hall of the Consistorium to hold a congregation; that is to say, to consult on current business. Assembled in that hall they receive the condolences of the diplomatic corps and of the Knights of Malta. The general congregation deals with the most important business; and a special congregation (the senior cardinal bishop, the senior cardinal priest and the senior cardinal deacon, with the cardinal camerlengo) meets daily to transact affairs of minor importance. At the first general congregation the seals of the deceased pope (the Fisherman's ring and the leaden seal of the Apostolic chancellery) are handed over to the Sacred College and are at once broken. On nine consecutive days the obsequies of the pope (the *novendialia*) are celebrated in the Basilica of St. Peter's. At the last service the funeral sermon is preached.

The cardinals used to enter into conclave one day after the *novendialia*. In order, however, to give the cardinals from distant parts of the world time to reach Rome, Pius XI increased the interval between the death of the pope and the entry into conclave to 18 days. On the morning of the day on which they go into conclave, the cardinals meet in the Pauline chapel to hear the Mass of the Holy Spirit celebrated by the cardinal dean and to listen to a sermon preached by a prelate on the election of the pope.

From the beginning to the end of the conclave that part of the Vatican palace which is reserved to it is closed to outsiders, and the doors giving access to it from the outside are walled up. The walls, however, are pierced by rotas or turning-boxes, through which it is possible to pass objects without seeing the recipient and to converse provided that the voice is raised. The guardianship of the rotas is entrusted to prelates, who decide in what cases persons may be authorized to converse with the cardinals, are present at such conversations and inspect all objects which it is desired to introduce into the conclave. The conclave is guarded from the outside by the marshal of the Holy Roman Church and by one of the palatine prelates. Within the palace are only the cardinals with their secretaries or "conclavists," the masters of the ceremonies, certain other ecclesiastics with definite duties, doctors and the service staff. All matters connected with the conclave are directed by the secretary of the Sacred College and the prefect of papal ceremonies. The admission of anyone who is to reside within the precincts of the conclave must be approved in advance by the general congregation of cardinals. The interior of the palace is divided into small apartments (*cellae*), one for each cardinal, assigned by lot.

Every day the cardinals proceed to the Sistine chapel, for their double vote. Within this chapel, along the lateral walls, small thrones are arranged, each surmounted by a violet-coloured canopy, one for each cardinal. Each vote is immediately counted by three scrutineers, elected at each morning and each afternoon session in such a way that they are never the same, minute precautions being taken to ensure that the voting shall be secret and sincere. Immediately after the count, the voting papers are burned in a stove in a corner of the chapel, and the smoke, passing up an iron pipe through a window, enables the crowd assembled on the piazza of St. Peter's to guess how the voting has gone: when no candidate receives the requisite majority of two-thirds plus one, the votes are burned with wet straw so that the smoke shows black; when a pope is elected, the votes are mixed with dry straw so that the smoke is white. When one cardinal has at last obtained the requisite majority, the cardinal dean formally asks him whether he accepts his election and what name he wishes to assume. The canopies are removed from all the thrones save that of the cardinal who has been elected pope. On his accepting the pontificate, the news is announced to the assembled populace by the senior cardinal deacon from the central balcony in the façade of St. Peter's. Soon afterward the new pope himself, wearing the pontifical robes (for before the first vote took place three sets of robes of different sizes were placed in readiness in a cabinet adjoining the Sistine chapel), appears at the same balcony and gives his first benediction to the crowd assembled on the piazza. On the day that the election has taken place the cardinals leave the conclave, which comes to an end with the election.

The coronation of the new pope takes place a few days later, the day being fixed by the pope himself. If the new pope does not possess episcopal rank the privilege of consecrating him belongs to the cardinal bishop of Ostia.

CONCORD, a city in Contra Costa county near Mt. Diablo, California, U.S., 20 mi. E. of Oakland and 30 mi. from San Francisco, is primarily residential. Many citizens commute to work in the industrialized cities of Antioch, Pittsburg, Martinez and Port Chicago.

Under the Spanish Dons, cattle grazed the region. Later, wheat, orchards and vineyards predominated in the valley. Salvio Pacheco built the first house in 1853. The city was surveyed in 1869 and incorporated in 1905. A council-manager form of city government was established in 1953.

For comparative population figures *see* table in CALIFORNIA: *Population*. (R. M. W.)

CONCORD, a town of Middlesex county, Mass., U.S., 19 mi. N.W. of Boston, was the site of the first forcible resistance of the American Revolution, immortalized as "the shot heard round the world." Situated at the confluence of two streams forming the Concord river, Concord was founded in 1635, the first town above the fall line on the New England frontier. Simon Willard, one of its founders, was a fur trader and the early economy centred on fur trade and cattle raising.

In 1774 the first county convention to denounce the "Coercion acts" depriving Massachusetts of its charter and the right to choose its own magistrates met in Concord. The first and second provincial congresses defied British authorities there. To destroy arms and ammunition, the British army occupied the town on April 19, 1775. Forewarned, citizens had removed most of the supplies. The British who crossed the river at North bridge were driven back by minute men. This action opened the military phase of the American Revolution.

Nineteenth-century Concord became a cultural centre. Transcendentalist philosopher Ralph Waldo Emerson, naturalist Henry Thoreau, novelist Nathaniel Hawthorne, sculptor Daniel Chester French, A. Bronson Alcott and his daughter Louisa May (author of *Little Women*) and others lived there. From 1879 to 1887 a summer School of Philosophy begun by Bronson Alcott met. The Industrial Revolution brought the railroad, which undermined Concord as a trading centre and led to the development of dairying and fruit growing. Around 1850 Ephraim Bull perfected the Concord grape, marking the beginning of the cultivation of table grapes in the U.S. on a commercial scale. The rapid influx of commuters after 1950 necessitated the establishment of the selectmen-manager form of government in 1956.

Historic sites include French's "The Minute Man" statue at North bridge, Revolutionary buildings, the homes of Emerson, Hawthorne, the Alcotts and others, Walden pond, the cemetery and the Antiquarian Society's museum.

For comparative population figures *see* table in MASSACHUSETTS: *Population*.

See Austin Warren, "The Concord School of Philosophy," *New England Quarterly*, II, pp. 199–233 (April 1929). (N. P. N.)

CONCORD, capital of New Hampshire, U.S., seat of Merrimack county, on the Merrimack river, is near the centre of the southern part of the state. The site was granted by the Colony of Massachusetts Bay in 1726 as Pennycook plantation. At that time the colony, which claimed rightfully to a point 3 mi. N. of the lower Merrimack river, assumed to project this line, 3 mi. from the left bank, along the north-south course of the upper river to Lake Winnipesaukee. Consequently the grant of 1726 lay astride the river, as the city does today. Settled in 1727, the community's name soon became Rumford, when Benjamin Thompson, resident of the town for a few years before the American Revolution, took the title of Count Rumford.

In 1741 it was determined that the town was within the jurisdiction of the Province of New Hampshire, which had granted towns whose lines fell within the bounds of the old plantation. Bitter litigation ended in an appeal to the privy council in London, and there the inhabitants of Rumford were successful. The town was named Concord in 1765.

New Hampshire's legislature, after 1775, moved from place to place until 1808, when, after experimental sessions at Concord,

it settled there. In 1823 Merrimack county was organized from parts of other counties, and Concord became the county seat.

In the early 19th century the principal nonagricultural industry was printing. Carriage making and the Concord coach, famed for its use in cross-country stage coach travel, soon challenged the older industry, as did the production of granite. The railroads and car-repair shops took predominance at the end of the century. Meanwhile the manufacture of sterling silverware had become important, but it faded and died before 1950. With the mid-20th century decline of railroads, printing was again the chief single industry, with tanning and leather goods in second place. The state government was the largest employer. Small industries included the manufacture of electric and electronic equipment. Businesses included banks and a life and accident insurance company and a farm bureau mutual fire and casualty company.

The well-known St. Paul's school for boys (Protestant Episcopal, 1853) is 2 mi. W. of the city.

Chartered as a city in 1853, the government shifted from a council and weak mayor (1853–1950) to a city manager and council (1950–58), and to a strong mayor and council in 1958.

For comparative population figures *see* table in New Hampshire: *Population.* (E. L. Pa.)

CONCORD, BOOK OF (Lat. *concordia,* "agreement"), the collected doctrinal standards of the Lutheran Church. It consists of (1) a preface signed by 51 electors, bishops, princes and nobles of the Holy Roman empire and representatives of 35 free cities; (2) the three Catholic Creeds (the so-called Apostles', Nicene and Athanasian); (3) the "unaltered" Augsburg Confession (1530) and (4) its Apology (1531); (5) the Schmalkald articles (1536–37); (6) Philipp Melanchthon's *Tractate on the Authority and Primacy of the Pope* (1537); (7) Martin Luther's Small and Large Catechisms (1529) (*see* Catechism); (8) the Formula of Concord, consisting of an "epitome" and a "solid declaration" (1577); and the Catalogue of Testimonies (1580), an optional supplement of patristic citations.

The authoritative German edition was published June 25, 1580, the 50th anniversary of the presentation of the Augsburg Confession; the authoritative Latin translation followed in 1584. The issuance of the Book of Concord represented the climax of 30 years of effort to heal the schisms that had broken out in the Lutheran movement after Luther's death and to keep the Lutheran churches from being absorbed into a pan-Protestant union. After two political conferences (Frankfurt am Main, 1558; Naumburg, 1561) had failed, the princes concerned entrusted the project to theologians, among them Jakob Andreä of Tübingen, Martin Chemnitz, Nikolaus Selnecker of Wolfenbüttel, David Chyträus of Rostock and Andreas Musculus and Christoph Corner of Frankfurt an der Oder. These six theologians produced the Formula of Concord.

Although the Book of Concord was not everywhere adopted in its totality (churches in the Danish-Norwegian tradition, for instance, receive only the Catholic Creeds, the Augsburg Confession and the Small Catechism), its formulations have remained the standard of orthodox Lutheran theology. In committing themselves to the Book of Concord, Lutheran churches and clergymen accept the pre-eminent authority of the Catholic Creeds and receive the Augsburg Confession as the decisive Lutheran particular creed; the remainder of the Book of Concord is regarded as an explication of the Augsburg Confession.

A critical German and Latin text, with extensive bibliographies, may be found in Hans Lietzmann (ed.), *Die Bekenntnisschriften der evangelisch-lutherischen Kirche herausgegeben im Gedenkjahr der Augsburgischen Konfession 1930,* 4th ed. (1959). A modern English version is Theodore G. Tappert (ed.), *The Book of Concord* (1959).

See also Creed; Augsburg Confession; Confessions of Faith, Protestant: *Lutheran Churches;* Lutheranism.

See Willard Dow Allbeck, *Studies in the Lutheran Confessions* (1952); J. L. Neve and George J. Fritschel, *Introduction to the Symbolical Books of the Lutheran Church,* 2nd ed. (1956); Edmund Schlink, *Theology of the Lutheran Confessions,* Eng. trans. by Paul F. Koehneke and Herbert J. A. Bouman (1961). (A. C. Pn.)

CONCORDANCE, literally, "agreement," "harmony"; hence derivatively a citation of parallel passages, and specifically an alphabetical arrangement of the words contained in a book with citations of the passages in which they occur. Concordances in this last sense were first made for the Bible, and though they also have been prepared for secular literature (particularly the works of Shakespeare), it is in connection with the Bible that the word is used most often.

The original impetus to the making of concordances was due to the conviction that the several parts of the Bible are consistent with each other, as parts of a divine revelation. To Anthony of Padua tradition ascribed the first concordance, the anonymous *Concordantiae Morales,* of which the basis was the Vulgate Bible. The first authentic Latin concordance to the Vulgate was due to Hugh of St. Cher, a Dominican monk (d. 1264), who, in preparing for a commentary on the Scriptures, found the need of a concordance. This, the *Concordantiae Sacrorum Bibliorum* (or *Sancti Jacobi*), in the compilation of which Hugh was assisted by others of his order, became the basis of one by Conrad of Halberstadt (*c.* 1290) and of another by John of Segovia in the next century. The concordance to the Vulgate in modern use is based on one by F. P. Dutripon (1838).

The first Hebrew concordance was compiled in 1437–45 by Rabbi Isaac Nathan ben Kalonymus of Arles and printed at Venice in 1523. Its errors were corrected by Mario di Calasio, a Franciscan friar, who published an edition at Rome in 1621, much enlarged, with proper names included. Another concordance based on Nathan's was that of Johannes Buxtorf the elder (1632), several times revised and republished. The standard modern concordance to the Hebrew Old Testament is that by Solomon Mandelkern (1925); an excellent later one is that of Gerhard Lisowsky (1955–58).

A Concordance to the Septuagint was published at Frankfurt in 1607. The still standard *Concordance to the Septuagint and the Other Greek Versions of the Old Testament Including the Apocryphal Books,* by Edwin Hatch and H. A. Redpath, assisted by other scholars, was published in 1897 and completed in 1900 by a list of proper names.

A concordance to the Greek New Testament, published in 1638 by Erasmus Schmied or Schmid, has been the basis of other subsequent concordances, including a well-known edition by B. F. Westcott and F. J. A. Hort, with readings of S. P. Tregelles, in 1888. The standard work is the *Concordance to the Greek Testament,* edited by W. F. Moulton and A. S. Geden (1897).

The first concordance to the English New Testament was published in London, in 1535, by Thomas Gybson, the first to the entire English Bible by John Marbeck in 1550. They were followed by many others. Then, in 1737, Alexander Cruden (*q.v.*) published his *Complete Concordance to the Holy Scriptures of the Old and New Testament, to Which Is Added a Concordance to the Books Called Apocrypha,* which surpassed all its predecessors. Three editions were published during Cruden's life, and many since his death. Later concordances supersede his notably accurate work only by combining an English with a Greek and Hebrew concordance. Among late-19th- and 20th-century concordances to English translations of the Bible are R. Young's (1879); J. Strong's, to the Revised Version (1894); M. C. Hazard's, to the American Standard Version (1922); W. J. Grant's, to the Moffatt translation (1950); and that supervised by John W. Ellison, to the Revised Standard Version (1957).

CONCORDAT, a term originally denoting an agreement between ecclesiastical persons or secular persons but later applied to a pact concluded between the ecclesiastical authority and the secular authority on ecclesiastical matters that concern both, and, more specially, to a pact concluded between the pope, as head of the Roman Catholic Church, and a temporal head of state for the regulation of ecclesiastical affairs in the territory of the latter. It is to concordats in this second sense that this article refers.

For the purposes of a concordat the state recognizes the official status of the church and of its ministers and tribunals, guarantees it certain privileges, etc. The pope on his side grants the temporal state certain rights, such as that of appointing or controlling the appointment of dignitaries; engages to proceed in harmony with the government in the creation of dioceses or parishes; etc. The

Gemas, *Le concordat de 1516* (1910); on the German concordat
J. Micklem, *National Socialism and the Roman Catholic Church*
(C. J. H., X.)

CONCRETE (IN PHILOSOPHY). Roughly, such things
numbers, classes, states, qualities and relations are called ab-
ct while persons, physical things and events are concrete.
ilosophers have traditionally classified terms or names as being
ther of concrete according as they are intended to denote
ract or concrete things. Many, however, add a third category
collective names; i.e., names of classes or collections of concrete
ngs, distinct from the category of abstract names. *See* ABSTRACT
D ABSTRACTION; and NAME (IN LOGIC).

The distinction between abstract and concrete, though clear
ough in general, is not a very sharp one, and borderline cases may
found. For example, consider the series of terms *theory, true
position, fact, event*, or, to turn to theoretical physics, the series
*activity, speed, heat, magnetic field, light, electric charge,
ron, molecule*. In each case the series begins with an abstract
rm and it may be thought that the terms grow successively *more*
crete. Some, however, may prefer a different order as that of
creasing concreteness. In any case, if an absolute separation
abstract and concrete is demanded, it becomes difficult to
ll where to draw the line.

(*Cf.* J. S. Mill, *A System of Logic Ratiocinative and Inductive* (1884);
V. Quine, *Methods of Logic* (1950). (AD. C.)

CONCRETE is a building material consisting of a mixture in
ich a paste of portland cement and water binds inert aggregates
o rocklike mass as the paste hardens through chemical reac-
n of the cement with water. Concrete occupies a dominant po-
n in modern construction. It is used in highways, bridges,
oodams; in the construction of virtually all large buildings,
walks, farm structures, and homes; and in airport runways,
docks, irrigation structures, *piping*, harbours, silos, and a
ultude of other major and minor construction projects.

Ever since man first started to build, he has sought a material
at would bind sand and stones into a solid, formed mass. The
Assyrians and Babylonians used clay for this purpose, and the
ient Egyptians advanced to the discovery of lime and gypsum
cementing agent. The Greeks made further improvements.
the Romans developed a cement by mixing slaked lime with
canic ash. Roman cement concrete was used in construction
aqueducts, bridges, and buildings, some of which survive in
excellent state of preservation. Lime in some form remained
e principal cementing material until portland cement was dis-
ered shortly after 1800. Portland cement became the domi-
nt cementing material used in concrete construction about
0, and the word "concrete" without a qualifying term has since
en used mainly as an abbreviation of "portland cement concrete."
ined use is also made of other cements having properties simi-
to portland cement, such as natural cement and blast-furnace
ment (*see* CEMENT).

Sand, gravel, and crushed stone are common aggregates used
concrete. Clays and shales processed by heat into hard stone-
e particles, natural volcanic aggregates, and cinders and proc-
d blast-furnace slag are also used. The specific gravity of ordi-
y concrete is about 2.4 (150 lb. per cu.ft.); compressive
ength from 1,000 to over 10,000 lb. per sq.in. (70 to more
an 700 kg./cm.²) can be obtained by varying the proportions
the concrete mixture. By use of heavy stone aggregates such
limite and magnetite, dense concrete mixtures with a specific
avity of more than 4.0 can be made for shielding purposes in
mic-reactor structures. On the other hand, if light aggregates
d special foaming processes are used, concrete for thermal in-
lation can be made so light that it will float on water, and it
n be sawed and nailed like lumber. The type of concrete mix-
re used is determined by the purpose for which it is intended—
g fish pool, an office floor, or a tunnelling pad for rockets.

TECHNOLOGY OF PLAIN CONCRETE

The technology of plain concrete is a materials engineering
ce; it concerns the mixing, casting, finishing, and curing of
ncrete—and effects of these processes on the physical and chemi-
cal properties of the material, concrete. The uses of concrete in structures, highways, etc., involve other civil engineering sciences, such as structural, highway, foundation, sanitary, and railway engineering.

Concrete Mixtures. Good concrete for small jobs and minor repairs at home and on the farm can be made by amateurs. The design and construction of important concrete structures, however, is a combination of science, art, and experience; it should be undertaken only by professional persons very familiar with concrete technology.

The character of concrete is determined primarily by the quality of the cement-water paste that binds the aggregates together. If too much water is used, the paste becomes thin and will be weak when it hardens. The strength of the cement paste and ultimately the durability, strength, watertightness, and other properties of the concrete depend strongly on the amount of mixing water used. The proportions of water and cement are usually referred to as the water-cement ratio expressed as the weight of water used per unit weight of cement. The lower this ratio, so long as the concrete is workable, so long as each particle of aggregate is completely surrounded by paste and all spaces between the aggregate particles are completely filled with paste, the more durable and strong will be the concrete. Developed primarily by the U.S. engineer Duff A. Abrams, the water-cement ratio law became widely known and used about 1920. It is the basis of modern concrete technology.

For most home repairs and improvements such as floors, walks, driveways, playcourts, or garden pools, the following proportions of concrete materials should be used: 1 bag (43 kg.) of portland cement, 6 U.S. gal. of water (23 litres), and such quantities of sand and gravel or crushed stone as will result in a workable mixture—usually 2 cu.ft. (57 litres) of dry sand and 3 cu.ft. (85 litres) of gravel or crushed stone. If the sand is wet, only 5 U.S. gal. (19 litres) of mixing water should be used for each bag of cement, since 2 cu.ft. of wet sand will contain about 1 U.S. gal. of water. Any potable water is suitable to use for making concrete.

The aggregates should be clean, sound, and free from soft particles and vegetable matter. Even small quantities of the organic compounds present in topsoil will seriously retard and impair the strength-producing chemical reaction between cement and water. All sand (fine aggregate) should pass through a ¼-in. sieve (one with four openings to the inch). The best results are obtained when the sand is a good blend of grain sizes from ¼ to $\frac{1}{100}$ in. Gravel or crushed stone (coarse aggregate) should also be a blend of grain sizes from ¼ in. up to the maximum size used. The proper maximum size of coarse aggregate depends on the thickness of the member for which the concrete is to be used. For example, pea-size coarse aggregate would be used in building garden pools or other structures with thin sections, while aggregates over six inches in diameter are used in large dams. In general, the maximum diameter of coarse aggregate should not be larger than one-fifth of the narrowest dimension of the concrete member in which it is used.

The proportions of coarse aggregate to fine aggregate, and the total amount of aggregate that can be used with a given water-cement paste, depend on the grading, shape, and size of the aggregates and also on the consistency of the concrete required. Stiff dry concretes require less paste than highly plastic mixtures. Less paste is required when aggregates are graded up to a large size than when the maximum size is small. Aggregates made up of rounded particles require less paste than rough and angular ones such as crushed stone. Concrete mixtures are therefore designed to produce the most economical concrete meeting the various requirements of construction and service.

Although good concrete can be mixed by hand, machine mixing is preferred because it results in more thoroughly mixed and uniform batches. Mixing should always continue until every piece of aggregate is completely coated with a thoroughly mixed cement paste. After the concrete is mixed and the desired workability attained, it should be placed in the forms within 30 min. after wet has been added. It should be well compacted (vibrated) during the placing process. For floors, walks, steps, and driveways, the concrete should be leveled off with a straight-edged board as

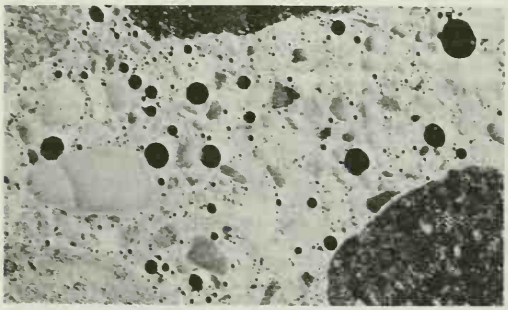
soon as it is placed, and then allowed to stand until the film of moisture disappears from the surface. It should then be smoothed off quickly with a wood float to produce a nonslippery surface. When a very smooth surface is desired, the concrete may be finished with a steel trowel after the wood float has been used. The trowel should be used sparingly and only after the concrete has become quite stiff, in order to avoid bringing an excessive amount of fine particles to the surface.

When exposed surfaces of the concrete have hardened sufficiently to resist marring, they should be sprinkled with water and protected by moisture-retaining materials such as polyethylene sheets, burlap, or moist sand. Hardening of the cement paste requires time, moisture, and favorable temperatures. The longer concrete is kept moist, therefore, the more durable and strong it will become.

Specifications governing concrete materials, proportions of concrete mixtures, methods of construction, and properties of hardened concrete are issued by the British Standards Institution, the American Society for Testing Materials, the American Concrete Institute, and by similar organizations in most other countries.

Air-Entrained Concrete.—The most destructive of nature's weathering forces are repeated freezing and thawing when the concrete is wet. Furthermore, the action of chloride salts applied to concrete pavements to melt ice has a tendency to disintegrate the pavement surface. Air-entrained concrete, which contains billions of microscopic air cells per cubic foot, provides tiny chambers for the expansion of freezing water so that internal pressure on the concrete is relieved. Air-entrained concrete is produced through the use of air-entraining portland cement (*see* CEMENT) or by adding an air-entraining resinous substance with the mixing water at the concrete mixer.

The amount of entrained air is usually between 4 and 7% of the concrete volume. This results in concrete that is practically immune to frost action and highly resistant to the action of salts used to melt pavement ice. Air-entrained concrete is used widely in construction of pavements, bridges, and other exposed structures in cold climates. Entrained air also improves the workability and cohesiveness of fresh concrete. When such concrete is placed and compacted, there is less tendency for the ingredients to separate, and less water will rise to the surface of the fresh concrete. Better uniformity is thereby maintained throughout the concrete. Accordingly, air-entrained concrete is often used even when resistance to frost action is not required.



CROSS SECTIONS OF HARDENED CONCRETE

(Above) Air-entrained concrete, greatly magnified, showing air bubbles (dark circles) and pieces of sand-particle aggregate and gravel (large dark areas) within the cement paste; (below) concrete, in which cement paste surrounds each aggregate particle

BY COURTESY OF PORTLAND CEMENT ASSOCIATION

Ready-Mixed Concrete.—This concrete is produced by a manufacturer and delivered by truck to the construction site. The mixing methods used vary. In some instances the concrete is mixed completely at the manufacturer's plant, and the mixed concrete is transported to the construction site in trucks equipped to agitate the concrete during transport. In another procedure, the dry materials are weighed and batched into a truck mixer at the central plant. Water is then added and mixing is completed in transit to the construction site. Truck mixers consist essentially of a mixer with separate water tank mounted on a truck chassis. They are usually made with capacities of 1, 1½, 2, 3, 4, and 5 cu.yd. For small home repairs, mixtures of dry concrete materials are available in small bags at hardware and building supply stores.

From a modest beginning in the 1920s, ready-mixed concrete became established as a construction material in the 1940s. By the 1960s well over 50% of the portland cement produced in the United States was shipped to the ready-mixed concrete industry. This industry produced annually in excess of 150,000,000 cu.yd. of concrete valued at more than $2,000,000,000.

STRUCTURAL CONCRETE

Concrete used in buildings and bridges, known as structural concrete, is characterized by relatively thin sections as compared to the massive concrete sections used in foundations and dams. It was made possible by the development of reinforced concrete shortly before 1900, and through new techniques—such as prestressing, shells, and architectural concrete—its use as an architectural medium has been continuously improved and expanded.

Reinforced Concrete.—When steel bars are embedded in the concrete, the result is called reinforced concrete. Concrete is about ten times stronger in compression than in tension. When structural concrete members such as floor beams must resist large tensile stresses, steel is embedded in the concrete in the form of bars or mesh. Thus, the tensile strength of steel supplements the compressive strength of concrete, forming reinforced concrete structural members capable of sustaining heavy loads over considerable spans.

Two fundamental properties permit concrete and steel to work together as a composite material. Their coefficients of thermal expansion are approximately equal; if this were not so, reinforced concrete would tear itself apart by internal stress when subjected to wide temperature changes. Secondly, the cement paste in concrete bonds strongly to the steel bars, transferring stress from concrete to steel and protecting the steel against corrosion. In bridge girders spanning a single opening between two abutments, reinforcing bars are placed near the lower side, as that is the side subject to tensile stress when the beam is loaded by the weight of the bridge itself and crossing vehicles. In some cases, such as fence posts, light poles, and chimneys, the load may come from any direction. It is then necessary to reinforce all portions that may be subject to tensile stress. Long beams (such as those supporting the floor of a warehouse) extending continuously over a number of columns may be subjected to tension on the upper side near intermediate column supports. Steel bars referred to as negative reinforcement are then placed in the upper portion of the beam near columns. Between column supports, bars referred to as positive reinforcement are placed in the lower portion of the beams to resist tensile stress in a manner similar to that of the single-span beam. Where space limits the size of structural members and loads are such that concrete alone is not adequate, steel bars are used as reinforcement to increase the compressive strength of members. Finally, steel bars are used to increase shearing strength and to prevent cracking that would otherwise result from wide temperature changes.

Reinforced concrete has become one of the mainstays of modern

construction. Not only is it economically competitive with steel frame construction, but its advantageous properties have had a radical effect on architectural design.

The first clear record of an attempt to use reinforcement in concrete was an experimental arch built in 1832 by Sir Marc Isambard Brunel in connection with his construction of a tunnel under the Thames River at London. Other experiments soon after this time suggest that the idea of using steel or iron to withstand tension in concrete was not developed by a single mind, but was rather the product of a period marked by the use of iron as a structural material. While Joseph Louis Lambot built a small rowboat of reinforced concrete in 1849, and François Coignet is believed to have obtained his first patent for reinforced concrete construction in 1855, the discovery of reinforced concrete is usually attributed to the Parisian gardener Joseph Monier, who made garden pots and tubs of concrete reinforced with iron mesh. He obtained his first patent July 16, 1867. Among many other patents that followed was one issued in 1878 to Thaddeus Hyatt, U.S. lawyer and inventor.

The practical development of reinforced concrete was initiated in the 1880s primarily by G. A. Wayss of Berlin, François Hennebique of France, and Johann Bauschinger of Austria. Design methods based on scientific principles of engineering mechanics were developed shortly after 1900. Since that time vast improvements in reinforced concrete design and construction practice have resulted from research and experience. Indicative of the expanded usage of reinforced concrete is the fact that the production of reinforcing steel in the United States grew from a few tons in 1900 to about 2,500,000 tons by the 1960s, as reinforced concrete became widely used, not only for building and bridge construction but for a variety of purposes ranging from fence posts to the largest and most complex civil engineering projects.

Specifications governing the principles and methods of design for reinforced concrete are issued by the American Concrete Institute, by the British Standards Institution, and by standards associations or government departments of public works in most other countries.

Prestressed Concrete.—Reinforced concrete that has been placed in a state of permanent precompression before service loads are applied is called prestressed concrete. This is commonly done by tensioning high-strength steel wire or rods used as reinforcement. Prestressing extends previous limitations on the spans and loads for which a concrete structure can be economically designed. It permits construction of concrete bridges, roofs, floors, and other structural members of longer free spans; it enables engineers and architects to design and build lighter, shallower, and more graceful concrete structures without sacrificing strength; and it permits construction of thin-walled concrete pipe and tanks able to resist great internal pressure without leakage. Prestressed concrete does not replace conventional reinforced concrete. When spans are so great or loads so heavy as to make the use of reinforced concrete impractical, prestressed concrete often provides an economical solution, but reinforced concrete continues to be widely used where the unique properties of prestressed concrete cannot be used to an economic advantage.

The basic principle of prestressing has been used for many years in the manufacture of wagon wheels. The steel rim is expanded by heating before it is placed on the wooden wheel. As the rim cools, it contracts, placing itself in tension and the wood in a state of compression. Similarly, the steel hoops of a barrel place the wooden staves in precompression. The precompression introduced by tensioned steel contributes importantly to the strength and resiliency of both wheel and barrel. This analogy is particularly striking for large prestressed concrete pressure vessels used for containment in atomic power plants.

The strengthening compressive stresses are usually induced in prestressed concrete by either pretensioning or posttensioning. In the pretensioning process, the steel is stretched between two abutments before the concrete is placed. After the concrete has hardened around the tensioned reinforcement located in the lower portion of beams and slabs, the stretching forces are released. Then, as the steel seeks to regain its original length, tensile stress in the steel is translated into compressive stress in the concrete by bond between steel and concrete. This process is easily adaptable to mass-production methods and is widely used in large factories. In the posttensioning process, steel cables are located in ducts embedded in the concrete. The steel is stretched by hydraulic rams after the concrete has hardened and is fastened externally by wedges or other gripping devices. In this process, the steel is tensioned against the concrete so that tension exerted on the steel corresponds to an equal compression on the concrete. Many systems of posttensioning are in use; they differ primarily in the type of gripping devices employed.

The first patent on prestressed concrete was issued in 1888 to P. H. Jackson of San Francisco. Prestressing was attempted with little success both in the United States and in Europe. Low-strength steels were used, and the prestressing forces were lost by gradual drying shrinkage of the concrete. In 1928 the French engineer Eugène Freyssinet (*q.v.*) proved that when high-strength steel wires are used for prestressing, the shrinkage losses amount to only a few percent of the tensile force in the steel. Prestressed concrete was developed in full maturity in western Europe and in England in the 1940s; it was widely used in reconstruction after World War II. The first major prestressed structure in the United States was a bridge completed in Philadelphia, Pa., in 1951, and by the end of the 1950s prestressing had become an established part of the U.S. construction industry.

Concrete Shells.—Concrete shells are thin slabs of concrete shaped as a curved surface, the thickness being small compared to the lateral dimensions of the surface. The tremendous carrying capacity imparted by curvature is demonstrated by a table-tennis ball, which has exceptional strength and resiliency compared with the thinness of its plastic shell. Indeed, a plane sheet of plastic of the same thickness as the ball's wall is almost as flexible as a sheet of paper.

According to the shape of their surface, shells are classified as elliptically, parabolically, or hyperbolically curved shells, and as folded plates. Elliptical curvature (*e.g.*, the sphere) involves maximum rigidity and usually requires less material than other types. Built in reinforced concrete, however, elliptical shells require rather complex formwork. Parabolically curved shells are most frequently used, primarily because they are curved in only one direction so that the formwork can be made from straight boards or plane sheets. The simplest type is the cylinder, which is well suited for roofing rectangular areas. Hyperbolically curved shells are practically always shaped as a warped or saddlelike surface. Straight lines contained in the warped surfaces can often be utilized to simplify construction of the formwork. Folded plates consist of a series of flat plates inclined toward each other in accordion fashion. Beyond these four basic types, more complex forms have been used to achieve added architectural grace and beauty; *e.g.*, the shape of a seashell.

The basic principle of shell action is that every portion of a shell where a load may be placed is supported by compressive and tensile forces in the plane of the surrounding shell. A load applied to a plane slab, on the other hand, is resisted only by bending forces, with the consequence that the induced stresses are proportionately much more intense. A plane reinforced concrete slab three inches thick can be used to span only some 20 ft. when used as a roof cover. Shells with a thickness of three inches have been used to span several hundred feet.

Application of the shell principle in reinforced concrete construction was initially developed in Germany in the 1920s under the leadership of Franz Dischinger and Ulrich Finsterwalder. Since then, design theory and construction methods have been extended and improved greatly. The practicality and economy of shell roofs have led to their ever-increasing use throughout the world in gymnasiums, hangars, auditoriums, exposition halls, and many other industrial and commercial buildings that require high ceilings and large unobstructed floor areas.

Architectural Concrete.—Reinforced concrete can be used for both the ornamentation and the load-carrying parts of a building, so that aesthetic values are combined with structural practicality. For several decades, concrete was used almost exclusively

for load-carrying purposes, while its potential beauty remained unrecognized and undeveloped. Its emergence as an architectural material coincided with the development of the modern style of architecture characterized by clean, uncluttered lines.

An important property of architectural concrete is its plasticity when first placed, a quality that permits molding into practically any shape or form the architect may require. Thus, it allows almost complete freedom in architectural and functional design without sacrificing strength and economy. Concrete's plasticity is particularly valuable in construction of ornamental detail. All elements of a concrete building—ornamental as well as strength producing—may be cast integrally in a single operation at a substantial cost saving. Fluting, rustications, relief patterns, and other ornamental devices are executed easily and economically in concrete. Molds may often be reused many times to carry out a motif. A variety of paints, stains, coloured aggregates, and pigments used in the cement paste are available to increase the aesthetic value of architectural concrete.

Fire Protection.—Concrete is widely used as a casing around structural steelwork for protection against fire. Because of its high heat conductivity, bare steelwork soon reaches a dangerous temperature in a fire with consequent failure from softening. Concrete is a poor conductor of heat and furnishes protection by delaying the flow of heat to the encased steelwork. A thickness of two inches of concrete well bound to the steelwork by wire mesh reinforcement meets the protection requirements of many building codes and fire associations. A combination of structural steel and reinforced concrete is also used in which structural steel members, designed to carry a principal part of the load, are encased in reinforced concrete of such quality that the concrete also carries part of the load. The concrete then serves the dual purpose of strengthening and fire protection.

Foundations.—The foundations, those parts of a structure that serve exclusively to transmit the weight of the structure to the natural ground, are usually made of reinforced concrete. If a stratum of soil suitable for supporting a structure is located at a shallow depth, a single slab known as a mat or raft may be used to cover the supporting soil stratum beneath the entire area of the superstructure. Various parts of the structure may also be supported individually; a continuous footing supports a wall, a combined footing supports a group of columns, and an individual footing supports a single column. If the upper soil strata are too weak, the superstructure's loads are transferred to more suitable supporting soils or rock at greater depth by means of piles and piers. Concrete piles may be precast and driven into the soil, or they are cast in their final position in holes drilled into the soil.

CONCRETE PRODUCTS

A variety of concrete products are produced in permanent factories. Specifications for the manufacture and performance of these products are issued by standards associations in most countries, and production is characterized by a high degree of mechanization and standardization.

Concrete Masonry.—Block and brick building units molded of concrete are often used for the construction of walls and other structural members. There are three principal steps in the manufacture of concrete masonry units: the careful proportioning and mixing of portland cement, water, and aggregates; molding of the units; and curing and drying. The units are molded by: tamping, in which the concrete is mixed to a semiwet consistency and then tamped into the molds; vibrating, in which a fairly stiff mix is consolidated in the molds by powerful vibration; or pressure, in which the concrete is placed in the molds and compacted by pressure. The units are removed from the molds on pallets immediately after compacting and placed in a curing kiln where the temperature is kept from 110° to 165° F (about 43° to 74° C). Heat and moisture speed up the hardening process. In some factories high-pressure steam curing in autoclaves is used.

Concrete masonry units are made in several sizes and shapes to fit different construction needs. The units are usually designated by their nominal dimensions. Thus, a unit measuring $7\frac{5}{8}$ in. wide, $7\frac{5}{8}$ in. high, and $15\frac{5}{8}$ in. long is known as an $8 \times 8 \times 16$-in. unit. When it is laid in a wall with $\frac{3}{8}$-in. mortar joints, this unit will occupy a space exactly 16 in. long and 8 in. high. This is in accord with modular co-ordination of architectural design based on a four-inch module. In addition, there is a wide variety of nonmodular-size units. Either normal weight or lightweight aggregates are used. Normal weight units are made with sand, gravel, crushed stone, and air-cooled slag. Lightweight units are made with coal cinders, expanded shale, clay, or slag, and natural lightweight materials such as volcanic cinders, pumice, and scoria. Both hollow and solid units are made.

Units are produced to comply with the requirements of standards associations and local building codes. Compressive strength requirements provide a measure of concrete masonry's capacity to carry loads and withstand structural stresses with an adequate margin of safety. Absorption requirements provide a measure of the density of the concrete. Moisture content requirements are intended to indicate whether the unit is sufficiently dry for use in wall construction. In common with a number of building materials, concrete block shrinks slightly when moisture is lost. When moist units are placed in a wall and this natural shrinkage is restrained, as it often is, tensile and shearing stresses are developed which may cause cracks in the walls. Hence, it is important that the units be dried, and they must be kept dry during storage on the construction site.

Particularly in western Europe, patented methods of aerating concrete for masonry units are in use. Finely divided chemicals that generate gases are added to a mixture of portland cement and very fine silica sand, causing this paste to expand so that numerous small air spaces remain after hardening. Concrete units as light as cork are made in this manner; they can be sawed and drilled by carpentry tools. Aerated concretes are also made by mixing a preformed foam and a paste of cement, sand, and water. Most aerated concrete units must be high-pressure steam cured to control drying shrinkage.

Concrete units are used for all types of masonry construction, including load-bearing and non-load-bearing walls; piers; partitions; fire walls; backup walls for brick, stone, and stucco facing materials; fireproofing around steel columns, stairwells, and enclosures; and chimneys. Many plants also make concrete masonry sills, lintels, and concrete floor filler units.

Concrete Pipe.—This product is manufactured throughout the world for irrigation, drainage, sewers, culverts, and water supply mains. Pipe is made of either plain or reinforced concrete, and it can be produced to exhibit characteristics corresponding to the intended function.

Concrete pipe is made by several manufacturing methods. Cast pipe is made by placing concrete into forms of the desired sizes. In the "Packerhead" method, a very dry concrete mixture is packed into the form with such force that the freshly made pipe section can be taken to a curing shed where the form is removed immediately and the newly compacted pipe stands vertically during the curing and hardening period. Similar results are obtained by various other mechanical tamping methods. Centrifugal concrete pipe is manufactured in forms rotating at high speed so that the concrete is compacted as excess water is forced out by the centrifugal force. The pipe may be plain concrete, or it may be reinforced or prestressed concrete. Curing is accomplished by steam, water spray, saturated covers, or in water.

Pipe is produced to comply with the requirements of standards associations. Structural tests indicate the ability of the pipe to resist the pressure of soils in which it is buried. Freezing and thawing tests indicate resistance to ice pressures. Hydrostatic pressure tests reflect resistance to internal pressure.

Cast Stone.—Artificial building stone and even artistic sculpture are manufactured from concrete by a highly developed art that often makes use of intricate designs and patterns. By making forms of the desired shape and using coloured aggregates, colour pigments in the cement paste, and various grinding and polishing methods, a wide variety of architectural effects can be obtained. Forms for cast stone are constructed of metal, gelatin, plaster of Paris, concrete, plastics, wood, or sand, whichever is most convenient for the work involved.

Precast Structural Concrete.—Large structural members are made in a mechanized central plant and erected in buildings and bridges by cranes. A partial list of precast members would include piles and decks for bridges, floor and roof slabs, wall panels, joists, beams, girders, rigid frames, and shell units. Members from a few pounds to over 200 tons have been precast.

Precasting can be done by relatively crude methods at the building site; a mechanized temporary factory can be established at the site of extensive construction; and there are permanent factories in many countries. Several European factories are outstanding examples of highly mechanized mass production offering permanent employment for over 1,000 men. In the United States, precasting has been combined with prestressing techniques; a group of rapidly growing factories started production in the 1950s.

It is evident that economies may be realized from casting a bridge in a yard on the river bank rather than in midstream—and casting a building's beams in a factory rather than several stories up in the air. The most important aspect of precasting, however, is that it permits strict production controls which in turn make safe and economical use of unusually high quality concretes and highly advanced design techniques. Furthermore, precasting in factory buildings is protected from the weather—heavy rains and cold winter weather do not interrupt production. Complete buildings—even large industrial structures—have been factory precast in the winter and erected in a few weeks in the spring. This may provide important economies by advancing the date when a new structure begins to give economic returns.

More precast concrete factories have initiated a trend toward standardization of the cross sections of the precast beams and piles to facilitate economic and repeated use of forms. Some factories offer a variety of standardized sections made in whatever lengths are needed. Such products are often offered for sale in catalogues, including the strength and performance characteristics needed in architectural and engineering design of buildings and bridges assembled for each specific structure from precast units. Thus, individual members such as columns, beams, and slabs are standardized, but each building or bridge is custom designed to fit its particular function and architectural style.

APPLICATIONS

Bridges.—There are four major types of concrete bridges: rigid frame, slab, girder, and arch (*see* BRIDGES). Any of these may consist of a single span or a series of several spans, the latter being referred to as multispan bridges. By far the most widely used type of concrete bridge is the girder type, the economical span of which was greatly increased by the introduction of prestressed concrete. Numerous single-span prestressed bridges were built across European rivers following World War II. In the United States, a notable multispan bridge was built across Lake Pontchartrain near New Orleans, La., in 1956. Its total length of 24 mi. established a new world's record for concrete bridges. Most spectacular, however, are the long-span arch bridges. A notable example of the latter is Sweden's Sandö Bridge with its 866-ft. single free span across a turbulent river. This bridge, carrying a 34-ft. roadway, set a new record for reinforced concrete span length when it was completed in 1943. But this record was broken in 1964 by the unique Gladesville Bridge in Australia, which has a 1,000-ft.-long concrete arch.

The limited access highways brought about by modern traffic call for bridge construction on a scale without parallel in history. For example, the 41,000-mi. system of interstate highways begun in the United States in 1952 requires an estimated 27,000 bridges ranging from great river crossings to small bridges carrying secondary roads over the superhighways. Concrete bridge construction, which traditionally has concerned design and construction of a single bridge at a time, has therefore developed mass-production procedures. Thousands of concrete bridge girders weighing up to 50 tons each are produced annually in permanent factories for shipment and erection at bridge sites throughout western Europe, Britain, and the United States.

Highways.—The first concrete highways were built in Inverness, Scot., in 1865, and in Edinburgh in 1866. The first concrete pavement in the United States was built in Ohio in 1892. Concrete highway construction on an enlarging scale began about 1910, and by the mid-1960s there had been constructed almost 3,000,000,000 sq.yd. of concrete highways and streets in the U.S.

Design Requirements.—The principal requirements in concrete highway design are strength and durability. Early pavement slabs were cast on the natural soils of the prepared roadbed. This practice is often inadequate for modern traffic. Some soils are affected by frost action; some swell when they come in contact with water; and some are susceptible to softening in the presence of excess moisture. For satisfactory performance of a concrete pavement on these soils, a four- to six-inch layer of granular material—sand, gravel, or crushed rock—may be required under the pavement to provide a well-drained foundation free from frost action. Considering the nature of the soil support, the concrete pavement is designed to resist the loads of moving vehicles by theories of slab strength originated by the Danish-American engineer H. M. Westergaard in 1926. To ensure durability of the pavement itself in the presence of severe frost action, the use of air-entrained concrete is essential; it became widely used in cold climates shortly after its development in the late 1930s.

To accommodate small changes in length of concrete pavement slabs caused by shrinkage or wide temperature change, longitudinal and transverse joints are used. For unreinforced pavements, the spacing of transverse joints is usually 15 to 30 ft., depending largely on the type of coarse aggregate used. Such joints are made by inserting a preformed strip or ribbon in the freshly placed concrete or by sawing narrow grooves in the hardened concrete.

In addition to strength and durability, the safety and comfort requirements of the traveling public call for additional major design considerations: First, the pavement must be smooth and have properly banked curves. By highly automated modern mechanical equipment, concrete pavements are trimmed to a precise tolerance of about $\frac{1}{8}$ in., and smooth transitions between superelevations of curves are carefully designed to facilitate driving. A gritty pavement surface that provides uniform traction and prevents skidding even when the pavement is wet, and good visibility at night are the two final design considerations. Several finishing methods have been developed to produce a granular, gritty surface; dragging a coarse broom transversely across the pavement is most commonly used. Broomed pavements are highly skid resistant and provide increased visibility at night because light from automobile headlights strikes the small transverse ridges and is reflected back to the driver. (*See* also ROADS AND HIGHWAYS.)

Soil-Cement.—Soil-cement is a tightly compacted mixture of soil or roadway material, portland cement, and water that forms a strong, durable pavement base as the cement hardens the soil. Developed in the United States in the early 1930s, soil-cement is generally built from soil on or near the paving site. Old, deteriorated granular materials can also be used. Only cement and water need be transported to the site.

The basic steps in soil-cement construction are spreading cement, mixing, and compacting. After the roadway has been shaped to grade and the soil loosened, the required amount of cement is spread. Cement and the required amount of water are thoroughly mixed with the soil by traveling mixing machines; the mixed material is then compacted by rollers, shaped to the proper pavement contour, and rolled again to obtain a smooth finish. A bituminous material is sprayed on the soil-cement soon after finishing to seal in moisture needed for the cement to harden the natural soil into a strong, low-cost pavement. The pavement is then completed by the addition of a concrete pavement or a bituminous surface.

In the mid-1960s about 36,000,000 mi. of soil-cement roads and streets were in service in the U.S., and airports had more than 35,000,000 sq.yd. of soil-cement runways.

Airport Pavements.—The first concrete airport pavement in the United States was built at the Ford Airport, Dearborn, Mich., in 1927. Thirty-five years later, 366,000,000 sq.yd. of concrete runways, taxiways, and aprons were in service at civil and military

airports in the U.S. The John F. Kennedy International Airport in New York, one of the world's largest and most modern airports, has seven concrete runways totaling ten miles in length. Each runway is 200 ft. wide by 12 in. thick and is constructed to accommodate aircraft weights up to 300,000 lb.

The design and construction methods for airport pavements are similar in nature to those used for highways, but weights of aircraft of more than 500,000 lb. are encountered, which far exceed the heaviest trucks in use. Similarly, skid resistance, overall pavement smoothness, and visibility at night are even more important than for highways. In addition to increased plane weights and speeds, the development of heavy jet aircraft has resulted in further design considerations. When these planes are moving slowly or standing still with engines "revving up" prior to takeoff, the pavement must withstand tremendous heat and blast. It is imperative that the pavement must not soften or disintegrate. Particles must not tear loose, since they would tend to enter air-intakes of other aircraft engines, damaging their rapidly moving turbines. Concrete has an inherent resistance to heat and blast. Adequate strength, durability, skid resistance, smoothness, and visibility can be provided economically. (*See* AIRPORT.)

Railways.—Among the essential structures of any railroad are its track, depots, freight houses, bridges, signal structures, and motive power maintenance and fueling facilities. In all of these concrete plays an important part. Cement grout—a mixture of portland cement, sand, and water—is forced into the ground underneath the track to stabilize troublesome pockets of water and soft soil, thereby providing an evenly supported railbed. Prestressed concrete ties (called "sleepers" in Britain) are used extensively in Europe. Most tunnels are lined with reinforced concrete to eliminate the hazards of falling rock, and reinforced concrete retaining walls are used extensively to prevent earth slides from disturbing the track.

Harbour Facilities.—In the shipping industry, concrete is widely used in the construction of harbour facilities (*see* HARBOURS), breakwaters, piers, warehouses, docks, canals, locks, dry docks, and even in ships. In some climates, the seas rising and falling with tides are above freezing temperature throughout the year, while the winter air may be considerably below freezing. In the tidal zone, therefore, concrete structures are subjected to severe repeated freezing and thawing and must be protected against frost damage by air entrainment.

In the construction of harbours and breakwaters, extensive use is made of huge precast concrete blocks made in a construction yard ashore. Some blocks are transported by barges and lowered into position by heavy cranes; others are made in the form of large boxes, referred to as caissons, that are launched, towed into position by tugboats, and sunk into position by opening valves in the bottom. Under the code name "Phoenix," such floating concrete caissons towed from England served a vital function in the "Mulberry" harbours during the 1944 invasion of Normandy. Extensive use was made of prestressed concrete structures in the reconstruction of west European harbour facilities after World War II, notably at Le Havre in France.

Concrete in Small Buildings.—Though they lack the spectacular features of heavy construction, the many small uses in housing and on farms make up a large volume of concrete—in some countries this is the largest single area of concrete usage. The foundations of most homes and farm structures are concrete. There are various types of concrete buildings used, and concrete enters into sidewalks, driveways, play courts, fireplaces, lily ponds, garden walls and benches, birdbaths, flagstone walks, swimming pools, and a variety of farm structures.

Foundations.—Strength, durability, and watertightness have made concrete ideal and widely used for construction of footings, which prolong the life of houses and farm structures by assuring uniform support on the soil. Footings for foundation walls should be built on firm soil below the lowest possible level of frost penetration, and they should be well drained. A basement constructed of ten-inch-thick concrete walls, footings, and a concrete floor can be a useful and attractive part of a home. To avoid cracking and leaks, it is essential that a good quality concrete without excessive mixing water be used. In sections of the world where basements are not used, slab-on-ground concrete floor construction is becoming increasingly popular. A major reason is that concrete offers complete protection against rot and termites—an important consideration in warm climates.

Masonry Homes.—A common method of home construction is with block units made in factories, delivered to the building site, and laid into walls by masons. Concrete masonry house walls are usually built with eight-inch-thick units, although sometimes two walls are built of four-inch units with an air space between. Such walls lend themselves to almost any type of insulation.

A variety of attractive wall treatments may be produced in concrete masonry. Surfaces may be painted in any desired colour with portland cement paint or other suitable paints, or they may be left unpainted. Paint serves not only as a decorative finish but also as weatherproofing on exterior walls. Stucco may be applied to achieve whatever special surface texture will best suit the architectural style of the house. Units of different sizes may be laid together in a wall to form patterns traditional in stone work—for example random or coursed ashlar. Unusual effects may also be created with various block patterns and special treatments of mortar joints.

Concrete masonry is widely used as backup inside brick and stone facings to provide added strength and improved insulation. Particularly in the Scandinavian countries, very light block units made from special foam concretes are placed as insulation on the outside of houses and other buildings and covered with a weather-resisting layer of stucco.

Reinforced Concrete Homes.—These homes are produced by a variety of construction methods. Three types of walls are most frequently used when the concrete is placed in walls located in their final position. One type is a solid wall, four to eight inches thick according to strength and other requirements, with lath and plaster or other insulation applied to the interior surface. A second type, known as a cavity wall, consists of two four-inch walls with a two-inch air space between them. In a third type, a high-air-content concrete is used to provide adequate thermal insulation without a cavity. The exterior concrete surface can be given a wide variety of textures and colours.

Tilt-up construction is a fast, economical method in which walls are cast on a horizontal base and then tilted and lifted into position by cranes after the concrete has hardened. It is economical because it requires a minimum use of forms and permits efficient use of modern mechanical equipment. The fact that the exterior wall surface may be finished in a horizontal position facilitates inexpensive preparation of a variety of architectural effects. The top surface of such walls is often covered by a thin layer of coloured aggregate concrete. The cement paste is removed by brushing soon after it has begun to harden so that the coloured aggregate is exposed to form an attractive exterior finish when the wall panels later are tilted and lifted into position.

Various methods of constructing reinforced concrete houses developed in the late 1940s involve extensive use of large sections manufactured in heavily mechanized factories and erected at the site. This method is particularly well developed in Denmark, the Netherlands, and the U.S.S.R.

Farm Structures.—Dairy barns, feeding floors, farrowing houses for hogs, poultry houses, silos, and other structures are often constructed of concrete to reduce fire losses by eliminating combustible construction materials, to curb livestock diseases by improving sanitation, and to obtain durable, warm, dry structures. Both masonry block units and reinforced concrete are used in wall construction. Concrete-paved yards and feeding floors are generally four inches thick, and a stiff broom is stroked against the surface of the fresh concrete to provide a nonslip surface.

Concrete stave silos are constructed of hundreds of interfitting units about 10 in. wide, 30 in. long, and $2\frac{1}{2}$ in. thick. As the factory-made staves are being fitted to form the silo wall, external steel reinforcing rods are tightened to hold firmly against internal pressure—like the hoops of a barrel. Silo walls are also cast at the farm site by placing concrete in circular forms, which are

raised as construction progresses. The walls are usually 6 in. thick and are reinforced. Large reinforced concrete grain elevator structures are constructed in rural areas. Concrete is also used in structures preventing soil erosion.

Dams.—Gravity, arch, and buttress dams are the three major types of concrete dams. Gravity dams are essentially triangular in cross section. The upstream face is steeply inclined, while the downstream face slopes gradually to provide a width at the dam base equal to 0.65 to 0.85 times the dam height. The heavy gravitational weight of these dams prevents them from sliding on their foundation base and from overturning under water pressure. The large mass of gravity dams leads to several complications in concreting operations. For example, the heat developed when portland cement reacts with water is not a problem for thin sections, but this heat of hydration must be safely dissipated in large dams by elaborate systems of cooling pipes. Crushed ice added to the concrete mixture as part of the mixing water and fanning of aggregate stockpiles are also used to control the development of heat. Arch dams consist of a single horizontal arch; they are suitable only for narrow gorges with sound rock at the sides to absorb the thrust from abutments. Water pressure is resisted partly by arch action, partly by cantilever action since the dam is in contact with the bottom of the gorge, and partly by the weight of the dam. This combined action leads to complex design methods, in the solution of which electronic computers and model tests are most helpful. Buttress dams consist of a series of triangular-shaped buttresses which support a series of concrete slabs or arches resisting the water pressure. (*See* DAM.)

Irrigation.—The extensive use of concrete in modern irrigation stems from the fact that it is important to store, transport, and use the available water without undue loss through evaporation and seepage. Concrete lining of canals effectively prevents seepage losses, which average about 40% of the water transported in unlined canals. Underground concrete pipelines are also used extensively to transport water. Since pipe systems can operate under pressure, water can be delivered to land that could not be served by canals. Concrete is used to line tunnels and to construct siphons and flumes for carrying water over, under, and through natural and man-made barriers such as rivers, mountains, valleys, highways, and railroads. (*See* also IRRIGATION.)

Water Supply.—As water consumption increases, it has become necessary for many cities to transport water from distant natural sources. Others have impounded water in artificial reservoirs. To provide the source of water supply, concrete is used in the construction of dams, spillways, intakes, and pump houses. Most storage reservoirs are constructed of concrete to form an impervious barrier preventing water loss by seepage, to facilitate cleaning of the reservoir, and to protect the stored water from contamination. Finally, high-pressure concrete pipe is used extensively in the water distribution system as main lines 12 in. or more in diameter (*see* WATER SUPPLY AND PURIFICATION).

Sewage Works.—These installations are required to control disease and prevent pollution of rivers and lakes. Concrete has been used in sewer construction since Roman times. In modern practice, concrete sewer pipe is used in sizes from 6 in. to 12 ft. in diameter. Concrete is used for large sewer tunnels which are often cast in their final position using traveling forms.

See also references under "Concrete" in the Index.

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CONCRETION, in petrology, a name applied to nodular or irregularly shaped masses of various size occurring in a great variety of sedimentary rocks, differing in composition from the main mass of the rock, and in most cases obviously formed by some process which ensued after the rock was deposited. As these bodies present so many variations in composition and structure, it will conduce to clearness if some of the commonest be briefly described. In sandstones there are often hard rounded lumps, which separate out when the rock is broken or weathered. They are mostly siliceous, but sometimes calcareous, and may differ very little in general appearance from the bulk of the sandstone. Through them the bedding passes uninterrupted, thus showing that they are not pebbles; often in their centres shells or fragments of plants are found. Argillaceous sandstones and flagstones very frequently contain "clay galls" or concretionary lumps richer in clay than the remainder of the rock. Nodules of pyrite and marcasite are common in many clays, sandstones and marls. Their outer surfaces are tuberculate; internally they commonly have a radiate fibrous structure. Usually they are covered with a dark-brown crust of limonite produced by weathering; occasionally imperfect crystalline faces may bound them. Frequently these pyritous nodules contain altered fossils.

Another type of concretion, abundant in many clays and shales, is the "septarian nodule." These are usually flattened, disk-shaped or ovoid, often lobulate externally like the surface of a kidney. When split open they prove to be traversed by a network of cracks, which are usually filled with calcite and other minerals. These white infillings of the fissures resemble partitions; hence the name from the Latin *septum*, a partition. Sometimes the cracks are partly empty. They vary up to one-half inch in breadth, and are best seen when the nodule is cut through with a saw. These concretions may be calcareous or may consist of carbonate of iron. The former are common in some beds of the London Clay, and were formerly used for making cement. The clay-ironstone nodules or sphaerosiderites are very abundant in some Carboniferous shales, and have served as iron ores; some of the largest are three feet in diameter, and in the centre fossils are often found, *e.g.*, coprolites, pieces of plants, fish teeth and scales. Phosphatic concretions are often present in certain limestones, clays, shelly sands, and marls.

Another very important series of concretionary structures are the flint nodules which occur in chalk, and the patches and bands of chert which are found in limestones. Flints consist of dark-coloured cryptocrystalline silica. They weather gray or white by the removal of their more soluble portions by percolating water. Their shapes are exceedingly varied, and often they are studded with tubercules and nodosities. They sometimes have internal cavities and frequently contain shells of echinoderms, mollusks, etc., partly or entirely replaced by silica, but preserving their original forms. Chert occurs in bands and tabular masses rather than in nodules; it often replaces considerable portions of a bed of limestone (as in the Carboniferous limestone). Corals and other fossils frequently occur in chert, and when sliced and microscopically examined both flint and chert often show silicified foraminifera, polyzoa, etc., and sponge spicules.

These examples will indicate the great variety of substances which may give rise to concretions, which seem to arise from the tendency of chemical compounds to be slowly dissolved by interstitial water, either while the deposit is unconsolidated or at a later period; it is highly probable that such solutions are usually in the colloidal state. Certain nuclei, present in the rock, then determine reprecipitation of these solutions, and the deposit once begun goes on until either the supply of material for growth is exhausted, or the physical character of the bed is changed by pressure and consolidation until it is no longer favourable to further accretion. The process resembles the growth of a crystal in a solution by slowly attracting to itself molecules of suitable nature from the surrounding medium; but in the majority of cases it is not the crystalline forces, or not these alone, which attract the particles. The structure of a flint, for example, shows that the material had so little tendency to crystallize that it remained permanently in cryptocrystalline or subcrystalline state. That the concretions grew in the solid sediment is proved by the manner in which lines of bedding pass through them and not around them. (J. S. F.)

CONCUBINAGE is the state of cohabitation of a man and a woman as married persons without the full sanctions of legal marriage. The term is derived from the Latin *concubina*, a concubine (from *con*, "with" and *cubare*, "to lie"). Most societies recognize more than one kind of marital relationship, the legal status of the woman being a determinant of the legal status of her offspring. The children of a full marriage are legitimate and are thereby endowed with specific rights of inheritance and succession, but the children of a lesser-grade marriage, though "illegitimate" in some senses, may still possess definite legal rights. The story of Hagar (Gen. xxi, 10 ff.) and the account of Abraham's gifts to the sons of his concubines (Gen. xxv, 6) exemplify such a distinction.

In Roman law a state of fully legitimate marriage could be established either as the result of public ceremonies (*confarreatio* or *coemptio*) or less formally on the basis of *affectio maritalis* by declaring a fixed intention of taking a particular woman as a permanent spouse, as in Scottish law. The Romans were strictly monogamous and a man legally could not maintain more than one spouse, of whatever category, at any one time. The Roman *concubina* differed from a wife married in *affectio maritalis* in that (1) she brought her husband no dowry (dos); (2) she was not raised, like the wife, to the rank of her husband; and (3) her children were not legally the relatives of the father but cognates of the mother. In the 4th century A.D. Constantine the Great ruled that the marriage of a *concubina* should legitimate her children as heirs to her husband provided that there were no existing legitimate heirs; Justinian allowed this even if there were legitimate heirs. The *concubina* was usually of lower rank than her husband but the relationship did not entail stigma. On the contrary, some men of high rank took respectable concubines because they were discouraged by the immorality of higher ranking Roman women with whom they could have made orthodox marriages. That *concubina* continued to be recognized as a distinct but respectable status as late as the 11th century is evident from injunctions by church councils at Rome that a layman who had a wife and a *concubina* at the same time should be suspended from communion.

The institution of morganatic marriage (*q.v.*), which was widely current in diverse forms among the nobility of medieval Europe, was similar to Roman concubinage in many respects. A noble who married a commoner was deemed fully married in the eyes of the church, but the commoner wife did not assume the rank of her husband, and the children's rights (whether the wife or husband was of lower rank) to inheritance and succession in the property and titles of their parent of higher rank were severely circumscribed.

Christian legal theory is quite unambiguous—a man may have one wife only and her marriage must be explicitly established by church ritual—but civil practice has often been relatively flexible. For example, in the 17th century, although the only legitimate heirs of the English and French kings were the children of their properly married queens, the kings' numerous bastard offspring were regularly raised to the nobility. Moreover, the mothers of these children had an honourable public status which might fairly be described as one of concubinage.

The concubinage of later medieval Europe was likewise a reflection of the divergence between the rigid requirements of canon law and the less precise conventions of practical behaviour. In 1241 the Jutland code of Valdemar II provided that a concubine kept openly for three years should thereby become a legal wife; this section of the code remained in force till 1582. A similar custom (handfasting) prevailed in Scotland. In the 13th century, the English jurist Henry de Bracton wrote of *concubina legitima*, a status which seems to have differed from that of wife only as regards ceremonial and in being a less strong position from which to claim a widow's dower after her husband's death. A wife was married in church, a "legitimate concubine" was not.

It was the clergy themselves who benefited most from this distinction. In the 12th century the Roman Church declared that any marriage made after ordination was invalid, but those who were denied a wife often took a concubine instead. It is against this background that one must view the rejection of clerical celibacy by Protestant reformers in the 16th century. It should be noted that the context of European concubinage is consistently monogamous. It is not the inferior standing of the concubine herself that is stressed but the inferior legitimacy of her offspring. In contrast, where the term concubine has been applied to non-European institutions the emphasis is on the inferior status of the woman, the context being that of polygyny. For example, Koranic law permits a man to have not more than four wives at any one time. Where a Muslim harem contains numerous women, the excess over the Koranic four are rated as concubines or slaves. In many cases there is no discrimination between the children of wives and the children of concubines, but a wife is entitled to receive a widow's dower from her husband whereas a concubine is not.

The marital customs of the Ottoman monarchs were in this respect extreme. By the 16th century the sultan very seldom took any legal wife, all his women having the status of slave-concubine. A concubine who bore a child was raised to the rank of *haseki* and the chief of these, the mother of the first male child, was second only to the sultan's mother within the harem. But in a technical legal sense even the highest *haseki* were slaves and not wives.

In traditional China the context of concubinage was rather similar. Confucian orthodoxy combined an ideal of lifelong marital union with the obligation that all males should produce male heirs. Divorce was impossible but it was considered morally proper for the husband of a barren wife to take a concubine to raise up progeny; in practice, most concubines were taken simply for sexual pleasure. The marital status of the Chinese concubine hardly differed from that of the legitimate wife and her children were legitimate, but, whereas the wife would belong by birth to the same social class as her husband, the concubine was more likely to have been reared as a slave or in a brothel.

It is important to remember that the word concubine was initially applied to non-European institutions by missionaries who had a prejudice in favour of Biblical terminology and the virtues of monogamy. Anthropology has shown that, in the world at large, polygamy is no less admired than monogamy and in polygynous households the statuses of the different women and of their respective offspring may be differentiated in a variety of complicated ways. The ordinary English meanings of the words wife, concubine and slave are often inappropriate to such situations. A phrase such as secondary or junior wife will usually be less misleading than the term concubine with its specific Biblical and Roman law associations.

See also MARRIAGE, PRIMITIVE.

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CONDÉ, PRINCES DE, the heads of an important French branch of the house of Bourbon (*q.v.*). The property of Condé in Hainaut (Condé-sur-l'Escaut, in the modern French *département* of Nord) had passed, together with the countship of Enghien, into the possession of François de Bourbon, comte de Vendôme, through his marriage with Marie de Luxembourg in 1487.

Special Designations.—As the leading adult prince of the French royal blood on the Huguenot side (apart from the king of Navarre), Louis, 1st prince de Condé (*see* below), came to be designated colloquially by the Huguenots as Monsieur le Prince, without any further specification. This designation was soon generally adopted and passed to his successors. The 3rd, 4th and 5th princes, however, were also premier princes of the blood (*see* below) from 1589. Hence in the 17th century the designation came to be regarded not as a hereditary right of the Condés but as attached to the rank of premier prince. Thus when the Condés could no longer claim that rank, the designation ceased to be theirs (with the 5th prince's death). In the 4th prince's lifetime, meanwhile, his eldest son, as duc d'Enghien, had been able to assume the designation Monsieur le Duc, without further specification, and this was retained, after the 5th prince's death, by his son, the duc de Bourbon, who passed it also to his successor.

The Huguenot Leaders.—LOUIS I DE BOURBON (1530–69), 1st

prince de Condé, was born at Vendôme on May 7, 1530, the hunchback youngest son of Charles, duc de Vendôme, and Françoise d'Alençon. Brought up among Huguenots, he was married in 1551 to Éléonore de Roye, a Huguenot herself. He served in Henry II's armies in the campaigns of 1551–57, but won no favour. On Henry II's death (1559), Condé came forward as the military leader of the Huguenots: he needed their backing to make himself at all considerable politically; they needed a princely patron more resolute than his eldest brother Antoine, king of Navarre, though Condé's licentious way of life accorded ill with their principles. On the failure of the Huguenot conspiracy of Amboise (March 1560), Condé fled from court. On presenting himself to Francis II at Orléans (Oct. 1560), he was arrested and, on Nov. 26, sentenced to death. The king's death (Dec. 5) saved him, as the new regent, Catherine de Médicis, needed him to counterbalance the Guises, with whom he was formally reconciled in Aug. 1561. After the massacre of the Huguenots at Vassy (March 1562), he occupied Orléans and marched on Paris, but was defeated and captured by François de Guise at Dreux (Dec. 19). For the three years following the peace of Amboise (March 1563) he tried to restrain the Huguenots and collaborated with the government, being preoccupied with love affairs. His first wife died in 1564, and he married Mlle de Longueville (Françoise d'Orléans) in 1565. Finally, however, disappointed in his hope of being made lieutenant general of the kingdom and alarmed at the government's dealings with Spain, he left the court again (July 1567) and led the Huguenots in another attack on Paris. Defeated in battle at St. Denis (Nov. 10), he made a skilful withdrawal and then, reinforced by German mercenaries, went to besiege Chartres (Feb. 1568). He signed the peace of Longjumeau (March 1568) against the admiral de Coligny's advice. When war broke out again in August, he found himself tied down to operations in western France. Fighting to save Coligny at Jarnac (March 13, 1569), he had to give himself up to the enemy and was shot through the head on the spot. He left three sons by his first wife, Henry (*see* below), François, prince de Conti (1558–1614), and Charles (1562–94), cardinal de Vendôme; and one by his second, Charles, comte de Soissons (1566–1612).

Henry I de Bourbon (1552–88), 2nd prince de Condé, was born at La Ferté-sous-Jouarre on Dec. 29, 1552. His father's death left him and his cousin Henry of Navarre as titular leaders of the Huguenots. After the peace of St. Germain (1570) Condé retired to Béarn and married Marie de Clèves. She died after giving birth to his daughter Catherine (1574–93). Condé, meanwhile, caught in Paris during the massacre of St. Bartholomew's day (1572), had been forced to confess Catholicism. Nominally governor of Picardy, he was kept under surveillance till, in 1574, he escaped to Alsace and began raising troops for the Huguenots. Invading France with a horde of mercenaries to collaborate with the duc d'Alençon, he was disappointed at the terms which Alençon made with the government (1576). In the next civil wars (*see* France: *History*) he became rather an embarrassment to Henry of Navarre, set himself up as chief of the most fanatical Huguenots and failed conspicuously in his travels abroad in search of foreign help (1580) and in his campaign of 1585 in western France—when he was driven to take refuge in Guernsey. Returning to France, he married, in 1586, Charlotte de La Trémoïlle (1565–1629), who renounced Catholicism for him and bore him a daughter, Éléonore (1587–1619). Wounded at the battle of Coutras (Oct. 1587), Condé died suddenly at St. Jean-d'Angély on March 5, 1588.

The Premier Princes of the Blood.—The princesse de Condé (La Trémoïlle) was accused of having poisoned her husband, and doubts were cast on the paternity of the son to whom she gave birth on Sept. 1, 1588, Henry II de Bourbon, 3rd prince de Condé (1588–1646). Henry IV of France, however, rejected these allegations and recognized his cousin as his heir presumptive until the birth of the dauphin, later Louis XIII. Henry IV's accession to the crown, moreover, meant that Condé became premier prince of the blood (*premier prince du sang*), a rank that was conventionally regarded as still his even after the birth of Henry IV's younger sons, as they had the superior quality of *fils de France* (sons of an actual king). Moreover, as the new quality of *petitfils de France* (grandson of a sovereign, viz. of Louis XIII) was to be accorded to Louis XIV's nephew, the future regent Philippe duc d'Orléans, the rank of premier prince, in this conventional sense, was allowed to the Condés for three generations in all.

The 3rd prince de Condé was brought up as a Catholic by his mother, who abjured Calvinism in 1596. In 1609 he married Charlotte de Montmorency (1594–1650). The new princesse, however, attracted Henry IV so much the Condé had to send her out of the country and then to flee abroad himself to escape the king's fury. After Henry IV's assassination he returned to France (July 1610), to compete with the other princes and nobles in making demands on the regent, Marie de Médicis. When she and the marquis d'Ancre (*q.v.*) began to refuse his demands, he twice blackmailed them by open rebellion, obtaining not only money but the governments of important strongholds under the treaties of Ste. Menehould (May 1614) and Loudun (May 1616). Finally he was arrested (Sept. 1616).

Three years of prison (till Oct. 1619) changed Condé's mind. Thenceforth he was the crown's obsequious servant, operating against the rebellious princes in 1620; against the Huguenots—whom, in reaction from his ancestral tradition, he particularly detested—in 1621 and in 1627–29; and in frontier campaigns till 1638, when his invasion of Spain ended in disaster at Fuenterrabia. Rewards included the government of Burgundy (1631), which remained a family perquisite, and most of the property confiscated from his brother-in-law Henry de Montmorency (executed in 1632). Part of this was Chantilly, which became the Condés' principal country seat. Under Anne of Austria's regency he supported Cardinal Mazarin. He died in Paris on Dec. 26, 1646. His children were Anne Geneviève, duchesse de Longueville (*q.v.*); the Great Condé; and Armand, prince de Conti (*see* Conti, Princes de).

For the 4th prince, the Great Condé, *see* Condé, Louis II de Bourbon, Prince de.

Henry Jules de Bourbon (1643–1709), 5th prince de Condé, was born in Paris on July 29, 1643, the eldest son of the Great Condé. Known from 1646 as the duc d'Enghien, he was taken to and fro by his mother during the Fronde and eventually into exile with his father, returning to France in 1659. He was married in 1663 to Anne of Bavaria, daughter of Edward, prince Palatine. At this time he was proposed as a candidate for the Polish throne. His father tried to embark him on a military career, but Henry Jules showed no aptitude, though he served in campaign after campaign between 1666 and 1693. On his father's death (1686), however, he devoted himself chiefly to expanding and improving Chantilly. A little man, interested in the arts, the sciences and technology, an able courtier and a magnificent host, he was eccentric, given to malicious practical jokes and a terror to his wife and children. In his last years he was mentally quite deranged. He died in Paris on April 1, 1709. Of his nine children by his wife, one son and three daughters survived him, the most notable being Louise Bénédicte (1676–1752), duchesse du Maine.

The Last Princes.—Louis III de Bourbon (1668–1710), 6th prince de Condé, born on Oct. 10, 1668, was the 5th prince's second son and eventual successor. Almost a dwarf, with an enormous head and a yellow complexion, he was notoriously malevolent and offensive. In 1685 he was married to one of Louis XIV's bastards, Louise Françoise de Bourbon (previously known as Mlle de Nantes). As a soldier (from 1688), he showed bravery, notably in the battles of Steinkerk (1692) and Neerwinden (1693). On his father's death he was unable to assume the designation Monsieur le Prince (*see* above) since the Condés could no longer claim the rank of premier prince. He therefore never used his title of prince de Condé, continuing to be known as Monsieur le Duc (he was duc de Bourbon). He died suddenly in Paris on May 4, 1710, leaving three sons and six daughters by his wife.

For the 7th prince, *see* Bourbon, Louis Henri, Duc de.

Louis Joseph de Bourbon (1736–1818), 8th prince de Condé, was born in Paris on Aug. 9, 1736, only son of the duc de Bourbon and Charlotte of Hesse. He assumed the Condé title on his father's death (1740). In 1753 he married Godefride de Rohan-Soubise (d. 1760). Brought up for the army, he did good service in the Seven Years' War. On the fall of the Bastille (1789), he was one

of the first princes to emigrate. Establishing himself at Worms in 1791, he set about raising the *émigré* "army of Condé," which took part, not very effectively, in the antirevolutionary campaigns of 1792–96 (*see* FRENCH REVOLUTIONARY WARS). After the Franco-Austrian peace of 1797, Condé went to Russia, served with the Russians in 1799, then passed to Austria in 1800 and to England in 1801. Returning to France in 1814, he died in Paris on May 3, 1818.

LOUIS HENRI JOSEPH (1756–1830), 9th prince de Condé, born in Paris on April 13, 1756, the 8th prince's son. As duc de Bourbon, he was married in 1770 to Louise Marie Thérèse d'Orléans (1750–1822), who bore him a son, Louis Antoine, duc d'Enghien (*q.v.*), in 1772, but from whom he parted in 1780. Emigrating with his father and son in 1789, he went in 1795 to England to prepare the abortive expedition of the comte d'Artois (*see* CHARLES X, king of France) to the Vendée. Thereafter he gave himself up to sordid ease in London, where he picked up Sophie Dawes, the future baronne de Feuchères (*q.v.*). Returning to France in 1814, he tried to organize resistance in Anjou during the Hundred Days, then escaped to Spain till the Second Restoration. On his father's death he did not assume the Condé title. As Enghien had been shot at Napoleon's behest in 1804, the duc de Bourbon had no heirs, so that in 1829, to ingratiate herself with the house of Orléans, his mistress made him leave the residue of the Condé inheritance (after splendid bequests to herself) to Henri d'Orléans, duc d'Aumale. On Aug. 27, 1830, he was found hanging from a window fastening in his bedroom at St. Leu, the magnificent estate that he had bought six years earlier.

This ended the great house of Condé. Aumale in gratitude chose the title prince de Condé for his elder child, Louis (1845–66), and wrote a monumental study of the first four princes, *Histoire des princes de Condé . . .*, 7 vol. plus index and maps (1863–96).

(J. G. R.-S.)

CONDÉ, LOUIS II DE BOURBON, PRINCE DE (1621–1686), called THE GREAT or LE GRAND CONDÉ, or MONSIEUR LE PRINCE LE HÉROS, French prince and general, was born in Paris on Sept. 8, 1621, son of Henry II de Condé and his wife Charlotte de Montmorency. The sense of being a prince of the royal blood of France (*see* CONDÉ, PRINCES DE) dominated Condé's life; even in his deathbed letter to the king he mentioned his birth. From this came his contempt for the lesser princes, his indecision in opposing royal authority in the person of the queen regent and, finally, his submission to the monarchical dogma of Louis XIV.

His father gave to the duc d'Enghien, as he was at first called, a complete and strict education: six years with the Jesuits at Bourges, as well as mathematics and horsemanship at the Royal Academy at Paris. At 17 he was governor of Burgundy, in touch with the armies of the Thirty Years' War (*q.v.*). Cardinal de Richelieu and Louis XIII, visiting him at Dijon, noted his fitness for a command. His father had long intended to marry him to the cardinal's niece, Claire Clémence de Maillé-Brézé; and after Enghien had served as a volunteer with the army in Artois, working hard as a professional soldier, they were married (Feb. 1641). She was barely 13, and they began so badly that the cardinal summoned him to Narbonne (1642). There, during the conspiracy of Cinq-Mars, the cardinal appreciated his loyalty, and before his death the king had agreed that the young Enghien should command an army in 1643.

Less than a month after Enghien had taken command at Amiens he heard that the Spaniards, far to the east, were attacking Rocroi and would invade Champagne; he also received news of Louis XIII's death, but from the first he acted with full professional confidence. He marched straight to the enemy, placed his army before them in battle order too rapidly for a countermove and next day (May 19, 1643) began the battle of Rocroi by breaking the opposing cavalry wing. He checked his horsemen and turned them on the rear of the Flemish infantry, moved on to rally his own defeated left wing and concentrated his troops to crush the strong core of old Spanish regiments. It was the greatest French victory for a century and due, beyond question, to his personal effort. He had the genius for direct, decided action on the military facts which faced him.

In 1644 Gaston, duc d'Orléans, as Louis XIV's uncle, claimed the main army command. Enghien collected troops in Champagne and was sent, not to Flanders to help Gaston but east to reinforce the marshal de Turenne. As prince he could give orders to the marshal, though Turenne was ten years older and had the larger army, but they were good colleagues. Their repeated attacks failed to break the lines of the Bavarian general Franz von Mercy, near Freiburg, but at last Mercy withdrew. Enghien seized Philippsburg as a base across the Rhine and occupied the Rhineland up to Mainz, an occupation which his control of his troops made tolerable to the inhabitants. In July 1645 he came again to help Turenne on the borders of Bavaria, far into Germany. Their victory at Nördlingen (Aug. 3) after costly frontal attacks on strong positions, drove the Bavarians across the Danube and completed Enghein's fame as a great commander. During the campaign of 1646 he went to serve under the ineffective Gaston d'Orléans in Flanders; then gout brought Gaston back to court, and in two months Enghien had secured the great prize of Dunkerque.

His father died on Dec. 26, 1646, and Enghien became prince de Condé and premier prince of the blood. Now he had power as well as glory and so was carefully watched by Cardinal Mazarin (*q.v.*), chief minister of the queen regent, Anne of Austria. In 1647 he was sent to restore the defeated army in Catalonia and to strike some blow which would force Spain to accept peace on French terms. (If Masaniello's revolt in Naples and Henry de Guise's attempt to win that kingdom had been more successful, Condé might have been moved still farther from the centres of power in France.) He invested Lérida (with the legendary gesture of the fiddlers leading the first trench party). Paris, expecting Lérida's fall, was disappointed when Condé decided that he must be free to move against the growing Spanish army and raised the siege. He held Catalonia successfully, but Lérida was a blow to his reputation, as both he and Mazarin knew. Mazarin had to give Condé the Flanders command in 1648, but listened more to his subordinates than to him and split up the army for different objectives. Condé had only part of his army when he seized the opportunity for a battle at Lens (Aug. 20) and by his tactical mastery, a simulated retreat drawing the enemy out, crushed the Spanish forces under the archduke Leopold and secured the signing of peace at Münster.

With this victory power swung back to Condé on his return from Flanders, for Mazarin was faced by the first emergence of the Fronde (*q.v.*). Condé had his own personal grievances against Mazarin (a list of promotions and appointments not granted to his friends and family) and did not like Mazarin's sudden *coups d'état*, but he despised the house of Vendôme and the duc de Beaufort, its representative among the Frondeurs, and could not be courteous to the lawyers of the Paris *parlement*. In any case, he alone could provide and command the troops for the blockade of Paris, which began in Jan. 1649. The peace of Rueil, in the following March, left him undecided. He was not a party leader; he could not agree with his brother Armand, prince de Conti, or with his sister Anne, duchesse de Longueville, or even with the duchesse de Châtillon (Isabelle Angélique de Montmorency-Bouteville), sister of one friend and widow of another, whom he much admired. Yet all the intriguers, Mazarin, Gondi (the future cardinal de Retz), the duchesses and the other princes were bound to consider him for an alternative government. Certainly he was not a conspirator, though every violent speech of his was exploited. Mazarin resolved the case by arresting Condé, Conti and their brother-in-law, the duc de Longueville (Henry d'Orléans) on Jan. 18, 1650, when they were in attendance at court. They were in prison for 13 months. Their supporters began civil war. (*See* FRONDE.)

When the queen regent had to yield in Paris, Mazarin, before leaving France, released his prisoners at Le Havre on Feb. 13, 1651. Condé was well received in Paris and for three months was almost in control of France. He gave posts to his lieutenants and governments to his friends, he secured the return of Turenne (who had rebelled on his behalf) to France, he even welcomed his wife, who had taken up arms for him at Bordeaux. But neither the

court nor Frondeurs accepted him and he was soon taking precautions for his own security. He was safe neither from arbitrary arrest by the queen regent's guard, nor from murder, so in July he moved outside Paris. In Sept. 1651 he was in armed rebellion, and in November he signed a formal treaty which his agents had negotiated with the Spaniards for common action against the French government as long as it remained under Mazarin's influence.

Mazarin's return to France (Dec. 1651) made Gaston d'Orléans and the Frondeurs in Paris ready to come to terms with Condé. After riding in disguise with only eight companions from Guienne to the Loire, Condé took command of the rebel princes' army that was awaiting him and fought the battle of Bléneau (April 6–7), in the latter stage of which he was opposed by Turenne, now on the side of the government. He entered Paris in triumph on April 11. Yet he made no new friends and secured control over nobody. Indecision, violent tempers and illness exhausted him. He was nearly captured by Turenne in the astonishing battle of the Faubourg St. Antoine (July 2, 1652), in the streets outside the wall of Paris, but was at the last moment let in through the gate. At last, in October, he left Paris with 3,000 men, without money or resources to maintain independent action in Champagne. In less than a year he was only one of the king of Spain's commanders in the Netherlands, and not even the chief one. As a soldier, however, his exploits in the Spanish service were still splendid: his retreat from Arras (1654); his victory at Valenciennes (1656); his relief of Cambrai (1657). Each of these exploits was so exact an appreciation of the facts as to be a stroke of genius. From the final battle of the Dunes before Dunkerque (June 14, 1658) he did little more than escape; he advised against battle and the ground was unfit for his cavalry.

After the treaty of the Pyrénées (1659) Condé returned to France in Jan. 1660. There followed illnesses, debts, disappointed lieutenants and his final separation from his wife, whom he and his son callously confined at Châteauroux in 1671 for the rest of her life, when she was probably mentally disordered. His seat at Chantilly, however, became a centre of the arts of peace, visited by the most brilliant men in Europe. He enjoyed the possibility of being elected king of Poland, but was completely submissive to the royal will, which for some years kept him from politics and war. In 1672 Louis XIV flattered himself with the great parade of the invasion of Holland (*see* Dutch Wars) and with Turenne and Condé as his lieutenants, but in a skirmish near Arnhem (June 12) Condé was wounded and his nephew, the young Charles Paris de Longueville, killed. Afterward Condé was appointed to real commands, but with small forces, on the Moselle and then at Utrecht. In 1674 he commanded in the Netherlands, completed the evacuation of Holland and, from his well-chosen camp near Charleroi, faced the much larger allied armies. In the battle of Seneffe (Aug. 11) he cut off their rearguard of 8,000 men, but was engaged by William of Orange with increasing numbers from which he could escape only by continuing to attack. Both armies gladly withdrew in the night. Condé, wearing slippers and stockings because of his gout, had been in the saddle for 26 hours, and three horses were killed under him.

On July 31, 1675, Condé received the news that Turenne had been killed and the king's order to replace him in Alsace. He left the Netherlands at once, restored the confidence of the troops on the German front and maneuvered from one strong position to another until Raimund Montecuccoli abandoned Alsace and the Rhineland and took the imperial army back across the Rhine.

This was the end of Condé's active service; he was now so crippled that he could hardly move. He ceased to attend the king's council, but all the soldiers and statesmen came to Chantilly, and he enjoyed the king's full respect. The prince died at Fontainebleau on Dec. 11, 1686.

See Henri d'Orléans, duc d'Aumale, *Histoire des princes de Condé pendant le XVIe et XVIIe siècles*, vol. iii–vii (1886–96). (I. D. E.)

CONDELL, HENRY (d. 1627), English actor and friend of Shakespeare, may have been acting as early as 1590–91 but first appears definitely in 1598 in the cast of *Every Man in His Humour*. Thereafter, he was regularly with Shakespeare's company ("the Lord Chamberlain's men," "the King's men"), retiring as a man of substance about 1623. His name and that of John Heminge (*q.v.*) were linked with Shakespeare's for 30 years: they had been associates financially and as fellow actors in the Blackfriars and the Globe theatre, and Shakespeare left each of them a token remembrance in his will.

Condell and Heminge seem to have been the chief movers in sponsoring and preparing the Shakespeare First Folio of 1623, and they jointly signed the famous letters to the noble patrons and "the great variety of readers" that preface the volume.

(Fr. C. B.)

CONDENSATION TRAIL (Contrail), an artificial cloud of roughly tubular form, composed of liquid drops or ice crystals usually produced by the sudden condensation of water vapour emitted in the exhaust of aircraft engines. Short-lived trails may also be formed by the rapid cooling of atmospheric water vapour subjected to expansion effects near propeller tips or near wing tips. For each gram of typical fuel burned in the engine, about 1.4 g. of water vapour and about 10,000 cal. of heat are produced by combustion processes and are exhausted into the wake of the aircraft.

Saturation vapour pressure of water vapour depends upon temperature in such a way that the heating effect will not overcome the humidification effect if the aircraft is flying in air colder than about −60° C. or −75° F. Hence, a wake of supersaturated vapour is left behind, and in this narrow wake the condensation trail rapidly forms.

The advent of jet-powered aircraft operating in the cold upper atmosphere made this a much more commonly observed phenomenon than it was formerly, except in cold polar regions.

(J. E. McD.)

CONDENSED MILK: *see* Food Preservation.

CONDENSER. The term condenser is ordinarily employed to designate a device for condensing a gas into a liquid. Other types of condensers, however, are also extensively employed. In electrical circuits condensers are used for concentrating opposite electrical charges on plates (*see* Capacitor) and in optics condensers are used for concentrating light in order to secure powerful illumination of a slide or other object. The term condenser is also used in the textile industry to denote an apparatus which doffs the web from carding machines and separates it into slivers of soft yarn.

Condensers are employed in power plants for the condensation of exhaust steam from turbines and in refrigeration plants for the condensation of refrigerant vapours such as the Freons or ammonia. They are also employed in the petroleum and chemical industries for the condensation of hydrocarbons and other chemical vapours.

Steam Condensers.—In a power plant steam generated in a boiler exhausts from the turbine into a condenser where its latent heat is removed by means of water flowing inside tubes around which the steam condenses. The condenser performs two important functions: (1) it creates a low-pressure region into which the steam can exhaust; (2) it provides a means of collecting the condensed steam (condensate) so that it can be reused in the boiler without further chemical treatment.

The first of the above functions is important since by exhausting steam into a condenser capable of maintaining a low back pressure, approximately 50% more power can be obtained than would otherwise be available. The second function is important since all new water fed to the boiler must be chemically treated to assure a high degree of purity. By reclaiming the condensate only sufficient raw water need be treated to make up for leaks and other steam losses from the cycle. This function means that when a condenser is employed only 1% or 2% of the water fed to the boiler needs to be treated whereas, if a condenser were not employed, all feed water would require treatment.

Steam condensers may be grouped into two major classifications, surface condensers and direct-contact condensers. In surface condensers the condensing steam does not come into direct contact with the cooling water but is separated from it by the walls of the tubes through which the water flows. In direct-contact con-

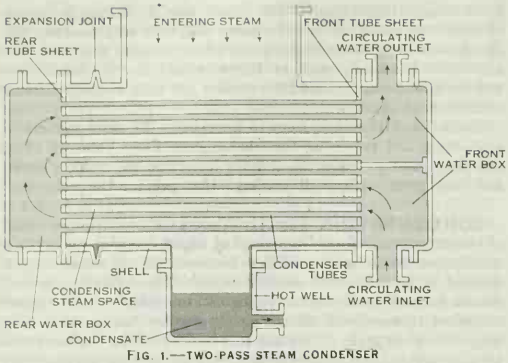

FIG. 1.—TWO-PASS STEAM CONDENSER

densers the cooling water is sprayed into the steam and intermingles with it, causing condensation.

The essential features of a surface condenser are illustrated in fig. 1. The unit shown consists of a circular or oval-shaped cylindrical shell into which the exhaust steam flows. Passing through the shell are many small tubes through which relatively cold water flows. Steam coming into contact with the cool surface of the tubes condenses and is collected in a chamber underneath the tubes called the hot well. From there it is removed by condensate pumps. In large condensers air tends to leak into the steam space and provisions must be made to remove this by means of special steam-operated pumps called ejectors (*see* EJECTOR).

Surface condensers of many shapes and sizes have been built. The smallest will handle only a few pounds of steam per hour while the largest may handle as high as 1,000,000 or more pounds per hour. The latter are found in large central station power plants.

Direct-contact steam condensers may be of either the barometric or jet type. In the barometric type the steam is directed into a chamber into which large quantities of water are sprayed. The water coming into contact with the steam condenses it and tends to create a vacuum because of the collapse of volume of the steam. In order to maintain this vacuum the water discharged from the condenser is directed into a long vertical pipe, called the tailpipe, which extends downward into a lake, stream or other body of water. The low pressure in the condensing chamber causes the water level to rise in the tailpipe and to maintain a level approximately 30 ft. above that of the body of water. The tailpipe thus serves as a pressure seal between the surrounding atmosphere and the condensing steam inside the spray chamber.

Jet-type condensers operate on the same principle as the barometric except that the low pressure in the mixing chamber is maintained by entraining the condensing steam in a high-velocity jet which at the outlet is reduced in velocity and increased in pressure to atmospheric by means of a divergent discharge passage.

Jet and barometric condensers are no longer extensively used because the condensed steam becomes contaminated by the cooling water and thus cannot be reclaimed for further use without chemical treatment.

Refrigeration Condensers.—In vapour-compression refrigeration systems the refrigerant gas, after being compressed in a refrigeration compressor, is liquefied in a refrigeration condenser. During the liquefaction process heat is rejected either to air passing over the condenser or to circulating water. The condensed refrigerant is then passed through an expansion valve where it cools to a low enough temperature to absorb heat from the space or compartment to be cooled, causing vaporization of the refrigerant liquid.

The vaporized gas then enters the compressor to begin another cycle. Refrigeration condensers may be of the shell and tube type similar to steam condensers, in which the refrigerant is condensed around tubes through which circulating water or other fluid is passed, or they may consist of a bank of finned tubes containing the refrigerant over which air circulates in order to absorb the latent heat. Evaporative condensers consisting of banks of tubes over which water is allowed to trickle may also be employed. In the latter some of the water trickling over the tubes is vaporized, thus absorbing the heat surrendered by the warmer condensing refrigerant.

In addition to steam and refrigeration condensers there are a variety of designs employed in the petroleum and chemical industries. These are used to liquefy hydrocarbons and other chemicals. In some instances condensers are employed for the purpose of separating condensable from noncondensable gases.

Heat-Transfer Characteristics.—An important consideration in the design of a surface condenser for power plants is the rate of transfer of heat from the condensing steam to the circulating water. This rate depends upon three factors, namely: (1) the total cooling surface area to which the condensing steam is exposed; (2) the over-all coefficient of heat transfer from condensing steam to circulating water; (3) the mean temperature difference between the condensing steam and the circulating water.

The first item depends upon the number of tubes employed and their length. The second depends upon the resistance to the flow of heat created by the tube walls and the thin films of stagnant fluid on either side of the walls (fig. 2).

The third factor depends upon the difference in temperature between the condensing steam and the water at inlet and exit to the condenser. The rise in temperature of the circulating water as it flows through the tubes is illustrated in fig. 2. The mean temperature difference between the condensing steam and the water can be shown to be given by the mathematical expression:

$$\Delta t_{\text{mean}} = \frac{\Delta t_1 - \Delta t_2}{\log_e \frac{\Delta t_1}{\Delta t_2}} \qquad (1)$$

where Δt_1 and Δt_2 are the temperature difference between the condensing steam and circulating water at inlet and outlet of the condenser, respectively. The heat which can be transferred per hour from the condensing steam to the circulating water will be

$$Q = AU\Delta t_{\text{mean}} \qquad (2)$$

where A = outside surface area of condenser tubes in square feet; U = over-all coefficient of heat transfer based on the outer surface area of the tubes in British Thermal Units per hour per square foot per ° F.; Δt_{mean} = logarithmic mean temperature difference between the condensing steam and the circulating water (° F.).

The weight of steam which can be condensed per hour may then be computed by the expression:

$$W = \frac{Q}{h - h_f}$$

where $h - h_f$ is the latent heat of condensation which must be removed per pound of steam. Methods of obtaining the over-all coefficient of heat transfer U and the latent heat surrendered per pound of steam $h - h_f$ are too involved to be considered here but may be found in the references listed.

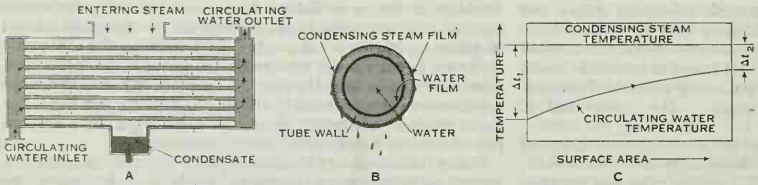

FIG. 2.—HEAT TRANSFER IN A SINGLE-PASS CONDENSER

(A) Plan of condenser, showing paths of steam and cooling water; (B) end view of single condenser tube, showing three resistances through which heat must pass; (C) diagram of condenser characteristics, showing temperature rise of circulating water

For further information on the heat transfer characteristics of surface condensers, *see* HEAT EXCHANGER.

See W. H. McAdams, *Heat Transmission*, 3rd ed. (1954); G. A. Gaffert, *Steam Power Stations*, 4th ed. (1952). (RD. A. BR.)

CONDENSER (ELECTRICAL): *see* CAPACITOR.

CONDER, CHARLES (1868–1909), English artist, whose unique and charming decorative style, in dainty pastoral scenes, won him a certain vogue. The son of a civil engineer, he was born in London, and spent his early years in India. After an English education he went into the government service in Australia, but in 1890 determined to devote himself to art, and studied for several years in Paris, where in 1893 he became an associate of the Société Nationale des Beaux-Arts. About 1895 his reputation as an original painter, particularly of Watteaulike designs for fans, spread among a limited circle of artists in London, mainly connected first with the New English Art club, and later the International society. Conder died on Feb. 9, 1909.

CONDILLAC, ÉTIENNE BONNOT DE (1715–1780), French philosopher, important as a psychologist, as a logician, as an economist and as the leading systematic exponent of Locke's principles in France, was born at Grenoble on Sept. 30, 1715, the third son of Gabriel Bonnot, vicomte de Mably. His elder brothers were Jean Bonnot de Mably, *prévôt des maréchaux* for the Lyonnais, and Gabriel (1709–85), abbé de Mably, the well-known political writer. Destined for the church, Condillac was early ordained priest, and the first part of his life was uneventful except for his making the acquaintance of J. J. Rousseau, who in 1740 was employed as a tutor by Condillac's brother Jean. This led to a lasting friendship.

In Paris, however, Condillac came into contact with Denis Diderot and the *encyclopédistes*. The publication of his *Essai sur l'origine des connaissances humaines* (1746) and *Traité des systèmes* (1749) established his position in the literary salons; he was elected a member of the Berlin academy in 1752. The *Traité des sensations* (1754) and the *Traité des animaux* (1755) followed, and in 1758 he was appointed preceptor to the young Ferdinand of Parma (his *Cours d'études pour l'instruction du prince de Parme*, 16 vol., was published in 1775). Returning to France in 1767, he was elected to the Académie Française in 1768. He published *Le Commerce et le gouvernement considérés relativement l'un à l'autre* in 1776; but the irreligious tone of Parisian intellectual society was offensive to him, and he spent the latter part of his life in retirement at Flux, near Beaugency, where he had purchased a house for his niece in 1773. He died during the night of Aug. 2–3, 1780. *La Logique* (1780) and *La Langue des calculs* (1798) appeared posthumously.

Psychology.—Voltaire had made Locke's philosophy fashionable in France, but it was Condillac who established it systematically in that country. In setting forth his empirical sensationism, Condillac shows many of the best qualities of his age and of his nation—lucidity, brevity, moderation and an earnest striving after logical method. Nevertheless, in the analysis of the human mind on which his fame chiefly rests, he omits the active and spiritual side of human experience. His first book, the *Essai sur l'origine des connaissances humaines*, keeps close to his English master. He accepts with some indecision Locke's deduction of our knowledge from two sources, sensation and reflection, and, unlike Locke, uses as his main principle of explanation the association of ideas.

His next book, the *Traité des systèmes*, is a vigorous criticism of metaphysical systems. His polemic, which is inspired throughout with the spirit of Locke, is directed against the innate ideas of the Cartesians, Nicolas Malebranche's faculty psychology, Leibniz' monadism and pre-established harmony, and, above all, against the conception of substance set forth in the first part of the *Ethics* of Spinoza.

The most important of Condillac's works is the *Traité des sensations*, in which he questions Locke's doctrine that the senses give us intuitive knowledge of objects—that the eye, for example, judges naturally of shapes, sizes, positions and distances. To clear up such questions we must study our senses separately, distinguishing precisely what ideas we owe to each sense and observing how the senses are trained and how one sense aids another. The result, he is confident, will show that all human faculty and knowledge are transformed sensation only, to the exclusion of any other principle, such as reflection. The plan of the book is that the author imagines a statue organized inwardly like a man, animated by a soul which has never received an idea, into which no sense impression has ever penetrated. He then unlocks its senses one by one, beginning with smell, as the sense that contributes least to human knowledge. At its first experience of smell the consciousness of the statue is entirely occupied by it; and this occupancy of consciousness is attention. The statue's smell experience will produce pleasure or pain; and pleasure and pain will thenceforward be the master principle which, determining all the operations of its mind, will raise it by degrees to all the knowledge of which it is capable. The next stage is memory, which is the lingering impression of the smell experience upon the attention: "memory is nothing more than a mode of feeling." From memory springs comparison: the statue experiences the smell, say, of a rose while remembering that of a carnation; and "comparison is nothing more than giving one's attention to two things simultaneously." And "as soon as the statue has comparison it has judgment." Comparisons and judgments become habitual and are stored in the mind and formed into series; and thus arises the powerful principle of the association of ideas. From comparison of past and present experiences in respect of their pleasure-giving quality arises desire; it is desire that determines the operation of our faculties, stimulates the memory and imagination and gives rise to the passions. The passions, also, are nothing but sensation transformed. So runs the argument in the first section of the treatise. In the second section Condillac invests his statue with the sense of touch, which first informs it of the existence of external objects. In a very careful and elaborate analysis, he distinguishes the various elements in our tactile experiences—the touching of one's own body, the touching of objects other than one's own body, the experience of movement, the exploration of surfaces by the hands; he traces the growth of the statue's perceptions of extension, distance and shape. The third section deals with the combination of touch with the other senses. The fourth section deals with the desires, activities and ideas of an isolated man who enjoys possession of all the senses; and ends with observations on a "wild boy" who was found living among bears in the forests of Lithuania. The conclusion of the whole work is that in the natural order of things everything has its source in sensation and yet that this source is not equally abundant in all men; and, finally, that man is nothing but what he has acquired: all innate faculties and ideas are to be swept away.

It is obvious enough that Condillac's naturalistic psychology, with its explanation of personality as an aggregate of sensations, leads straight to atheism and determinism. There is, however, no reason to question the sincerity with which he repudiates both these consequences. What he says upon religion is always in harmony with his profession; and he vindicates the freedom of the will in a dissertation that has very little in common with the *Traité des sensations* to which it is appended. The common reproach of materialism should certainly not be made against him. He always asserts the substantive reality of the soul; and in the opening words of his *Essai*, "Whether we rise to heaven, or descend to the abyss, we never get outside ourselves—it is always our own thoughts that we perceive," is found the subjectivist principle that had formed the starting point of Berkeley.

Condillac did notable work in the direction of making psychology a science. His method of imaginative reconstruction, however, in spite of his protests against abstraction, hypothesis and synthesis, is in the highest degree abstract, hypothetical and synthetic.

Logic.—Condillac was an original logician who emphasized the dependence of reasoning on language and analyzed language as a system of signs ultimately derived from natural sounds and gestures. He stressed the importance for science of a well-made language and held that mathematical calculation is the ideal or model for all language.

Economics.—In *Le Commerce et le gouvernement* Condillac came forward as an original economist, arguing that value depends not on labour but on utility: "Our needs give rise to value, our exchanges give rise to price."

Influence.—Condillac's psychological doctrine, so congenial to the intellectual climate of 18th-century France, was the foundation of the movement known as *Idéologie* and reigned in the French schools for more than 50 years, challenged only by a few, such as Maine de Biran, who saw that it gave no sufficient account of volitional experience.

In the 19th century, however, when German romanticism had spread to France, Condillac's sensationism was superseded by the eclecticism of Victor Cousin. Its effect on English thought is to be discerned in the works of James and John Stuart Mill, of Alexander Bain and of Herbert Spencer, in connection with the association of ideas, with the supremacy of pleasure and pain and with the general interpretation of all mental contents as sensations or transformed sensations.

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(H. St.; H. B. A.)

CONDITION, a stipulation, a provision that needs to be satisfied (from Lat. *condicio*, "something agreed upon or arranged"). Also, something that must exist or be the case or happen in order for something else to exist or be the case or happen (as in "the will to live is a condition for survival"). In a different set of senses, the word means a state or circumstance or mode of being (as in "the poor condition of the soil").

In logic, a sentence or proposition of the form "If A then B" (or, in symbols, $A \supset B$) is called a conditional (sentence or proposition). Similarly, "Whenever A then B" [or, in symbols, $(x) \cdot A(x) \supset B(x)$] may be called a general conditional. In such uses, "conditional" is a synonym for "hypothetical" and is opposed to "categorical." Closely related in meaning are the common and useful expressions, "sufficient condition" and "necessary condition." Suppose some instance of a property, P, is always accompanied by a corresponding instance of some other property, Q, but not necessarily vice versa; then P is said to be a sufficient condition for Q and, equivalently, Q is said to be a necessary condition for P. Thus a severed spinal column (or the property of having such) is a sufficient, but not a necessary, condition for death; while lack of consciousness is a necessary, but not a sufficient, condition for death. In any case where P is both a necessary and a sufficient condition for Q, the latter will also be a necessary and sufficient condition for the former, each instance of either property being regularly accompanied by a corresponding instance of the other. The terminology has no reference to the temporal relations, if any, of the corresponding instances, and is also applicable to logical or mathematical or other nontemporal properties. Thus, it is proper to speak of "a necessary condition for the solution of an equation" or "a sufficient condition for the validity of a syllogism."

(M. Bk.)

In philosophy the above uses of the term condition have led to the contrast between "conditioned" and "absolute" being (or "dependent" versus "independent" being). Thus all finite things exist in certain relations not only to all other things, but possibly also to thought; in other words, all finite existence is "conditioned." Hence Sir William Hamilton speaks of the "philosophy of the unconditioned," *i.e.*, of thought in distinction to things which are determined by thought in relation to other things (*see* ABSOLUTE). An analogous distinction is made (*cf.* H. W. B. Joseph, *Introduction to Logic*, p. 380 ff.) between the so-called universal laws of nature and conditional principles which, though they are regarded as having the force of law, are yet dependent or derivative, *i.e.*, cannot be treated as universal truths. Such principles hold good under present conditions, but other conditions might be imagined under which they would be invalid; they hold good only as corollaries from the laws of nature under existing conditions.

CONDITIONING, a term used in the sciences of behaviour to designate a process whereby a response becomes more frequent or more predictable in a given environment as a result of reinforcement. The history of this concept shows its dependence upon experimental techniques for the study of reflexes. Physiologists in Russia, England and the United States contributed the original procedures, observations and definitions. After the 1920s psychologists carried on the larger share of experimental work on the nature and prerequisites of conditioning.

Conditioning is a form of learning in which either (1) a given stimulus (or signal) becomes increasingly effective in evoking a response or (2) a response occurs with increasing regularity in a well-specified and stable environment. The type of reinforcement that is used determines which of these consequences obtains. When two stimuli are presented in an appropriate time and intensity relationship, one of them will come to induce a response resembling that of the other. The process can be described as one of stimulus substitution. This procedure is called classical (or respondent) conditioning. In the traditional technique of Russian laboratories, a dog is placed in a harness within a sound-shielded room. On each conditioning trial the sound of a bell or a metronome is promptly followed by food powder blown by an air puff into the dog's mouth. Here the tone of the bell is known as the conditioned (or sometimes conditional) stimulus, abbreviated as CS. The salivation to this sound is the conditioned response (CR). The strength of conditioning is measured in terms of the number of drops of saliva secreted during test trials in which food powder is omitted. The original response of salivation to introduction of food into the mouth is called the unconditioned response (UR) to food (the US). Using a variety of stimuli and responses, psychologists in the United States have shown that in man and other mammals there is a very consistent optimum interval between the CS and the US which the experimenter may utilize. This interval is approximately half a second. For cold-blooded animals, the optimum interval for conditioning is longer. In fish, for example, the CS may best precede the US by 1½ seconds. When the CS is appropriately followed by the US, reinforcement is said to occur. If the US is omitted on any trial or series of trials the procedure is referred to as extinction.

Instrumental (or operant) conditioning differs from classical conditioning in that reinforcement occurs only after the organism executes a predesignated behavioural act. No US is used to initiate the specific act to be conditioned. Here the required behaviour is known as an operant or, once it occurs with regularity, also as a conditioned response, to correspond to its counterpart in classical conditioning.

History.—The psychic reflex was observed in the 18th century by Robert Whytt, who noted that salivation was accelerated by the sight or even by the ideational recall of food. The fundamental fact of conditioning was observed in the United States by E. B. Twitmyer, who developed a knee-jerk conditioned reflex in a human subject in 1902. The modern development of conditioning in both fact and theory, however, is commonly associated with the name of I. P. Pavlov (*q.v.*), who devoted the last 36 years of his life to these researches. V. M. Bekhterev (1857–1927), a countryman of Pavlov, also played an important role. Both acknowledged their indebtedness to Ivan Sechenov, who outlined in 1863 a comprehensive reflex theory of behaviour.

The translation in 1913 of Bekhterev's book into French and German was important in arousing the interest of U.S. psychologists, most of whom preferred his motor method to Pavlov's salivary technique. Although "it is probably more to him than to Pavlov that we owe the bold acceptance of conditioning by psychologists" (E. R. Hilgard), Pavlov's terminology and conceptual system were more widely adopted.

In the United States objective psychology had already won appreciable support prior to the advent of conditioning. Backed by

the concepts of association and habit, J. B. Watson (*q.v.*), initially interested in animal behaviour, founded an objective psychology in 1913. He exploited conditioning as a substitute for introspection, using Pavlov's term (conditioned reflex) superimposed upon Bekhterev's type of motor-conditioning procedure. Watson was largely responsible for the incorporation of conditioning into U.S. psychology.

The early enthusiasm for conditioning in the U.S. was largely verbal. During the decade beginning with 1926, conditioning played a less conspicuous role in textbooks but was given more serious attention in the laboratories. The translation of Pavlov's major work into English in 1927 catalyzed research interest, and a mature theoretical framework was eventually constructed by C. L. Hull (*q.v.*) in an attempt to bridge the gap from conditioning to more complex forms of learning.

After the publication of B. F. Skinner's *The Behavior of Organisms* in 1938, the use of operant conditioning procedures became extensive. Specific techniques have varied somewhat from organism to organism. Although more commonly applied to the experimental study of animal behaviour, the method of operant conditioning also has been applied by Skinner and others in human behavioural experimentation. A. G. Ivanov-Smolensky reported his observations with this method in 1927 as he used it in studies of discriminatory learning in children. Chocolate candy constituted the primary reinforcement for these experiments.

Definitions and Methods.—Higher-order conditioning can be established on the basis of preceding conditioned responses. If tone is combined with food, a first-order salivary CR is developed. If this tone is then combined with light, the salivary response can eventually be evoked by light alone (second-order CR). Pavlov was unable to go beyond the second order by the salivary method and the third order by the motor method. Later work employing combinations or sequences of classical and operant conditioning techniques showed that conditioning can be extended at least to the fifth order.

By applying an unconditioned stimulus (food) at the end of a one-minute presentation of the conditioned stimulus (tone) a delayed CR will be developed, conditioned salivation being deferred until near the time for administration of food. Similarly, if the tone is presented for only 10 or 15 seconds, followed by food 45 seconds after cessation of tone, a trace CR will appear nearly one minute after onset of tone. This illustrates, according to Pavlov, internal inhibition, since there must be some internal trace inhibiting salivation during the period of silence. If a distracting influence, such as a loud or unusual sound, is applied during the interval, there will be inhibition of inhibition and salivation will occur at once.

If during the initial training period the conditioned stimulus is a tone of 1,000 cycles, many other tones will at first evoke the CR. This is known as sensory generalization. With continued training, specialization or differentiation will develop so that the CR is eventually evoked only by the particular tonal frequency used for conditioning. The process is more effectively developed by alternate trials with other tones which are not reinforced with food or shock. This technique is regularly used in the study of the limits of discriminative capacity in the experimental animal. When the organism is forced beyond its capabilities, experimental neurosis may result (*see* NEUROSES, EXPERIMENTAL).

Virtually any response is conditionable, subject only to the experimenter's ingenuity and to the organism's repertory of reflexes. Bekhterev's method has been used with a variety of responses (eyelid and knee-jerk reflexes, withdrawal movements of various types). The responses controlled by the autonomic nervous system have likewise been explored; *e.g.*, salivation, pulse, blood pressure, skin resistance (perspiration), gastrointestinal secretions, nausea and diuresis. Even the conditioning of immunity reactions has been reported, but these data are equivocal. In human subjects, autonomic responses have been conditioned to verbal stimuli such that vasomotor and pupillary changes are produced by voluntarily thinking of the stimulus word.

Experimental extinction may be induced by repeatedly applying the conditioned stimulus without reinforcement until the CR no longer appears. This process is analogous to negative adaptation or habituation, but the decrement is also explicable in terms of interference, in which a new response works to obliterate the old CR. Extinction suggests but may not be identical with human verbal forgetting. When the CR has just been extinguished, it can be readily reinstated with a few reinforced trials; the learned pattern was not "forgotten" but lacked motivation. The unconditioned stimulus apparently has two functions: that of evoking the required response (*e.g.*, salivation, paw flexion) and also that of offering the requisite motivation (E. A. K. Culler).

One experiment will illustrate this principle. The sound of a bell followed by stimulation directly applied to the motor cortex of the brain (thereby evoking paw flexion) will not set up a CR to the bell unless the dog is motivated (*e.g.*, sensory shock, food). Likewise the animal will seldom establish a flexion CR, however often its leg is passively flexed, unless motivation is provided (*e.g.*, food or a pat on the head). It is also possible, however, that with sufficient overlearning the CR may be susceptible to extinction no more or less readily than human verbal forgetting.

Conducive (perhaps requisite) to conditioning is a prepotent unconditioned stimulus. Although a bright light will produce sharp pupillary constriction, this stimulus can be combined with an even stronger agent (electric shock) so that the initial constriction is followed by dilation while the light is still on. This occurs because the startle reaction to shock, which includes pupillary dilation, is biologically prepotent over the pupillary reflex to light.

A fear CR developed in children to the sight of a rabbit (by paired combinations with loud noise) may be extinguished by presenting the rabbit in conjunction with cookies or candy. This method of reconditioning has had application in clinical practice, for example, in curing enuresis, but requires considerable skill in manipulating the conditions. Injudicious application of the stimuli, as in the fear CR to the rabbit, may not only fail to eliminate the fear but may instead expand the CR so as to incorporate the sight of cookies or candy into the pattern to the extent of producing nausea.

Neurological Correlates.—Pavlov's work was largely applied in the U.S. to the development of a behavioural theory of learning, but he was himself primarily concerned with the dynamics of the cerebral processes which he inferred from his conditioning data. Criticism has been directed at specific concepts such as irradiation, which was postulated as the cerebral mechanism underlying generalization. His basic presupposition that the locus of conditioning is exclusively cortical, upon which his theory of vicarious cortical function largely depended, was proved erroneous. Following his early report of negative results with one animal, a number of investigators were able to establish conditioned reflexes in totally decorticated cats and dogs. In one of these animals a simple discrimination was established between two auditory stimuli. CR's have also been established in organisms lacking true neocortex, and D. P. Marquis developed a feeding response to the sound of a buzzer in human infants only ten days old, at which time the cerebral cortex is presumed to be nonfunctional.

The sensory systems are synaptically integrated at several levels in the cerebrum with available associative centres and motor outlets. In the cat, CR to acoustic stimuli can be mediated at the collicular and bulbar levels (primitive brain centres). One group of experimenters reported that conditioning and extinction can be obtained with only spinal cord innervation in young cats and dogs. This suggests, as seems theoretically plausible, that any synaptic apparatus can mediate simple modifications in behaviour.

The role of the cerebral apparatus is being studied in connection with a variety of functions. Some mechanisms are solely a function of the cortex; permanent deficit follows extirpation of the appropriate cortical system. Other functions are maintained simultaneously at a subcortical level so that no appreciable loss follows cortical intervention. In other instances, although disruption of function follows cortical ablation, restitution results from postoperative training. In the last example it may be presumed that the function is normally mediated by cortical patterns, but that it may also be established and maintained, in their absence, by subcortical mechanisms.

The brain has been shown to respond with massive pulses of electrical potential when rhythmically stimulated, as with a flickering light. Using an initially neutral sound as a signal, followed repeatedly by flicker, F. Morrell and H. Jasper conditioned this driven brain rhythm so that it appeared a few seconds after the sound was given alone. The conditioning process was seen to develop through several intermediate stages involving both generalized and local activation within receiving areas of the brain. That such a massive participation of neural elements should be susceptible to conditioning was evidence that a reflexive neural switching theory may be too simple.

Much research has been directed to a determination of the essential components for conditioning in the arc from sense organ to motor response. In one experiment with electrodes implanted in the animal's brain, shock stimulation of the sensory cortex (conditioned stimulus) followed by normal shock to paw resulted in a CR, indicating that the sensory component of the conditioned stimulus was dispensable. Conditioning does not occur if the unconditioned response is produced by directly stimulating the effectors. Injection of pilocarpine causes increased salivation, but paired combinations of drug injections with an indifferent stimulus will not produce a salivary CR (N. Kleitman). When the neural apparatus is affected, as with morphine injections, a salivary as well as a more general nausea CR is readily established (G. Crisler). With respect to the motor component of the neurally innervated unconditioned response, W. H. Gantt concluded that actual limb flexion is not required in order to establish a limb-flexion CR. This study was repeated and was criticized because responses during training were possible in the other, nonparalyzed limbs (W. N. Kellogg). In a different approach, all striated musculature was paralyzed with curare during training. After recovery of muscular function the CR was restricted to autonomic components such as pulse and blood pressure (E. Girden), suggesting that, at least during the initial training, some activity by the conditioning reflex is required. This is known as the response theory. These researches provided answers by no means definitive, nor did they necessarily represent the most promising avenue in the study of such problems. There are theoretical formulations, some of which are basically conditioning concepts, that emphasize not the role of the peripheral components but depend upon synaptic switching in the cerebral apparatus.

In addition to the discriminative and associative mechanisms, the motivational properties of intracranial electrical stimulation also have been observed. The effort to find those brain centres whose activation constitutes the energizing component in conditioning has been successful (J. M. R. Delgado, J. Olds and P. Milner and others). Electrodes placed in discrete centres of the thalamus, hypothalamus or midbrain were used in place of rewards or punishment in the reinforcement of conditioning, both classical and instrumental. Rats and monkeys learned to give themselves electrical stimulation in "pleasure" centres by pressing a lever. Stimuli presented in conjunction with the electrical or chemical activation of other centres were subsequently used to produce second-order escape and avoidance learning. Some aspects of the neurochemical basis for emotional behaviour were demonstrated and anatomical relations mapped in these experiments. One important contribution attempted to encompass all the psychological processes, including learning, perceiving and emotions. This theory assumed the development of a three-dimensional lattice of "cell assemblies" in the cortical association areas of the cerebrum under repeated stimulations of the organism (D. O. Hebb). A full treatment of this proposal here would necessarily lead into a discussion of nonreflexological theories of neural integration (*e.g.*, field theory of cerebral activity as proposed by the Gestalt psychologists), which is clearly beyond the scope of the immediate discussion.

Finally, attention should be called to the somewhat related and basic problem of retention which still largely, if not completely, resisted understanding in the 1960s. An examination of the question of what occurs in the structure while learning takes place inevitably leads to the issue of how the organism retains, or remembers, what is experienced.

Traditional theories include, among others, the law of effect (E. L. Thorndike) and the drainage principle (W. McDougall). An early suggestion by C. U. A. Kappers, which proposed that retention is due to actual neural growth of neuronic endings during repeated stimulations, was being revived (Hebb). Another suggestion (J. J. Katz and W. C. Halstead) made use of the well-known structural complexity and modifiability of protein molecules. Evidence for the central role of proteins in nerve-cell chemistry added plausibility to this proposal.

Evaluation.—As a method, conditioning is an unsurpassed technique for precise measurement of sensory capacity (absolute and differential thresholds) in animals; *e.g.*, hearing. It has been of considerable value in the investigation of the cerebral correlates of behaviour. It has also been useful in studies of the effect of drugs, experimentally produced neurosis and even personality differences in animals. It has had some success in the study of emotional behaviour (fears) and has been clinically applied in the treatment of some specific maladjustments.

The Pavlovian inferences concerning cerebral dynamics as well as his behavioural hypotheses attracted staunch defenders as well as severe critics. While a number of his theories proved to be untenable, behaviourism later evolved a more mature theoretical formulation (K. W. Spence). Even as an indirect influence, the development of opposed theoretical views enriched science; to some extent, the history of Gestalt psychology is a reaction to reflexology.

Furthermore, of no small importance was the development of what is recognized as the organismic approach, in psychology, psychiatry and medicine, as contrasted with the older, primitive and even animistic mentalism. To this, objective psychology and reflexology also made their contribution. *See* ANIMAL BEHAVIOUR; BEHAVIOURISM; LEARNING; PSYCHOLOGY, COMPARATIVE; PSYCHOLOGY, EXPERIMENTAL; REFLEX. *See* also references under "Conditioning" in the Index volume.

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(ED. G.; A. H. R.)

CONDOMINIUM, the joint possession by two or more states of sovereignty over a territory, with a specified division among them of the powers of government. An arrangement of this nature is usually set up by treaty; often, but not always, it represents a compromise solution to a dispute over a territory, agreeable to all disputants. The U.S.–British condominium over the islands of Canton and Enderbury in the Pacific ocean, for instance, was created in 1939 to terminate a diplomatic contest for exclusive title. Prominent among condominiums was that established in 1899 for the Sudan by Great Britain and Egypt, under which the flags of both were used in the territory and the governor general was appointed by the khedive with the approval of the British government; in 1956 the Sudan became independent. A list of historic condominiums would include, among others, Schleswig-Holstein under Austria and Prussia (1864–66); the Samoan Islands under the United States, Great Britain and Germany (1889–99); and Egypt under Great Britain and France (1879–82). Although the occupation system for Germany after 1945 was occasionally called a condominium, strictly it was not one, for German sovereignty was understood to be only interrupted, not terminated, during the years of government by the United States, Great Britain, France and the Soviet Union.

See A. A. El-Erian, *Condominium and Related Situations in International Law* (1952).

(N. L. HL.)

CONDOR, a South American vulture (*Vultur gryphus*), one of the largest of existing birds of flight, about four feet in length

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CALIFORNIA CONDOR (GYMNOGYPS CALIFORNIANUS) IN FLIGHT

and nine feet between the tips of its wings, but large specimens span ten feet or more. The head, flattened above, and the neck are devoid of feathers. In the male the head has a caruncle or comb and the skin of the neck forms a wattle. The adult plumage is a uniform black, with the exception of a frill of white feathers nearly surrounding the base of the neck, and patches of white in certain wing feathers. The middle toe is greatly elongated, and the hinder one only slightly developed. The talons are comparatively straight and blunt. The female, contrary to the usual rule among birds of prey, is smaller than the male.

The condor is a native of the Andes, from the Strait of Magellan to latitude 4° N., where its favourite haunts are at elevations of 10,000 to 16,000 ft. There, during February and March, on inaccessible ledges of rock, it deposits two white eggs, from three to four inches in length, in a nest consisting merely of a few sticks. Incubation lasts for seven weeks, and the young are covered with a whitish down until they are almost as large as their parents. They do not fly well until a year old.

Condors feed on carrion, but may attack sheep, goats and deer. They are exceedingly voracious, feeding in the morning and evening. When gorged with food, they are sluggish and may then be more readily caught. They sleep during the greater part of the day, and hunters may climb the trees on which they roost, noosing them before they wake. In flight the condor is remarkably graceful. The birds flap their wings on rising from the ground, but after attaining a moderate elevation they seem to sail on the air with motionless wings.

The California condor (*Gymnogyps californianus*) is found in the coast ranges of southern California from Monterey bay to Lower California. It has white underwing coverts, with a wing-spread of ten feet. It is somewhat larger than the condor of South America, though of less heavy build.

See also VULTURE. (HT. FN.)

CÓNDOR, CORDILLERA DEL, one of the eastern ranges of the Andes, about 160 mi. long, lying mostly in Ecuador, about 60 mi. S.E. of Cuenca city. A number of tributaries of the Santiago and Cenepa rivers rise there. The Cordillera lies close to the southeastern Ecuador-Peru boundary, a disputed area since colonial days. The Cenepa river, discovered by the U.S. army air force when it was mapping the area, played an important role in the final stages of the border issue, for the 1942 protocol drew the border between the two nations along a presumably uninterrupted water divide. The air force map divulged the interposing Cenepa valley. (L. WE.)

CONDORCET, MARIE JEAN ANTOINE NICOLAS DE CARITAT, MARQUIS DE (1743–1794), French mathematician, philosopher and revolutionary, whose ideas of progress greatly influenced 19th-century philosophy and sociology, was born at Ribemont, in Picardy, on Sept. 17, 1743. He was descended from the ancient family of Caritat, who took their title from Condorcet in Dauphiné. He was educated at the Jesuit college in Reims and at the Collège de Navarre in Paris, where he showed his first promise as a mathematician. In 1769 he became a member of the Academy of Sciences, to which he contributed papers on mathematical and other subjects.

He was the friend of almost all the distinguished men of his time and a zealous propagator of the religious and political views then current among French men of letters. He was induced by D'Alembert to take an active part in the preparation of the *Encyclopédie*. He was elected to the perpetual secretaryship of the Academy of Sciences in 1777 and to the French Academy in 1782 and was a member of other European academies. In 1785 he published his *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix*, a remarkable work which has a distinguished place in the history of the doctrine of probability; a second edition, greatly enlarged and completely recast, appeared in 1805 under the title of *Élémens du calcul des probabilités et son application aux jeux de hasard, à la loterie, et aux jugemens des hommes*. In 1786 he married Sophie de Grouchy (1764–1822; a sister of Emmanuel de Grouchy, the future marshal), said to have been one of the most beautiful women of her time. Her *salon* at the Hôtel des Monnaies, where Condorcet lived in his capacity as inspector general of the mint, was one of the most famous of the time.

Condorcet published his *Vie de M. Turgot* in 1786 and his *Vie de Voltaire* in 1789. Both works were widely and eagerly read and are perhaps, from a purely literary point of view, the best of Condorcet's writings.

The outbreak of the Revolution, which he greeted with enthusiasm, involved him in a great deal of political activity. He was elected to represent Paris in the Legislative Assembly and became its secretary. He was active in the reform of the educational system. He was chief author of the address to the European powers (Dec. 29, 1791); and on April 21 and 22, 1792, he presented a scheme for a system of state education, which was the basis of that ultimately adopted. Condorcet was one of the first to declare for a republic and drew up the declaration justifying the suspension of the king and the summoning of the National Convention (Aug. 1792). In the convention he represented the *département* of Aisne and was a member of the committee on the constitution. His draft (presented Feb. 15, 1793), however, was rejected in favour of that of the Jacobins. In the trial of Louis XVI he voted against the death penalty. But his independent attitude was becoming dangerous, and his opposition to the arrest of the Girondists (June 1793) led to his condemnation and outlawry.

To occupy his mind while he was in hiding, some of his friends prevailed on him to engage on the work by which he is best known, the *Esquisse d'un tableau historique des progrès de l'esprit humain*. Other works were written at the same time, including the *Avis d'un père proscrit à sa fille*. Some of them were published by friends at the time and others were issued after his death. Still interested in public affairs and believing that the house in which he had been hiding was watched, he escaped and, after hiding in thickets and quarries for three days, entered the village of Clamart on the evening of March 27, 1794. His appearance betrayed him, and he was taken to Bourg-la-Reine and imprisoned. On the morning of March 29 he was found dead, whether from exhaustion or by poison is unknown.

Mme de Condorcet divorced her husband (having obtained his consent) during his proscription and succeeded in regaining possession of the family property, which had been confiscated by Robespierre's government. She lived for a time with J. J. Mailla Garat (nephew of Joseph Garat the *idéologue*) and later with Claude Fauriel, the philologist, who outlived her. She translated Adam Smith's *Theory of the Moral Sentiments* into French (1798; with her own *Huit lettres sur la sympathie* appended) and cooperated in editing the complete works of her husband, 21 vol.

(1804). Her *salon* was a meeting place of those opposed to Napoleon's autocratic regime. She died in Paris on Sept. 8, 1822.

Philosophy.—Condorcet's philosophical fame rests chiefly on the *Esquisse*, which was first published posthumously in 1795 (Eng. trans. by June Barraclough, *Sketch for a Historical Picture of the Progress of the Human Mind*, with an introduction by Stuart Hampshire, 1955). Its fundamental idea is that of the continuous progress of the human race to an ultimate perfection. He represents man as starting from the lowest stage of barbarism with no superiority over the other animals save that of bodily organization and as advancing uninterruptedly at a more or less rapid rate in the path of enlightenment, virtue and happiness.

The stages which the human race has already gone through, or, in other words, the great epochs of history, are regarded as nine in number. The first three can confessedly be described only conjecturally from general observations as to the development of the human faculties and from the analogies of savage life.

In the first epoch, men are united into hordes of hunters and fishers, who acknowledge in some degree public authority and the claims of family relationship and who make use of an articulate language.

In the second epoch—the pastoral state—property is introduced and along with it inequality of conditions and even slavery, but also leisure to cultivate intelligence, to invent some of the simpler arts and to acquire some of the more elementary truths of science.

In the third epoch—the agricultural state—as leisure and wealth are greater, labour better distributed and applied and the means of communication increased and extended, progress is still more rapid. With the invention of alphabetic writing the conjectural part of history closes, and the more or less authenticated part begins.

The fourth and fifth epochs are represented as corresponding to Greece and Rome. The middle ages are divided into two epochs, the former of which terminates with the crusades and the latter with the invention of printing. The eighth epoch extends from the invention of printing to the revolution in the method of philosophic thinking accomplished by Descartes. The ninth epoch begins with that great intellectual revolution and ends with the great political and moral revolution of 1789 and is illustrious, according to Condorcet, through the discovery of the true system of the physical universe by Sir Isaac Newton, of human nature by John Locke and the Abbé de Condillac, and of society by Turgot, Richard Price and Jean Jacques Rousseau.

There is an epoch of the future—a tenth epoch—and the most original part of Condorcet's treatise is that which is devoted to it. After insisting that general laws regulative of the past warrant general inferences as to the future, he argues that the three tendencies which the entire history of the past shows will be characteristic features of the future are: (1) the destruction of inequality between nations; (2) the destruction of inequality between classes; and (3) the improvement of individuals, the indefinite perfectibility of human nature itself—intellectually, morally and physically. The equality to which he represents nations and individuals as tending is not absolute equality but equality of freedom and of rights. Nations and men, he thinks, are equal if equally free and are all tending to equality because all are tending to freedom.

As to indefinite perfectibility, he nowhere denies that progress is conditioned both by the constitution of humanity and by the character of its surroundings. But he affirms that these conditions are compatible with endless progress and that the human mind can assign no fixed limits to its own advancement in knowledge and virtue or even to the prolongation of bodily life. This theory explains the importance that he attached to popular education, to which he looked for all sure progress. The book is notable for its intense aversion to all religion, especially Christianity, and to monarchy. Pervaded by a spirit of excessive hopefulness, it contains numerous errors of detail, due to the circumstances in which it was written. Its value lies in its general ideas. Condorcet's ethical position gives emphasis to the sympathetic impulses and social feelings and had considerable influence upon Auguste Comte.

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(H. B. A.; X.)

CONDOTTIERE (plural *condottieri*), an Italian term for the leader of the mercenary military companies, often several thousand strong, which were hired out to carry on the wars of the Italian states. The word is often extended so as to include the soldiers as well as the leader of a company.

The *condottieri* played a very important part in Italian history from the middle of the 13th to the middle of the 15th century. Because of the special political and military circumstances of medieval Italy, and in particular the wars of the Guelphs and Ghibellines, the *condottieri* and their leaders played a more conspicuous and important part in history than the "free companies" elsewhere. Among these circumstances the absence of a numerous feudal cavalry, the relative luxury of city life and the incapacity of city militia for wars of aggression were the most prominent.

From this it resulted that war was not merely the trade of the *condottiere* but also his monopoly, and he was thus able to obtain whatever terms he asked, whether money payments or political concessions. These companies were recruited from wandering mercenary bands and individuals of all nations, and from the ranks of the many armies of middle Europe which from time to time overran Italy.

Montreal d'Albarno, a gentleman of Provence, was the first to give them a definite form. A severe discipline and an elaborate organization were introduced within the company itself, while in their relations with the people the most barbaric licence was permitted. Montreal himself was put to death at Rome by Rienzi, and Conrad Lando succeeded to the command. The Grand Company, as it was called, soon numbered about 7,000 cavalry and 1,500 select infantry, and was for several years the terror of Italy. Its members seem to have been chiefly Germans. On the conclusion (1360) of the peace of Brétigny between England and France, Sir John Hawkwood led an army of English mercenaries, called the White Company, into Italy, where it took a prominent part in the confused wars of the next 30 years.

Toward the end of the century the Italians began to organize armies of the same description. This ended the reign of the purely mercenary company and began that of the seminational mercenary army which endured in Europe till replaced by the national standing army system.

The first company of importance raised on the new basis was that of St. George, originated by Alberigo, count of Barbiano, many of whose subordinates and pupils conquered principalities for themselves. Shortly after, the organization of these mercenary armies was carried to the highest perfection by Muzio Attendolo Sforza, *condottiere* in the service of Naples, who had been a peasant of the Romagna, and by his rival Brancaccio di Montone in the service of Florence. The army and the renown of Sforza were inherited by his son Francesco Sforza, who became duke of Milan (1450).

Less fortunate was another great *condottiere*, Carmagnola, who first served one of the Visconti and then conducted the wars of Venice against his former masters, but at last awoke the suspicion of the Venetian oligarchy and was put to death before the palace of St. Mark (1432). Toward the end of the 15th century, when the large cities had gradually swallowed up the small states and Italy itself was drawn into the general current of European politics and became the battlefield of powerful armies—French, Spanish and German—the *condottieri*, who proved unequal to the gendarmery of France and the improved Italian troops, disappeared.

The soldiers of the *condottieri* were almost entirely heavy armoured cavalry (men-at-arms). They had, at any rate before 1400, nothing in common with the people among whom they

fought, and their disorderly conduct and rapacity seem often to have exceeded that of other medieval armies. They were always ready to change sides at the prospect of higher pay. They were connected with each other by the interest of a common profession and by the possibility that the enemy of today might be the friend and fellow soldier of tomorrow. Further, a prisoner was always more valuable than a dead enemy. In consequence of all this their battles were often as bloodless as they were theatrical and skilful, and splendidly equipped armies were known to fight for hours with hardly the loss of a man.

CONDUCTING. In the musical context, conducting is the art of controlling a group of performers in the execution and interpretation of a musical composition, principally by means of silent and partially codified gestures.

These gestures indicate the rhythm and bar-shape (phrasing) of the music, the direction of the beat making immediately apparent to the musicians the number of pulses (beats) to the measure. These beats are normally given by a slender baton held in the conductor's right hand, the left being largely reserved for expression, nuances, entries of the different parts and other subtleties of interpretation. Some conductors, especially in the United States, have, however, developed a technique that dispenses with a baton. This has long been the more usual style in unaccompanied choral conducting where the fact that the number of different parts is limited (each singer, moreover, having a full score of the music) enables the conductor to dispense with many of the formalities of gesture that may be indispensable in a complicated orchestral texture.

Origins.—The art of conducting has been pursued in a highly specialized form only since the early 19th century, though its origins are undoubtedly of great antiquity. The earliest positive records of such external control are of the 15th-century custom within the Sistine choir in Rome of beating the pulse of the music with a roll of paper. This practice, whether with paper or with a lengthy pole or baton, seems to have continued and even to have been much abused to the point of becoming grossly audible during actual performance. By the time of Bach and Handel it had become established tradition, especially in Germany, that a composer be appointed to court or chapel who would not only write the music required but be personally in charge of all performances. The act of presiding would generally be carried out by the *Kapellmeister* seated at the organ or harpsichord. This custom was also widely accepted in other countries not only for resident but also for visiting musicians, and it was from the keyboard that Haydn directed the performances of his symphonies at the "Salomon" concerts in London in 1791 and 1794.

In Paris, with its particular requirements for the Opéra, the evolution of the conductor passed from the time thumpers to the concertmaster (or leader, as he has always been called in Great Britain), who controlled the proceedings as best he could from the first violin desk. This custom was also adopted in opera houses in Germany and Italy, though the leader might be responsible only for the orchestra, the singers coming under the jurisdiction of the *maestro al cembalo,* who would probably be seated in the midst of the orchestral musicians. Such divided control led on many occasions to confusion and doubtless precipitated the rise of the conductor who, alone among the performers, made no sound whatever and whose direction was necessary for the more complicated scores of the middle decades of the 19th century.

The Modern Conductor.—Johann Stamitz and Gasparo Spontini had already been responsible for a distinct improvement in the standard of performance. With composer-conductors from Berlioz, Weber and Spohr to Mendelssohn and Wagner following closely upon their heels, the musical scene was quickly transformed. If Berlioz may be regarded as the father figure of modern conducting, it is Wagner and the school of dominating personalities who followed his inspired example of imaginative gesture and control who are the first important conductors in the 20th-century sense of the term. Hans von Bülow, Hermann Levi, Hans Richter, Felix Mottl, Karl Muck and Felix Weingartner were the pioneers of a new tradition in the art of orchestral training to a degree of finesse and sensitivity hitherto undreamed of, and in the exercise of comprehensive direction vested in a single controller.

As the conductor found his power and prestige rising, so his opportunities grew for influencing the musical taste of the time, and even of changing the course of musical history. Mendelssohn's position of undisputed authority at the Gewandhaus in Leipzig enabled him to inaugurate a revival of the music of Bach, and conductors were also able to play an important part in the promotion and commissioning of contemporary compositions. In his earlier days as a resident German conductor, Richard Strauss did admirable work in the championing of music by his younger contemporaries such as Engelbert Humperdinck and Gustav Mahler. The concerts in Berlin promoted and conducted by Ferruccio Busoni at the beginning of the 20th century were of paramount importance in their presentation for the first time of works by Debussy, Bartók, Sibelius, Elgar, Delius and Nielsen. The name of Serge Koussevitzky stands as an example of enlightened autocracy in this respect during his term as conductor of the Boston Symphony orchestra, his patronage extending at one time to the creation of a publishing house bearing his name. Hermann Scherchen similarly inaugurated an edition devoted to the publication of contemporary music.

As the new standards set and made possible by the baton-wielding conductors influenced the course of musical composition, so in its turn the new music made the tasks of the conductor enormously more varied and specialized. Moreover, apart from the already wide difference of organization and control required in the opera house and the concert hall (the latter now entailing expert flexibility in following the freedom of the modern virtuoso soloist), new factors arose, born of the changes in musical life all over the world. Recording, radio technique, ballet, television opera, the fitting of music to films, and above all the wide variety of styles provided by the more extreme schools of modern composition on the one hand and the music of earlier periods on the other (the latter often entailing much scholarly research)—all these and other tasks of musical direction may enter the conductor's province, requiring specialized knowledge, a thorough understanding of the music and of those who are playing under him, and a highly developed stick technique.

During the years immediately preceding, and between, World Wars I and II the figure of the international conductor was exalted to a remarkable extent. This was in some measure due to the dynamic personalities of many of the men who rose to unprecedented heights in this most far-reaching and demanding of musical careers. Mahler and Arturo Toscanini, for example, became legends for their tyrannical demands in the relentless search for the highest artistic standards.

It was Toscanini who initiated the vogue for conducting from memory, an accomplishment which poor eyesight led him to develop. The undeniably impressive feat of handling a large body of performers in an intricate work entirely without a score has, however, since been exploited for its own sake. This is part of a tendency to throw a spotlight on the conductor as a glamorous figure per se, and considerable controversy has arisen as to the visual part played by the conductor in performance; that is to say, whether he should be demonstrative (thus portraying his reactions to the music to both orchestra and audience in a way which can, at best, enhance greatly the impact of the music) or extremely reserved in manner and gesture lest his antics interfere with the listener's enjoyment and reception.

One thing seems certain: there can be no return to a conductorless orchestra. The interaction upon each other of conductor and composer has been so great over more than a century that it is impossible to consider performances of the majority of the repertoire that are not controlled by a single mind. Even if the desirability of a unifying interpreter be not accepted, it is doubtful whether a performance without a central figure who knows intimately and can control the various parts of the score would be a practical possibility. The experiment has occasionally been tried, but has resulted only in the revival of the old role of the concertmaster.

Rehearsing is one of the most important facets of the conductor's job and, certainly as far as the performers are concerned,

the one in which he is most likely to reveal his true potential. Here he naturally does not maintain silence since he must issue instructions and explain and even imitate the effect he wishes produced.

It has often been justly said that the truly great conductors have been men of wide learning and culture. Yet these qualities may not suffice to command a tough body of orchestral players unless they are accompanied by a powerful personality that arouses respect and maintains discipline. This strikes at the root of the conductor's position. Occasionally child prodigies appear and impress orchestras and public alike with their knowledge and ability. Yet this is paradoxical since to lead a body of professional musicians in a performance of great music requires a maturity that can only be acquired through many years of learning and experience of the world. It is possible that the days of the "personality" conductor are numbered; but the position itself, complicated and influential as it is, seems indispensable.

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(N. R. D. M.)

CONDUCTIVITY, in heat, is the quantity of heat passing per second through a slab of unit cross-sectional area when the temperature gradient between the two faces is unity (*see* HEAT: *Conduction of Heat in Solids; Conduction in Gases and Liquids*). Electrical conductivity is the current or the quantity of electricity passing per second through a similar slab when the potential gradient is unity, and it is the reciprocal of the resistivity (*see* ELECTRICITY, CONDUCTION OF: *Conduction in Solids*). In sound the conductivity of the orifice or neck of a resonator is the ratio of the area to the length of the orifice (*see* SOUND). *See* also references under "Conductivity" in the Index volume.

CONDUCTUS, a term employed in the 12th and 13th centuries for a musical setting of a Latin metrical poem for one, two or three voices. It is applied (in the form *conductum* in the *Codex Calixtinus, c.* 1130) to pieces that accompanied the reader of a lesson as he walked to the lectern; and in liturgical plays at Sens (*Conductus ad tabulam* for the Carnival of the Ass) and Beauvais (*e.g., Conductus Danielis venientis ad Regem*), to pieces accompanying processions. In church use the term was soon transferred to the tropes of and substitutes for the *Benedicamus Domino* at the end of the offices, a genre of composition that flourished in the Notre Dame school of the late 12th and early 13th centuries. Unlike the medieval motet, which arose about 1225, the polyphonic conductus was an original composition not based on a pre-existing tenor and was composed with uniform rhythm in the parts, all of which sang the same text.

(F. L. HA.)

CONDUIT: *see* AQUEDUCT; CABLE, ELECTRIC.

CONDYLARTH, any of several small, primitive, hoofed mammals comprising the extinct order Condylarthra. *See* UNGULATE.

CONE, in botany, the reproductive structure, also called strobilus, characteristic of the pines and other conifers and the club-mosses and horsetails. *See* CONIFERS; HORSETAIL; LYCOPODIUM.

CONE, in its earliest geometric use, denoted the solid space swept over by a right triangle rotating about one side (altitude or axis, *a*), the other side (base, *r*) tracing out the circular base of the cone, and the hypotenuse (slant height, *s*) its curved surface, the vertex V of triangle and cone being the same (fig. 1).

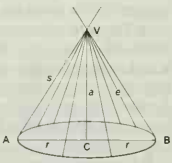

FIG. 1.—RIGHT-CIRCULAR CONE AND ITS ELEMENTS

Cones and Conics.—At first the size of the vertical angle of such a right-circular cone (twice that of the triangle) appeared important, and hence such cones were divided into three classes according to shape, and were named "acute-, right-, obtuse-angled." The natural position of a plane cutting through a cone seemed to be perpendicular to the slant height (*i.e.,* the hypotenuse or generatrix in any position, called also an element, *e,* of the surface). It is said that Menaechmus (*c.* 350 B.C.), in striving to construct the so-called double mean proportional, $a:x = x:y = y:b$, differentiated between three corresponding types of conic sections, afterward named, respectively, ellipse, parabola and hyperbola. It was the "great geometer," Apollonius, born at Perga in Pamphylia (fl. *c.* 225 B.C.), student in the Euclid school of Alexandria, who perceived and showed that the type of cone was indifferent. Apollonius proved that any plane section of any circular cone, parallel to an element, yielded a parabola, and that other sections yielded either an ellipse or hyperbola.

Volume and Area.—The conception of a cone as a solid called for the measurement of its volume, a fact enunciated first by the philosopher Democritus (5th–4th century B.C.), proved by Eudoxus of Cnidus (*c.* 400–*c.* 347 B.C.), and later completed by Archimedes (287–212 B.C.), who showed that a cone, hemisphere and cylinder, all of the same base and height (fig. 2) have volumes respectively as 1, 2, 3—a relation holding for any type of cone and cylinder. If they have equal bases and heights, the volume of the cone is one-third that of the cylinder, which is the product of base and height. It is clear that the curved surface of a right-circular cone may be thought of as being slit all along any element and then flattened out on a plane (tangent along the opposite element) into a circular sector; hence the curved surface equals in area the sector area; *i.e.,* the half-product of base-circumference as arc and slant height as radius.

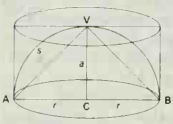

FIG. 2.—RELATION OF CONE, CYLINDER AND HEMISPHERE

Equation.—In analytic geometry the equation of the right-circular cone traced by rotating the line $y = mx$ around the y axis is $y^2 = m^2(x^2 + z^2)$. This simply means that, as any point P (of the line) rotates around the y axis, its y-co-ordinate remains unchanged, as does its distance $\sqrt{x^2 + z^2}$ from the y axis, and the fixed ratio of these two lengths is m.

Oblique Cone.—The circular cone was defined by Apollonius more generally as the surface (or its enclosed volume) traced by a right line passing through a fixed point (vertex) and gliding along a fixed circle. The perpendicular line through this vertex and the centre of this circle is the axis; if this axis is at right angles to the base (the plane of the circle), the cone is right; otherwise, it is oblique, in which case the vertical angle is not of constant size. Any plane containing the axis cuts the solid in such a vertical angle, and the surface in its sides (elements of the cone). The plane that contains the axis and is perpendicular to the base of the cone forms the "principal section"; any plane perpendicular to it and inclined equally but inversely (with the base) to the generator-elements is called a "subcontrary section." This section cuts the cone in a circle, as do all planes parallel to it or to the base; all such planes are called "cyclic planes" (fig. 3).

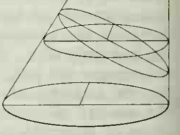
FIG. 3.—CYCLIC PLANES

The Cone as a Surface.—It was natural to regard and define the solid first rather than the bounding curved surface, and hence the early Greek achievements were largely in stereometry. It was only very gradually that it came to be felt that the surface alone possessed peculiar properties, the enclosed space being indifferent. There resulted a change in definition and treatment from three to two dimensions. From this new point of view the cone concept underwent a broad generalization, the term now designating any path of (or surface traced by) a straight line (the generatrix, *g*) that passes always through a fixed point V. This path, to be definite, is directed by some curve (the directrix, D), along which the line always glides (fig. 4). Thus, in the right-circular cone of

fig. 1, D is the circle bounding the cone's base, the track of the moving end of the hypotenuse (s). In the oblique circular cone, D is still a circle, but is no longer traced by one certain point of the line g. If D is a conic (*e.g.*, an ellipse) the surface is called a "quadric cone." If a fixed direction (or line called the axis) is assumed as passing through the fixed vertex V, the motion of the tracing line g might be directed by ordered variation in the vertical angle α between the fixed and the moving line. In the most important case, the right-circular cone, this variation is the simplest possible: the vertical angle is constant; the two lines are rigidly joined at V; and the generatrix swings freely around the axis (which may be thought of as turning in itself).

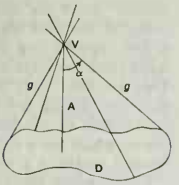

FIG. 4.—CONE AS A SURFACE DESCRIPTION

Tangency.—Such seems to be the simplest and most vivid conception of the right-circular cone; the two halves meeting at V and extending oppositely without end are called nappes or sheets. If slit throughout along an element, and rolled out (developed) on the plane tangent along the opposite element, the nappes would appear as centrally symmetric sectors of an infinite circle about V as centre. Any plane tangent to a cone passes through V and touches the cone along some element throughout. All such planes would touch the whole cone surface and would envelop it completely. The tangent plane at any given point of the surface (except V) is quite definite, but at V this definiteness disappears. All tangent planes pass alike through V.

Intersection.—The phenomenon of the intersection of a cone with other surfaces belongs to constructive geometry, where it is developed and applied. Its importance may be presumed from the fact that central projection is conelike, the lines of projection issuing like rays of light from a point, the vertex of the cone. An interesting special case is the spheroconic, the intersection of any quadric cone with a sphere about the vertex of the cone as centre.

Truncation.—In measurement, the word frustum (fig. 5) is encountered, especially in connection with the right-circular cone. Frustum, meaning piece, denotes a truncated cone, or the portion of a cone (viewed as a solid) between the base and a cutting plane generally parallel thereto. The problem of computation was apparently first proposed with respect to truncated pyramids, in Egypt. Indeed, one of the earliest extant computations of volume is Egyptian and relates to such a figure. Much later, in the *Stereometrica* of the encyclopaedic Hero of Alexandria (*c.* A.D. 50? or as late as A.D. 200?), the volume is calculated for a pyramid frustum on a square base (100), with the top section a square (4) and the oblique edge 9; the height is found to be 7, which, when multiplied by $\left[\left(\frac{10+2}{2}\right)^2+\frac{1}{3}\left(\frac{10-2}{2}\right)^2\right]$, gives $289\frac{1}{3}$. This is a correct result as may be seen by the now well-known rule or formula, viz., one-third the product of height by the sum of the bases and their geometric mean. But in a second example the sides of the square (base and top) are given as 28 and 4, and the slant edge as 15, which is impossible, since even the projection of any such slant on the base plane would be $\sqrt{12^2+12^2}$ or $\sqrt{288}$, which is more than $15=\sqrt{225}$. Accordingly, the reckoner, in applying his method, of which the foregoing rule is the resultant formula, meets with $\sqrt{-63}$, which he treats as $\sqrt{63}$. Whether or not this is the work of Hero, it is notable as the oldest-known appearance of the so-called "imaginary," the square root of a negative number. The rule or formula used above holds for all such frustums of cones and pyramids. It was used much later by the leading Hindu mathematician Brahmagupta (*c.* 628) in his *Brahma-sphuta-siddhanta*. The surface area of such a frustum is plainly the difference between the areas of two circular sectors (AVB and FVR) of the same angle and centre, into which the cone and the top could be rolled out on a tangent plane (fig. 5). Hero recommends similar practical methods for measuring other surfaces, such as wrapping the solid in a thin cover and then spreading this out.

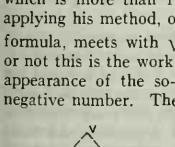

FIG. 5.—SURFACE OF A FRUSTUM

If the vertex of the right-circular cone retires indefinitely along the axis, the cone passes over into a cylinder (*q.v.*) or cylindric surface, and the frustum becomes an ordinary (right-circular) cylinder, its volume the product of base and altitude, and its curved surface area the product of the circle of the base by the altitude. This limiting case of the cone frustum is of course much simpler than the general case. *See* also ANALYTIC GEOMETRY; CONIC SECTION; SURFACE. (W. B. SM.)

CONEFLOWER, the popular name given in North America to species of *Rudbeckia* and other closely related genera of the family Compositae, many of which are cultivated as ornamentals. The large, solitary flower heads, often four inches or more across, consist of a cone-shaped central portion of disk florets surrounded by numerous brightly coloured ray florets. A striking example is the purple coneflower (*Echinacea purpurea*), called also red sunflower and black sampson, native to the central United States. It is a coarse, stout perennial herb, two feet to five feet high, bearing lance-shaped leaves and long leafless flower stalks each ending in a single head, sometimes five inches across, with a purplish centre and purple or crimson rays. *Rudbeckia californica* of the western U.S. is a rough-hairy, unbranched perennial, its solitary, yellow flower heads nearly five inches across. Cultivated species are easily grown in any garden soil in full sunlight. *See* BLACK-EYED SUSAN; GOLDEN GLOW. (N. TR.)

JOHN H. GERARD
PURPLE CONEFLOWER (ECHINACEA PURPUREA)

CONEGLIANO, a town in the Treviso province of the Veneto region, Italy, is near the Piave river, 26 km. (16 mi.) N. of Treviso by road. Pop. (1957 est.) 20,405 (commune). Conegliano is situated on a hillside and dominated by a large castle; there is much new building along the old perimeter of the town. It was the birthplace of the painter Giovanni Battista Cima; a fine altarpiece by him is in the cathedral (1493). A railway runs to Treviso, Vittorio Veneto and Udine. The town is noted for its wines and for its Venetian cooking and a national school of viticulture is located there. In World War I Conegliano was in Austrian hands from Nov. 1917 to Oct. 1918.

CONESTOGA, an extinct tribe of North American Indians of Iroquoian stock. Their country was Pennsylvania and Maryland on the lower Susquehanna river and at the head of Chesapeake bay. They were sometimes known as the Susquehanna. *See* also IROQUOIS.

CONEY ISLAND, a popular seaside resort in the southern part of the borough of Brooklyn, New York city. It was formerly an island separated from the mainland by Gravesend bay, Sheepshead bay, Coney Island creek and a broad stretch of salt marshes much of which has been filled in, so that the area is actually no longer an island. Coney Island, about 5 mi. in length and from $\frac{1}{4}$ mi. to 1 mi. in width, is the westernmost of a chain of outlying sandbars that extend along the southern shore of Long Island for about 100 mi. It can be reached by subway, parkways and boat.

Coney Island is one of the best known amusement resorts in the U.S. and frequently during the hot summer days over 1,000,000 people jam its sandy beaches and amusement parks. The bathing beaches stretch for $2\frac{1}{2}$ mi. and are bordered by an 80-ft.-wide boardwalk. To accommodate the huge crowds large parking areas and municipally owned bathing facilities have been constructed. Several amusement centres have been developed with carousels, exhibitions, dancing, concerts, freak shows, roller coasters, penny arcades, assorted game booths, Ferris wheels, shooting galleries,

souvenir shops and hundreds of eating places.

Coney Island is also a popular all-year residential community. At the extreme western end is the district known as Sea Gate, an exclusive residential section which became an all-year community with the natural influx of summer residents. A $123,000,000 housing project occupies the site of Luna park. In 1956 the Brooklyn Public library opened a new branch on Mermaid avenue. An aquarium, under the administration of the New York Zoological society, was built at Coney Island in the late 1950s. (D. L. D.)

CONFECTIONERY MANUFACTURE. For centuries man has devoted time and effort to perfecting the skills of confectionery manufacture, the art of properly blending various agricultural products into an attractive, palatable food known as candy. Written and pictorial records of candy were left by the Egyptians and from these it is learned that early candymakers used honey as a sweetener, sugar being unknown, and added figs, dates, nuts and spices. The sweets were shaped in rough, crudely shaped molds and were highly coloured to attract attention.

There is little reference to the manufacturing of candy until about the middle of the 14th century, when sugar shipped into Venice was used for making confections. It was not until the cultivation of sugar cane spread throughout the world and the refining of sugar was developed that the confectionery industry began to grow. Prior to this time, a confection was an item sold or dispensed only by pharmacists and spice stores. By the 16th century confectioners were making many kinds of sweetmeats and candy by molding sugar, nuts and fruits of various kinds into fanciful forms. In those days, only hand methods were employed. The few utensils and appliances used were primitive and crude. They were used principally in cooking or boiling the sugar and molding or shaping the candies. Not until the latter part of the 18th century was there any notable development in the invention of candy machinery. The 20th century saw the development of confectionery manufacture to a world-wide annual production totaling thousands of millions of pounds.

Candy Ingredients.—More than 77 agricultural products are used in making candy; they include sugar, corn products, chocolate, eggs, fruits, nuts, butter, milk and cream. The main ingredients used for manufacturing candy are cane and beet sugars combined with other carbohydrate foods such as corn sirup, corn sugar, cornstarch, honey, molasses and maple sugar. To the sweet base are added chocolate, fruits, nuts and peanuts, eggs, milk products, flavours and colours. In food value, candy is a concentrated source of food energy; milk, fruits and nuts, where used, supply additional nutritive value.

Classifications of Candy.—There are more than 2,000 different kinds of candy, but these all fall into a few general classes.

Hard Candy.—The simplest forms of candy are the hard candies, made mainly from sugar and corn sirup and characterized by their hard brittle texture. The ingredients are cooked to a practically moisture-free candy sirup, which is flavoured, coloured and formed into various shapes. Typical hard candies are lemon drops and the various intricately designed solid and filled Christmas candies. After-dinner mints, peanut brittle and taffy are considered hard candies.

Lozenges.—Lozenges and pressed tablets are made from powdered sugar with flavours, colours, natural gums and gelatin added. These ingredients are kneaded into a dough that is compressed and stamped by machine.

Caramel and Toffee.—Caramels depend on large amounts of milk for their typical texture. The other ingredients are sugar, corn sirup and fat, which are cooked until the desired degrees of caramelization and texture have been attained. The most popular flavours are vanilla and chocolate. Toffee is highly cooked or hard caramel.

Cream or Fondant Candies and Fudges.—Cream or fondant candies are made by kneading the cooled mass of a highly cooked sirup that consists principally of sugar with a small amount of corn sirup. Fruits, nuts, flavours and colours are added to make the variety of creams found in boxed chocolates. When the fondant cream has been prepared, it is extruded through a die and cut to the desired size, or it is molded in starch by the following process: trays are filled with food starch, then imprinted with molds of whatever shape is desired. Fondant cream is deposited in the imprints and allowed to set. When set, the centres are taken from the trays and cleaned of any starch that might adhere. They are then ready for dipping, crystallizing or glazing. Candy corn seen during the Halloween season is typical of the glazed hard cream or fondant candy. Another variety is the French cream, which has a sugar-crystal jacket formed by immersing the fondant centre in a saturated sugar solution.

Fudge, which contains milk, cream and edible fats in addition to sugar and corn sirup, is characterized by its smooth creamy texture. Flavours, colours, nuts, peanuts, fruit and chocolate are added to give variety.

Candy Jellies or Gums.—Candy jellies or gums are made with sugar, corn sirup and a jellying agent such as starch, pectin, natural gums or gelatin. They are characterized by their jellylike consistency, varying from a soft and tender to a hard gummy texture. Candy orange slices or soft gumdrops are typical of the soft-textured starch jelly, while the familiar jujube is an example of the hard-textured gum.

Marshmallows.—This familiar confection is made by whipping a combination of sugar, corn sirup, gelatin or egg whites or both, and flavours. It is characterized by its light, fluffy texture. The soft tender form is the popular sugar-dusted, white marshmallow, and the grained types are the circus peanuts, marshmallow bananas and the panned marshmallow eggs seen at Eastertime. Marshmallow candies are cast in starch in the same way as creams or some varieties are extruded and cut to size.

Nougats.—Nougats are aerated chewy candies made by adding a highly cooked candy sirup (made with sugar and corn sirup) to a frappé or whip, which is formed by whipping a solution of egg whites or gelatin or both. Vegetable fats are added to impart chewiness, and variety is given by adding fruits, nuts, honey and the like.

Licorice.—Licorice candies are made with flour, molasses, sugar and corn sirup and flavoured with licorice extract.

Chocolate.—The common chocolate coatings are bittersweet chocolate, sweet chocolate, milk chocolate, skim milk and buttermilk chocolate and imitation chocolate (summer coatings). These chocolates are used for coating other candies and also for manufacturing bars, plain chocolate and with a mixture of peanuts and other nut meats. Coatings are made by grinding roasted cocoa beans with sugars, cocoa butter, dried powdered-milk products and flavours to give the smooth texture associated with chocolates. (*See* Cocoa: *Manufacture and Uses.*)

Coated Candies.—Coated candies are usually a combination of one of the above basic candies and a special coating of chocolate, fondant, icing, coconut or nuts. Packaged chocolates are composed of a variety of types of chocolate-coated candies.

Coated candies that have a hard, glossy jacket are called panned candies and may be either sugar-coated or chocolate-coated. Sugar-coated panned candies, which are typified by jelly beans, Jordan almonds and French burnt peanuts, are produced by placing centres and a specific amount of sugar sirup in huge revolving pans similar in shape to barrels. Coating and polishing are accomplished by the continuous revolving action of the pans. Chocolate-panned caramels, nuts and peanuts, raisins and malted-milk balls are coated in the same manner by substituting a chocolate coating for the sugar sirup.

Candy Bars.—Because of their tremendous popularity, candy bars require a separate classification and can be defined as individually wrapped candies usually selling in the U.S. for five and ten cents. The three most popular types are (1) plain chocolate with or without nuts; (2) chocolate-coated simple and compound centres such as nut rolls (fudge centre rolled in caramel and nuts, then chocolate-coated), nougat-caramel combination and hard candy-peanut butter combination and (3) nonchocolate-coated (solid nut bars, caramel, toffee, fudges, etc.). The possible combinations for candy bars are practically endless.

Specialties.—These, some classifiable under headings given above, are of interest though representing a small percentage of candy manufactured. They include cotton candy or spun sugar,

popular with children at circuses and amusement parks; "message" candies, which are lozenges pressed in heart and flower shapes with messages printed on them; candies simulating other food items, such as bacon and eggs; in the Rocky mountain area, candies simulating pebbles; pecan pralines, common particularly in the southern U.S.; and cinnamon drops or hearts, sometimes called a specialty but regarded by some as a standard household item for decorating cakes and flavouring baked apples.

(*See* also CHEWING GUM.)

The Industry in the U.S.—The U.S. department of commerce, with financial support from the National Confectioners association, publishes an annual report entitled "Confectionery Sales and Distribution" that gives statistics covering more than 90% of the industry excluding chewing gum. By the end of the 1950s this report showed annual sales values (at the manufacturers' level) of $1,150,000,000, the highest recorded up to that time. Per capita consumption in the U.S. reached a high of 20.5 lb. during 1944 as a result of government purchases for military rations and resale. Consumption fell to a low of 15.5 lb. in 1955 and rose continuously to 16.8 lb. at the start of the 1960s. The mass producers of candy (manufacturers-wholesalers) are concentrated in five states. On a weight basis Illinois produced 39.3%, New York and New Jersey 17.7%, Pennsylvania 8.9% and California 4.8%, for a total of 70.7%. Types of candy produced on a quantity basis were chocolate-coated bars 14.8%, other bars 17.1%, other five- and ten-cent specialties 9.6%, package goods retailing above 50 cents per pound 13.4%, less than 50 cents per pound 23.1% and bulk goods 21.0%.

Sales Outlets.—Confectionery manufacturers in the early 1960s made their products available to the consumer in more retail outlets than did producers of any other food. Confectionery was available through vending machines located in many convenient places including industrial plants, newsstands, and in several hundred thousand food stores, department stores and candy stores. An estimated 20% to 30% of sales was through grocery stores.

For information about homemade candies *see* FOOD PREPARATION: *Confections.*

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CONFEDERATE STATES OF AMERICA, the name of the independent government formed by the southern states that seceded from the Union in 1860 and the early part of 1861. (*See* also AMERICAN CIVIL WAR; SOUTH, THE; UNITED STATES [OF AMERICA]: *History.*) For a quarter of a century before 1860 there had been developing a steadily increasing bitterness between the northern and southern sections of the United States, growing out of economic, social and political differences; and out of these differences there had arisen a disagreement on the meaning of important parts of the federal constitution. The South was largely an agricultural region producing cotton, sugar and tobacco; the North, though also an agricultural section, had developed more along industrial and commercial lines than had the South. From the settlement of the colonies, slavery had been an important factor in the development of agriculture in the South and with the increase of the Negro population it had come to be looked upon by slaveholders as well as nonslaveholders as a method of solving the race problem. After the American Revolution, the North gave up slavery as uneconomical, and by the 1830s a movement had sprung up there to abolish slavery in the South. (*See* ABOLITION MOVEMENT.) This opposition to slavery lay at the bottom of the sectional bitterness. The protective tariff also entered into the disputes, for it aided northern industries, increased the prices paid by southerners for goods they purchased and yet gave no protection to the South's agricultural products. As a move toward suppressing slavery, the North sought to prevent its spread into the territories, while the South declared it had a constitutional right to take its slaves there.

Secession.—The sectional dispute came to head in 1860 when Abraham Lincoln was elected president. The southern states held that both Lincoln and the Republican party threatened their constitutional rights in the Union, their social institutions and way of life and their economic existence. For a decade and more, important southern leaders had argued that secession might be their only protection; and the time for it seemed to be at hand. South Carolina began the process by withdrawing from the Union on Dec. 20, 1860. The movement quickly spread to Georgia and the states bordering on the Gulf of Mexico, and before the end of Jan. 1861 all had seceded except Texas, which withdrew on Feb. 1. The other slave states in the upper South and on the border were greatly agitated but they hesitated to secede for the time. But when on April 12, 1861, the southerners fired on Ft. Sumter, in Charleston harbour, and when war seemed evident by President Lincoln's call on the states then in the Union for troops to enforce the laws of the land, another wave of secession was set going. During April and May all of the states of the upper South withdrew, Virginia (April 17), Arkansas (May 6), Tennessee (May 7) and North Carolina (May 20). The border slave states became greatly excited, and there were strong secession movements in Maryland, Kentucky and Missouri. In Kentucky a meeting of delegates declared that state out of the Union, and in Missouri a fragment of the legislature passed a secession ordinance. The Confederacy admitted Kentucky and Missouri as states to make up the magical 13, but the action of both states was irregular. The other 11 states that composed the Confederacy had all been carried out of the Union by conventions elected by the people, except Tennessee, where the full legislature acted. And all except Tennessee had asserted their constitutional right to secede; Tennessee based its withdrawal on the right of revolution.

Confederate States Government Organized.—For many years some southerners had dreamed of a southern nation, and with six states in secession, they decided to bind these states into a new nation. It was necessary to make haste without waiting for the upper South to follow, for Abraham Lincoln would be inaugurated on March 4, 1861, and it was feared that he might take stern action immediately. So it was arranged for delegates from these six states (to be joined later by those from Texas) to meet in Montgomery, Ala., on Feb. 4. This convention, presided over by Howell Cobb of Georgia, immediately began to frame a document setting up the new government. Four days later it adopted unanimously the provisional constitution of the Confederate States of America, which was to serve until a permanent constitution could be written. This document was rudimentary, and its chief purpose was to provide the framework of a central government. It called for a president and a vice-president to be elected by the states (each state having one vote); a supreme court composed of the district judges; a congress of one house (the existing convention to continue as that body); the capital to be at Montgomery until congress should change it; and the government thus established to continue for only one year. The leaders were anxious that there should appear to be no factions in this convention. After various conferences they chose Jefferson Davis (*q.v.*) of Mississippi for president and Alexander H. Stephens (*q.v.*) of Georgia for vice-president. Davis, who was not a member of the convention and who had no desire for the presidency, set out immediately from his Mississippi home and was inaugurated on Feb. 18, after a grand procession with a band playing "Dixie" marched up the hill to the Alabama state capitol.

In selecting his cabinet, President Davis was careful to see that all of the seven states (except Mississippi, which held the presidency) were recognized. Christopher G. Memminger of South Carolina became secretary of the treasury; Robert Toombs of Georgia, secretary of state; Stephen R. Mallory of Florida, secretary of the navy; Leroy P. Walker of Alabama, secretary of war; Judah P. Benjamin of Louisiana, attorney general; and John H. Reagan of Texas, postmaster general. During the four years of the Confederacy, there were various changes in the personnel of the cabinet; but three served throughout the whole period. Benjamin, one of the ablest men in the Confederacy, was first transferred to the war department and finally to the state department; Mallory, who was bitterly criticized during the war and for

years afterward but came to be recognized as an able administrator, continued in the navy department; and Reagan, a stanch supporter of Davis, administered the post office throughout the war. President Davis was probably the best selection the Confederates could have made, despite the fact that he was ill much of the time, had the use of only one eye, and seemed to lack that warmth of character and approach which would have made him much more popular. Stephens was soon to become an outspoken critic of Davis and of many Confederate policies.

The convention, which was the congress under the provisional constitution, when not busy providing for the needs of the new government, turned its attention to framing the permanent constitution. On March 11 its work was completed when it adopted the document by a unanimous vote. The proposed constitution was then submitted to the states that had seceded and all of them ratified it. This constitution throughout its framework was a modified copy of the constitution of the United States, for the southerners had time and again insisted that they had no quarrel with that document. Their objection was to the way the North was interpreting it. But there were important additions and clarifications that made it one of the most interesting documents in U.S. history. The president and vice-president were to serve for a term of six years and be ineligible for re-election; the president might veto separate items in appropriation bills; with the consent of congress, cabinet members might have seats on the floor of either house; a budget system was adopted, and congress was not authorized to increase items in a budget except by a two-thirds majority; after the first two years the post office department was required to be self-sustaining; the foreign slave trade was prohibited; and no law could relate to more than one subject. By way of clarification, congress was forbidden to foster any industry by a protective tariff, appropriate money for internal improvements or limit the right to take slaves into a territory. Although there was a provision for a supreme court, congress never set one up, largely through fear of the power it might assume, reminiscent of the record of the U.S. supreme court.

The love of the old Union was reflected not only in copying the federal constitution but also in the search for a flag. The congressional committee appointed to design a flag received many suggestions for a modification of the Stars and Stripes and even to take over the flag itself. The result was the Stars and Bars, which continued the red, white and blue colours but had only three stripes; the field was blue with 7 white stars. However, this was enough to confuse it with the United States flag. Confederate troops at the first battle of Bull Run had difficulty, in the heat and dust of battle, in distinguishing their own reinforcements from those of the enemy. To prevent a repetition of this a new banner, the Battle Flag was designed, its red field crossed diagonally by a blue cross with 13 white stars. Despite its wide use, however, this famous flag was never officially adopted. In May 1863 the Confederate congress adopted a second national flag, known as the Stainless Banner. It was pure white with the Battle Flag in the left corner. Because this flag, when hanging limp, looked too much like a flag of truce, the Confederate congress on March 4, 1865, changed it by placing a broad red bar across its end. This was the last flag of the Confederacy. (For the succession of flags, *see* illustration.) (*See* also FLAG.)

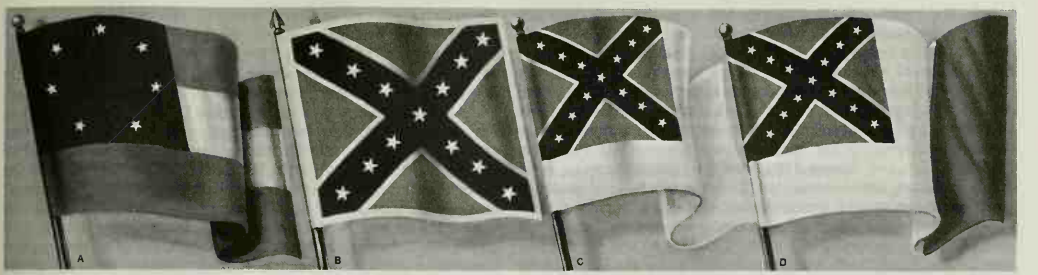
For the designs on its stamps the post office department selected national heroes, such as Jefferson, Jackson and Calhoun, but not Washington, whose portrait was at that time on a United States stamp. Very soon the Confederacy began a system that was unique in American history: it used the picture of a living person on its stamps—Pres. Jefferson Davis. The letter rate soon came to be ten cents per ounce—twice the rate in the North.

In Nov. 1861, as provided by the permanent constitution, elections for president, vice-president and members of congress were held throughout the Confederacy. Davis and Stephens, who had been serving provisionally up to this time, were elected to full six-year terms, and a congress of two houses was chosen for the first time. In the meantime the convention had changed the capital city from Montgomery to Richmond, Va., and the government had moved there during the summer. The second inauguration took place in the Virginia capital on Feb. 22, 1862, on a bleak, cold, rainy day—a sombre occasion as the president looked out on a sea of black umbrellas and read his address. It was a great contrast to the balmy day in Alabama when he was first inaugurated. Already the superstitious were thinking that here was a harbinger of dark days ahead.

Ft. Sumter.—On assuming office President Lincoln had declared that states could not secede, that the Confederate states were not actually out of the Union and that he would enforce the laws everywhere. His first problem was to hold the forts in the Confederacy which that new government had not already seized. Ft. Sumter was the most troublesome and the most explosive, for the Confederacy held that it was unthinkable that one of its forts should be occupied by a foreign country. It immediately attempted to open negotiations in Washington but President Lincoln would not receive the Confederate emissaries. The Confederate military forces fired on the fort and after suffering a bombardment of more than a day it surrendered on April 13. This was war, and both parties began to make preparations to carry it on effectively.

Raising Troops.—Immediately after its organization the Confederacy had made preparations to raise, organize and equip an army, although it hoped (and many of its leaders believed) that it would not have to fight to maintain its independence. After the fall of Ft. Sumter and Lincoln's call for troops, the Confederacy speeded up its preparations for defending itself. Originally it had expected its armies to be made up of troops offered by the states, for at that time the general feeling prevailed that the Confederacy was little more than a combination of "sovereign" states; but after Ft. Sumter, congress gave President Davis the right to accept troops through direct volunteering and fixed the number at 400,000. Great enthusiasm prevailed everywhere and soon the Confederacy had more troops than it could equip; some were even sent back home. But before the end of the year 1861, the war had exploded into far-flung battlefields, from Virginia to Missouri and along 3,500 mi. of coast line. Additional laws were passed for raising troops, but less than a year after war had begun the Confederacy found that it needed more troops than were coming forward. With the passing of a law in April 1862 that established a system of conscription (*q.v.*), the Confederacy embarked on a policy which the United States government had not yet attempted. All male citizens between the ages of 18 and 35 were declared to be in the Confederate army unless they were exempted for physical reasons or were needed in civilian capacities to provide for the armies or maintain the general welfare. There were a great many industrial exemptions as well as the exemption of teachers, preachers, hospital workers and others in similar occupations. By later legislation the age limits were extended from 17 to 50 and the number of exemptions was greatly reduced. Finally, before the end of the war, the system of exemptions was abandoned, and the president was given the task of "detailing" persons for necessary civilian work. No accurate records of the total number of Confederate soldiers survived the war, but careful estimates suggest about 750,000. They fought against about twice that number of Federal troops.

Disappointed in their hopes of peaceable separation, the Confederates were prepared to defend themselves, despite their great disparity of men and resources. The 11 Confederate states had a white population of about 5,500,000. There were about 3,500,000 slaves and 130,000 free Negroes. Remaining under the federal government were about 22,000,000 people. In industrial resources, the Confederacy was far inferior to the United States. It had only about 9,000 mi. of railroads as compared with 22,000 mi. in the North. But President Davis in his two inaugural addresses, in his messages to congress and in many proclamations and public addresses built up the enthusiasm of the people and steeled their hearts to win the war. The race, he asserted, was not to the swift, nor the battle to the strong; the will to win would in the long run bring victory. In his second inaugural address he said: "True to our traditions of peace and our love of justice, we sent commissioners to the United States to propose a fair and amicable settlement of all questions of public debt or property



(A) FIRST FLAG OF THE CONFEDERATE STATES OF AMERICA, THE STARS AND BARS, MARCH 4, 1861, CONSISTING OF A HORIZONTAL WHITE BAR BETWEEN TWO RED BARS, AND A CANTON OF 7 WHITE STARS ON A BLUE FIELD; (B) BATTLE FLAG, A WHITE-BORDERED RED FIELD, USUALLY SQUARE, WITH 13 WHITE STARS ON THE DIAGONAL ARMS OF A WHITE-EDGED BLUE CROSS; (C) STAINLESS BANNER, MAY 1, 1863, A PURE WHITE FIELD WITH THE BATTLE FLAG IN THE CANTON; (D) LAST FLAG, MARCH 4, 1865, THE STAINLESS BANNER WITH A BROAD RED VERTICAL BAR AT THE OUTER EDGE

which might be in dispute. But the government at Washington, denying our right to self-government, refused even to listen to any proposals for a peaceable separation. Nothing was then left to do but to prepare for war."

President Davis, who had been an officer in the Mexican War and later U.S. secretary of war, was active in dictating military policy and major strategy of the Confederacy. With a few exceptions he tenaciously clung to a policy of defense instead of taking the offensive and carrying the war into the North. Failing to give due recognition to the importance of the military frontiers across the Appalachian mountains and beyond the Mississippi river, Confederate military policy held that Richmond must be defended to the utmost and that the war would be won or lost in Virginia. Also there was a feeling among some Confederate military leaders that early in the war not enough attention was being given to the development of the cavalry, which might have been used to invade the North and bring the war to a close.

The initial strength of the Confederacy lay not only in the fighting qualities of its common soldiers, who had the feeling that they were defending their homes from the despoilers, but also in the ability of its officers, many of whom had resigned from the U.S. army to join the Confederacy. There was a tower of strength in Robert E. Lee after he became commander of the army of northern Virginia in 1862. Thomas J. ("Stonewall") Jackson was his most able lieutenant until his death the next year at the battle of Chancellorsville. James Ewell Brown ("Jeb") Stuart, mortally wounded at Yellow Tavern in 1864, was a cavalry leader par excellence. Nathan Bedford Forrest, as daring and resourceful a cavalryman as fought in the war, was discovered too late to greatly affect Confederate prospects of ultimate victory. Albert Sidney Johnston, killed early in the war at Shiloh, did not live long enough to contribute much of his ability as an outstanding soldier. Joseph E. Johnston and Pierre G. T. Beauregard were able leaders but wasted some of their time and enthusiasm in disagreements with President Davis.

Losses of Confederate soldiers resulted not only from their deaths on the battlefield and in hospitals but also from desertion and capture. A system for exchanging prisoners of war was soon abandoned because of disagreement between Confederate and Federal commissioners, and it became the task of each belligerent to set up prison camps. The principal camps in the North were Elmira, Camp Chase, Johnson's Island, Camp Douglas, Point Lookout, Delaware and Rock Island. The Confederates, much less able to take care of prisoners, established camps at Richmond (Libby and Belle Island); Salisbury, N.C.; Florence and Columbia, S.C.; Millen, Macon and Andersonville, Ga.; and at other places. Andersonville became notorious for the large number of deaths that took place there. The Confederate government sought frequently but unsuccessfully to reinstitute an exchange of prisoners, and offered to accept and administer any medical aid that the federal government might give; but this offer was rejected. The Confederacy cited these facts and also the large number of Confederate deaths in northern prisons in defending itself against northern charges of barbarous conditions in southern prisons.

Financial Affairs.—The Confederacy began its existence with an empty treasury. To tide it over its first few days, the state of Alabama loaned it $500,000. It soon seized a few hundred thousand dollars in the customhouses and almost $400,000 in the New Orleans mint. But the Confederacy needed to set up a system to provide steady income. At first, thinking that there would be no war or at most a short one, the Confederate government resorted to printing money and issuing bonds. This method was less painful, more popular and even more logical than taxation, for it was argued that if a complicated system of wartime taxation were set up it might have to be abandoned very soon. An act of March 9, 1861, provided for the issuance of not more than $1,000,000 of paper money in denominations of not less than $50. This act was soon followed by other laws providing for smaller denominations and in amounts that reached almost astronomical proportions. Throughout the war about $1,500,000,000 was issued; and although at times the amount in circulation was somewhat reduced by being absorbed in payment for bonds, still Secretary Memminger (against whose recommendations this money was being printed) could say at various times that the amount in circulation was five times beyond the country's needs. As the currency increased, prices became fantastic. Near the end of the war a soldier could not have bought a pair of shoes with all the pay he would have received if he had enlisted at the firing on Ft. Sumter and had remained continuously in the service thereafter. At the end of the war a soldier wrote an apostrophe to a Confederate note on the back of one, in four stanzas, of which this is the first:

Representing nothing on God's earth now,
And naught in the waters below it,
As the pledge of a nation that passed away,
Keep it, dear friend, and show it.
Show it to those who will lend an ear
To the tale this paper will tell,
Of liberty born of a patriot's dream,
Of a storm-cradled nation that fell.

The Confederacy's record of bond issues was as reckless as its orgy in printing notes. Its first bond issue was provided for in an act of Feb. 28, 1861, that allowed the president to borrow not more than $15,000,000 at 8%. With the beginning of fighting the floodgates for bond issues were opened and through the passing of successive acts more than $700,000,000 of bonds were issued. To speed the marketing of bonds congress passed laws in May and August 1861 providing that bonds might be paid for to the amount of $100,000,000, in military supplies, manufactured articles and in agricultural products. This was commonly known as the cotton loan, since that product was generally used in paying for these bonds. Also, other issues of bonds were paid for in cotton, so that in the course of time the Confederate government came to possess almost 500,000 bales. With this cotton on hand, the Confederacy used some of it as a guarantee for the payment of a loan which it secured in Europe through the banking firm of Erlanger and Company of France. The bonds were to be issued to the amount of 70,000,000 fr. They bore 7% interest and were due in 20 years. As the cotton remained in the Confederacy, those who

bought the bonds lost their money but from the loan the Confederacy obtained about $2,600,000.

An export tax on cotton of ⅛ cent per pound was provided in Feb. 1861, and a so-called war tax of one-half of 1% on the taxable wealth of the Confederacy was levied in the following August. Both taxes were collected only once. Apart from these two taxes, the Confederacy tried to finance itself without any internal taxation at all for the first two years of its existence. In April, May and August 1861 laws were passed levying tariff duties on a long list of items; but since the blockade of southern ports greatly restricted commerce with other nations, the tariff throughout the life of the Confederacy brought in little more than $1,000,000 computed in specie. This was a tariff for revenue —not a protective tariff, which was forbidden by the Confederate constitution. Not until April 1863 did congress finally pass a general tax bill, later amended and made more inclusive. A large number of licence and occupational taxes were levied against banks, bowling alleys, liquor stores, hotels and so on. Taxes were also levied on the sales of certain articles. There was an income tax ranging from 1% through 15%. A profits tax was also included, designed to work against speculators. The products of agriculture were not included in this law, except to be taxed only once. Thereafter there was to be a tax provided in another law, reminiscent of tithing in biblical times, that levied a 10% tax on farm products, to be collected in kind. There was much opposition to this tax, for it was difficult to enforce against those living in out-of-the-way places.

In supplying the sinews of war, the Confederacy resorted to almost every conceivable device. The United States had instituted a blockade of southern ports in April 1861; but the Confederate blockade-runners were able to get through frequently during the first two years, and to some extent until Feb. 1865, when Wilmington, N.C., the last of the blockade-running ports, was finally captured. Large profits were made by private blockade-runners until 1864 when the Confederate government put all blockade-running under strict supervision. After that time fewer luxuries and more war necessities were brought in. Frantic efforts were made to set up iron foundries, armouries, arsenals and factories for the manufacture of cloth and the many other articles for which southerners before the war had depended on the North. They devised a long list of substitutes for the many drugs and medicines from which they were now cut off. To checkmate the horde of speculators who dealt in almost every necessary article, the Confederate government set up a system of impressment of farm products (in addition to the tax in kind) whereby the prices of food and feed for the armies were fixed periodically. Often these prices were about half the market price that civilians were forced to pay.

Foreign Affairs.—One of the reasons why southerners were so confident before secession and in the early days of the Confederacy that they could succeed in setting up an independent government was the power they believed rested in cotton—King Cotton, as they had long been calling it. As more than half of the value of U.S. exports had been in cotton, southerners felt that by withholding it permanently they could force the United States to recognize southern independence. They also believed that by withholding it from England and France they could force these countries to recognize the independence of the Confederacy. Immediately on the organization of the Confederate States government, President Davis sent a mission to Europe to ask for recognition of Confederate independence and to induce England and France to break the blockade by sending ships for cotton and thereby involve them in the war against the United States. William L. Yancey was the principal one of these three commissioners. They visited England, France, Belgium and the pope in Rome; but nowhere did they receive recognition of Confederate independence or a promise to break the blockade, though a later commissioner offered France a large bribe in cotton to do so. After a futile few months in Europe, Yancey returned with the advice that the Confederacy would have to win its independence on the battlefields. Before the end of 1861, two additional commissioners were sent, James M. Mason and John Slidell. On the way across the Atlantic, a United States warship removed them from the "Trent," a British merchantman, and nearly precipitated a war with England. Mason and Slidell were allowed to proceed to Europe, where for the remainder of the war they sought to gain recognition of southern independence. They and other Confederate agents, chief of whom was James D. Bulloch, succeeded in buying a great deal of war material and obtaining several fast ships that were fitted out as commerce raiders after delivery. The best known of these were the "Alabama," the "Florida" and the "Shenandoah." Under Comdr. Raphael Semmes, the "Alabama" destroyed a vast amount of U.S. shipping on the high seas and almost led to war between the United States and England (*see* "ALABAMA" ARBITRATION). The Confederacy did not receive recognition of its independence from any country, although in the last few months of its existence it offered to free all its slaves if England would give that recognition.

The Collapse of the Confederacy.—Having entered the war to defend their independence, the Confederates held the strong conviction that they would win. Although they suffered some disasters, they were greatly heartened by their military victories during the first two years and were still sure of final success. But the third year saw the defeats at Gettysburg and Vicksburg, which occurred almost simultaneously, and from then on, the wisest southerners felt that they probably could never win on the battlefield. Yet in the summer of 1864, when Gen. Ulysses S. Grant was suffering staggering losses of men in his campaign around Richmond, there was a possibility that the North would become discouraged and make peace, and especially so if, in the presidential election in November, Gen. George B. McClellan should defeat Lincoln. But Lincoln was not defeated, and from that time on, southerners became more and more war-weary and demanded that President Davis call a conference with Lincoln to make peace. Davis knew well, as Lincoln had so often said, that the North would never make peace unless the Confederacy gave up and reentered the Union. Finally, to silence the increasing spirit of defeatism in the Confederacy, in Feb. 1865 Davis sent a peace mission to talk to Lincoln on terms of a treaty. The meeting, held on a ship in Hampton Roads, was attended by Lincoln, Seward and others representing the North and by Alexander Stephens and others representing the South. The meeting was a complete failure. The will to win now sank lower in the South. The supply of soldiers had nearly run out so much so that the Confederacy was ready to make soldiers of its Negro slaves and desertion was increasing. On April 9, 1865, Lee surrendered a dwindling half-starved army at Appomattox, and a few weeks later all the armed resistance in other parts of the Confederacy collapsed. The war was over, and the Confederacy now became the Lost Cause.

See also references under "Confederate States of America" in the Index volume.

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CONFEDERATION, primarily any league or union of people or bodies of people. The term in modern political use is generally confined to a permanent union of sovereign states for certain common purposes; *e.g.*, the German confederation (*Bund*), established by the congress of Vienna in 1815. The distinction between confederation and federation (*see* FEDERAL GOVERNMENT), terms synonymous in their origin, has been developed in the political terminology of the United States. Up to 1789 the U.S. was a confederation; then the word federation, or federal republic, was introduced as implying closer union. This distinction was emphasized during the Civil War between North and South, the seceding states forming a confederation (Confederate States of America) in opposition to the Federal Union. Confederation thus came to mean a union of sovereign states in which the stress is laid on the sovereign independence of each constituent body (*cf.* Ger. *Staatenbund*); federation implies a union of states in which the stress is laid on the supremacy of the common government (Ger. *Bundesstaat*). The distinction is, however, by no means universally observed. The variant "confederacy," derived through the Anglo-French *confederacie* and meaning generally a league or union, whether of states or individuals, was applied in America in the sense of confederation to the seceding southern states. In its political sense confederacy has generally come to mean rather a temporary league of independent states for certain purposes. As applied to individuals "confederacy" is often used to describe a secret combination, probably for illicit purposes. In trade-union terminology a federation (*e.g.*, the Miners' Federation of Great Britain) is an alliance of autonomous unions; whereas a confederation (*e.g.*, the Iron and Steel Trades confederation) is a body to which the constituent unions have handed over the majority of their powers; *i.e.*, a disguised form of amalgamation, made necessary by the provisions of British law.

CONFEDERATION, ARTICLES OF: *see* ARTICLES OF CONFEDERATION.

CONFERENCE, a bringing together, for purpose of discussion and sometimes decision, of representatives of sovereign states or of delegates of all sorts of bodies and societies. In British constitutional history the Colonial conference was changed to that of Imperial conference in 1907, becoming the Commonwealth conference in 1949. The annual meetings of British political parties are also called conferences. In the United States national and state meetings of political parties are known as conventions. (*See* NATIONAL CONVENTION.)

The word is also applied to the regular assemblies for transacting church business. In this field the Lambeth conference, a decennial world meeting of archbishops and bishops of the Anglican communion, is one of the most important. In the Roman Catholic Church such an assembly is styled council and in the Orthodox Eastern Church, synod. Annual meetings of associations are described as conferences in Great Britain but generally as conventions in the United States. *See* also CONFERENCE, INTERNATIONAL; WORLD WAR II CONFERENCES, ALLIED.

CONFERENCE, INTERNATIONAL, in international relations, is a useful device of diplomacy. Originating in the 16th century (congress of Cambrai, 1529), it came into prominence with the congress of Westphalia (1645–48) and into more frequent and regular use in the 19th century with the congress of Vienna (1814–15). As a method of direct negotiation and consultation between states it was distinguished from negotiations through ordinary diplomatic channels and conferences. Congresses were defined in the Quadruple or Grand alliance (1814) as meetings "either under the immediate auspices of the sovereigns themselves, or by their respective Ministers." Thus the congresses of Aix-la-Chapelle (1818), Troppau (1820), Laibach (1821), Verona (1822), in the "congress period," and those of Paris (1856) and Berlin (1878) were indeed attended by sovereigns or their ministers. Other 19th-century meetings attended by ministers and plenipotentiaries were called conferences; these included the first Hague peace conference (1899).

The term congress was largely abandoned in the 20th century in favour of the term conference (*e.g.*, conference of Algeciras, 1906; Paris peace conference, 1919; San Francisco United Nations Conference on International Organization, 1945). However, the technical meetings of the Universal Postal union held periodically from 1863 were all called congresses. The prevailing tendency is to call all major official meetings conferences, and attempts to distinguish congresses from conferences on the ground of the rank of participants, the solemnity of the occasion or the importance of the agenda or of the results are scarcely tenable. The objective common to all of them, at whatever level, is the promotion of the orderly and peaceful coexistence of states.

The multilateral approach to the solution of major problems of general interest brought into use the phrase "diplomacy by conference." As the great powers were responsible for developing this method among themselves, the question arose as to the participation of powers of lesser rank. In 1818 at the congress of Aix-la-Chapelle, the great powers declared that meetings concerned with the interests of other European states would be held "under the express reservation of their right of direct participation therein, either directly or by their Plenipotentiaries." This principle was applied, if at all, in a manner resented by the states concerned which claimed participation on a footing of equality. From 1907 participation of lesser powers in international conferences was the rule. This may be attributed in part to the—misplaced—application of the principle of equality of states recognized in international law in the sense of equality of all states before the law, and in part to the principle that no state is bound by a treaty without its consent and that consequently it was the better part of wisdom to invite all interested states to conferences, especially those concerned with the progressive development of international law. Participation, then, is neither a right nor a duty but depends solely on convenience, power or geographic position, initiative of the inviting states or other factors, and may be unconditional or conditional regarding agenda, objectives, absence or presence of certain states.

Conferences are sometimes classified political or bargaining and nonpolitical; legislative, diplomatic and technical; and periodic and *ad hoc*. Nonpolitical conferences are subdivided into administrative, economic, humanitarian, social, communications, scientific, educational or cultural. Conferences may be called legislative if they result in the codification or development of international law, and diplomatic or technical depending on whether attended by diplomats or technical experts. Such classifications are merely of relative value as some conferences, notably peace conferences, embrace a wide range of objectives and include diplomatic along with technical representatives.

Proposals to convene a conference are subject to consultation among the states concerned as to desirability, time, place, agenda, objectives and other preliminaries. There are no fixed rules regarding the place, although conferences usually meet in the territory of the inviting state. Sometimes a place in a neutral territory or one removed from the pressure of public opinion and emotions is preferred (Locarno conference, 1925). The formal opening is usually performed by the chief delegate of the host state if that state is also a participant. Questions of precedence related to a doubtful hierarchy of states, once important, are largely obsolete.

The first item of business is the election of a permanent president and of vice-presidents, who together with the chairmen of committees constitute the bureau which assists the president in directing the conference. No definite rules regarding the presidency are recognized. Usually the chief delegate of the host or the initiating country is elected. If several countries sponsor a conference, the chief delegates of these countries may rotate the presidency (United Nations Conference on International Organization, 1945). The credentials of delegates are exchanged (at a small conference) or examined by a credentials committee which reports to the conference whether they have been found in "good and due form." Next, rules of procedure are drafted and adopted. They deal with such matters as secretariat, records, voting, publicity or secrecy of meetings, languages, order of speakers, resolutions and amendments, closure of debate, etc. In principle these

rules are adopted unanimously. The secretariat is usually headed by an experienced member of the host country's delegation who is elected secretary-general and who selects his staff from his own foreign office or from the participating delegations. The business of a large conference is transacted in plenary sessions and in committees, where most of the actual work is done, although it is subject to approval by the plenary sessions. The latter offer an opportunity for policy statements.

Each conference adopts its voting rules. The classic rule of international law requires a unanimous vote for all but procedural decisions. This principle was much criticized after 1907 on the ground that if any participating state can veto decisions, it endangers the conference as a method for the progressive development of international law and institutions. After World War I there was a trend toward majority voting; and it prevailed in organizations and conferences during and after World War II. This facilitates the adoption of treaties at conferences but does not ensure signature or ratification as there has been no departure from the principle that no state can be bound without its consent.

From the 17th century to World War I, French was the diplomatic language. Between 1919 and 1939 French and English predominated although German and Italian were also used. After World War II French, English, Spanish, Chinese and Russian were accepted as official languages at many conferences and in the United Nations; but the first two remained "working languages." This intrusion of linguistic nationalism into conference proceedings made them more protracted and more expensive. In multilingual meetings a system of simultaneous interpretation is used by means of telephone circuits running from the different interpreters to the delegates' seats.

Conference proceedings are recorded either in verbatim reports or in summaries. The former method is used for plenary sessions and the latter for committee debates. Verbatim and summary records are usually approved by the delegates before publication. Conference results are incorporated in treaties, conventions, declarations, recommendations or protocols. Sometimes a final act is adopted which summarizes the proceedings, lists the participating states and their representatives, as well as the treaties and other acts of the conference. Treaties and other acts imposing obligations are usually appended to the final act and are subject to separate signature and ratification. If the final act contains obligations it is also subject to ratification. In signing treaties any agreed order may be used, though often the *alternat* is adopted. According to this, each representative signs first the copy of the treaty intended for his state and other delegates sign in an agreed alphabetical order of their states. Sometimes the order of signature is determined by lot. When signing or ratifying a treaty governments may attach a reservation, that is, a formal statement to the effect that a particular provision shall not be binding on that state.

After the establishment of the League of Nations in 1920, many conferences were convened by it, by its successor the United Nations or by other international organizations. Such conferences were usually well prepared as the convening organization attends to all preliminary and "housekeeping" functions.

See also WORLD WAR II CONFERENCES, ALLIED.

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CONFESSION. Most religious groups within the Jewish–Christian tradition regard confession or the acknowledgment of sinfulness as a necessary condition for winning divine forgiveness. In the Old Testament the Lord said to Moses: "Say to the people of Israel, When a man or woman commits any of the sins that men commit by breaking faith with the Lord, and that person is guilty, he shall confess his sin which he has committed" (Num. v, 6). The mission of the prophets was to awaken in the people a sense of sinfulness and an acknowledgment of their guilt both personal and collective. The Psalter abounds with instances of such personal and corporate confession, and Ps. li is the classic expression of the sinner's realization that he must confess that he has sinned before the Lord. This avowal of guilt, at times public, at times secret, appears to be the normal preparation for the expiation of sin and its atonement. Before the destruction of the Temple (A.D. 70) the sin offerings on the Day of Atonement (Yom Kippur) were prefaced by a collective expression of sinfulness (Lev. xvi, 21), and even after the destruction of the Temple, the Day of Atonement has continued as a day of prayer, fasting and confession.

In the New Testament the public ministry of Jesus is prepared by the baptism of John, a baptism unto repentance, accompanied by a public confession of sins (Matt. iii, 6) and the New Testament is brought to a close by the apostle John's assurance: "If we confess our sins, he is faithful and just, and will forgive our sins and cleanse us from all unrighteousness" (I John i, 9). There is no direct evidence in the New Testament that confession had to be specific or detailed or that the confession had to be made to a priest. The scriptural foundation for subsequent Christian practice and teaching is usually found in the authority given by Christ to the apostles to bind and to loose (Matt. xvi, 19; xviii, 18) and to forgive and to retain sins (John xx, 23). It is argued that the authority given is clearly discretionary and implies a knowledge of what to bind and what to loose, knowledge that ordinarily can be supplied only by the sinner's confession. In any event, a detailed confession of sins to the bishop or the priest-penitentiary appears quite early in the church's discipline of penance.

Discipline of Penance.—The word penance can refer to the sinner's repentance, to the works of satisfaction imposed by the confessor or freely undertaken by the penitent, or to the whole discipline of penance leading up to and including the sinner's reconciliation. In the early 3rd century this discipline was called exomologesis ("confession"). Thereafter, the discipline was known in the east and west as penance. The discipline for the first five centuries was not everywhere uniform, but it followed a general pattern that reflects the action of St. Paul in delivering a serious offender over to Satan "for the destruction of the flesh," and later in pardoning him or a similar offender lest he be "overwhelmed by excessive sorrow" (I Cor. v, 5; II Cor. ii, 7). Accordingly, there were two stages in the discipline of penance: excommunication, an exercise of the power of binding; and reconciliation, an exercise of the power of loosing. That this power affected the sinner's relations with God and not merely with the church is suggested by Christ's commission: "whatever you bind on earth shall be bound in heaven, and whatever you loose on earth shall be loosed in heaven" (Matt. xviii, 18).

Although Christ's commission to bind and to loose is given in the most general terms, there is early evidence that not all bishops were prepared to loose or to reconcile those guilty of apostasy, adultery and murder. When, however, this policy of harshness was interpreted by the Montanists and the Novatianists of the 3rd century as an implicit denial of the church's competence to forgive, the church intervened and at the first ecumenical Council of Nicaea (A.D. 325) condemned not only the practice but the teaching of these early extremists.

Except in the case of the recalcitrant sinner, excommunication was medicinal and normally led to pardon through the ministry of the bishop or, in emergency cases, through the ministry of a presbyter or simple priest. Even in the case of lesser sins, excommunication entailed separation from the Eucharist; in the case of more serious crimes, such as apostasy, adultery and murder, excommunication involved enrollment in the order of penitents, an order that corresponded to the grade of catechumen (*q.v.*) in the discipline leading up to baptism. In the graded discipline of the east, a serious offender usually passed through four successive grades before being allowed to receive the Eucharist: (1) as a mourner, the sinner prostrated himself in tears outside the doors of the church and sought the intercession of the clergy and people as they entered; (2) as a hearer, he was allowed to enter the church and to remain for the reading of the lessons and the bishop's homily; (3) as a kneeler or penitent in the strict sense of the term, he was the object of special prayers said over penitents while prostrate, after which he was dismissed from the assembly; (4) as a bystander, he was allowed to remain for the eucharistic liturgy, but he was not privileged to make his offering or to receive Holy

Communion. In the west there seems to have been but one grade, that of kneeler or penitent.

Enrollment in the order of penitents followed upon confession to the bishop or, in the more populous churches, to the priest-penitentiary, whose office it was to assign the period of penance and to oversee its fulfillment. Whether the penitent was obliged to manifest publicly the sin or sins for which he was doing penance is not certain. Tertullian (*c.* A.D. 200) seems to have public confession in mind when he rebukes those who put off confession, "more mindful of their embarrassment than of their salvation. . . . As if by withdrawing anything from the knowledge of men we shall conceal it from God as well" (*De Paenitentia,* x). However, the 5th-century Greek historian Socrates informs us that the priest-penitentiary was appointed from the earliest times because bishops decided that "it was too much of a burden to announce one's sins as in a theatre with the congregation of the Church as witness" (*Ecclesiastical History,* vii, 16). Again, the local Italian practice of reading from a chart the sins of the penitent is regarded by Leo I the Great (*c.* A.D. 450) as a "defiance of apostolic rule" (*Epistles,* clxviii).

In the 5th-century discipline of the Roman Church, the practice was to hear confessions in the beginning of Lent and, unless sickness or some other emergency arose, to reconcile the penitents on Holy Thursday. After confession, the sinner was clothed in goats' hair, sprinkled with ashes and received into the order of penitents by an imposition of hands. Although the evidence is not conclusive, it would appear that the penitent was excluded from the eucharistic liturgy along with the catechumens until Holy Thursday, when he was once more privileged to make his offering and to receive the Eucharist. During the period of penance, which appears to have been considerably shorter in the Western Church than in the Eastern Church, the penitent was obliged to fast and to multiply his prayers. To compensate, perhaps, for the abbreviated period of penance in the west, disabilities were introduced that affected the penitent for life. Thus, the reconciled penitent was not ordinarily permitted to marry, or, if married, to resume marital relations; he was forbidden to engage in public trade and to undertake military service. Failure to observe these penalties reduced the penitent to the status of the bystander in the graded discipline of the east.

In the east, public penance did not long survive the action of Nectarius, patriarch of Constantinople, in abolishing the office of priest-penitentiary (A.D. 391). Serious sinners were no longer enrolled in the order of penitents nor were they excluded from the eucharistic liturgy. They were forbidden, however, to receive the Eucharist until their penance was fulfilled, a status that reflects the grade of bystander in the earlier discipline.

In the east and the west, public penance, modeled as it was on the discipline of the catechumenate, could be undergone but once. Whether or not there was a private penance for those guilty of sins that were secret or that fell short of the canonical triad (apostasy, gross impurity and murder) is still debated. Most historians are of the opinion that private and repeated penance was introduced first in the churches of the Celtic lands, and that it was through the influence of Irish monks and English missionary scholars that private penance won acceptance on the continent. In any event, by the year 850 and as a result of the Carolingian reform, the principle of "public penance for public crimes, private penance for secret sins" became the established rule. Gradually, too, was introduced the practice of reconciling or absolving sinners immediately after confession and before the fulfillment of penance, so that by the close of the 11th century only public or notorious sinners were reconciled in the solemn penance of Holy Thursday.

Although the discipline of penance was regarded in the early church as a second and more laborious baptism, those guilty of serious sins usually put off penance until death approached. To correct this abuse, the fourth Lateran council (A.D. 1215) established the following rule: "Let everyone of the faithful of either sex, after having reached the age of discretion, faithfully confess in secret to his own priest all his sins, at least once a year . . . ."

Modern Teaching and Practice.—The Roman Catholic Church teaches that penance is a sacrament, instituted by Christ, in which an integral confession of all serious sins committed after baptism is necessary by divine precept. Although venial sins need not be confessed to the priest, confessions of devotion are encouraged and are widely practised. The doctrinal position of the Eastern Orthodox Churches on the sacramentality and necessity of confession to a priest agrees with that of the Church of Rome.

Among Lutherans private confession and absolution survived the Reformation for a time. The Augsburg Confession of 1530 not only listed penance along with baptism and the Lord's Supper as sacraments of the New Law but asserted that "it is not customary to offer the Lord's body to those who have not first been examined and absolved." Luther himself was anxious that private confession be retained, and in his Short Catechism he drew up for the use of "simple folk" a method of examining their consciences and of confessing such sins "as we know and feel guilty of in our hearts." The instruction is followed by a rubric for the confessor, who is to use the then current formula: "I forgive thee thy sins in the name of the Father, the Son and the Holy Ghost. Amen. Go in peace." Calvin too recognized the value of private confession and absolution for those troubled in conscience, but he denied that such confession was sacramental or that it was necessary for the forgiveness of sins. Although there is a small but growing movement among German Lutherans and French Calvinists to restore the practice of private confession, most Protestants regard the general confession and absolution of the communion service as a sufficient preparation for the Lord's Supper.

The Church of England resisted to some extent the attempts of the Nonconformists to have all reference to private confession and absolution removed from the prayer book. Thus, in the Order for the Visitation of the Sick, the sick person "shall be moved to make a special confession of his sins, if he feels his conscience troubled with any weighty matter." The same directive is found in the Book of Common Prayer as used in the Protestant Episcopal Church in the United States. The Oxford movement in the 19th century fostered a revival of private confession even in times of health, a practice that has received some acceptance among Anglo-Catholics. However, many Anglicans and Episcopalians look with disfavour upon "romanizing" tendencies within their churches and favour the general confession and absolution of the communion service.

Confession of a generic nature plays an important role in most fundamentalist and Pentecostal churches, and the 1920s witnessed the rise of a new religious group, the Buchmanites, among whom a public and detailed confession of sins is regarded as the first step toward a sincere conversion (*see* MORAL REARMAMENT). Nor has the strictly therapeutic value of confession been overlooked by the psychiatrist, whose demands upon the sincerity and frankness of his patient are no less exacting than those made of the penitent in the early church. (*See* also ABSOLUTION.)

The term confession is used also to designate the tomb of a martyr and the building erected over the tomb (*see* CRYPT).

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(P. F. P.)

CONFESSION, in the criminal law, is an extrajudicial statement acknowledging guilt of an offense. Both the common law and U.S. constitutional law require that coerced or involuntary confessions be excluded from the evidence admitted in a criminal trial (*see* THIRD DEGREE). While a voluntary confession is competent evidence of guilt, it is not ordinarily regarded as sufficient evidence of guilt. Thus, in most jurisdictions the confession must be corroborated by other evidence before a defendant may be convicted. Ordinarily the corroborating evidence must relate to the corpus delicti; that is, it must establish that a crime was committed by someone. *See* CRIMINAL LAW; EVIDENCE. (F. A. A.)

CONFESSIONAL, in Roman Catholic churches, is a box, cabinet or stall in which the priest sits to hear the confessions of penitents. The confessional is usually a wooden structure, with a compartment (entered through a door or curtain) in which the priest sits, and on one or both sides another compartment or compartments for penitents; this is separated from the priest's compartment by a partition, with a latticed opening for the penitent to speak through, and contains a step on which he kneels. By this arrangement the priest is hidden; the penitent may or may not be visible to others. Confessionals usually form part of the architectural scheme of the church, but sometimes they are movable pieces of furniture.

In its present form the confessional dates no farther back than the 16th century. Previous to that time, the priest normally administered the sacrament in its private form while seated on a chair in some part of church; the penitent stood or sat beside him, and knelt for the absolution. Since the prevailing rite of absolution demanded that the priest lay his hand on the penitent's head, there could be no separating wall or curtain. From the 11th century, the chair was placed "in front of the altar," probably within the chancel. St. Carlo Borromeo in 1565 ordered that a metal grill separate priest from penitent in his archdiocese of Milan. This practice spread rapidly, and, after adoption into the Roman Ritual under Pope Paul V in 1614, soon became universal. Thus the essentially public nature of the sacrament was safeguarded, and a reasonable privacy assured. In baroque churches the confessional often developed into a highly ornate structure.

ALINARI

BAROQUE CONFESSIONAL OF THE CHURCH OF S. BERNARDO, PIEDMONT, ITALY; 1692

According to modern canon law, women's confessions may be heard only in a confessional in church; men may go to confession outside church, but when confession is heard in church, the confessional should be used.

In Eastern Orthodox churches the confessional is unknown, but it is becoming customary in some of the churches of oriental rite united to Rome. With the revival of auricular confession in some Anglican and Lutheran churches, a confessional chair, with or without separating grill, is finding gradual acceptance.

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CONFESSIONS OF FAITH, PROTESTANT. The medieval Christian church did not attempt an official codification of its doctrine. The creeds inherited from antiquity (Nicene Creed) or formulated in the early middle ages (Apostles' Creed, Athanasian Creed) were used in liturgical worship to confess the Christian faith (*see* CREED). Certain doctrinal points were defined by councils as a result of doctrinal controversies. A decree on the seven sacraments issued by the Council of Ferrara-Florence in 1439 was a statement concerning one important part of the doctrinal system. But there was still no codification of doctrine. Nor did the heretical movements in the middle ages produce comprehensive declarations of faith.

The Reformation in the 16th century led to the formulation of declarations aiming at a definition of all the main points of the doctrinal system. Most of these documents were compiled with the purpose of expressing the Church's doctrine; a few of them originally served other purposes (*e.g.*, Luther's catechisms) but were soon given the rank of doctrinal standards.

The first confessional documents of the Reformation were the drafts preceding the Augsburg Confession of 1530. This example set by the Lutherans was followed by the other Reformation churches, and it was even followed by the Council of Trent (1545–63), whose decrees and canons, together with the *Professio fidei Tridentina* of 1564, were a codification of Roman Catholic doctrinal tenets.

Motives Underlying Protestant Declarations of Faith.— A variety of motives underlay the elaboration of Protestant confessions of faith in the Reformation era as well as in post-Reformation times. Their obvious purpose is to give expression to convictions held by groups claiming to be the legitimate Christian Church. "We believe" are the opening words of most of the articles of the French Huguenot confession of 1559. "We believe, confess and teach" is a wording which constantly recurs in the Lutheran Formula of Concord. Such declarations frequently contain arguments in support of the tenets confessed. Accordingly they serve also an apologetic purpose when they intend to prove the orthodoxy of the doctrines professed by Protestant churches.

This motive is particularly conspicuous in the Augsburg Confession, which refers to the creeds and repeatedly quotes the Fathers of the early church besides recurring to arguments from Scripture. It is said expressly that the Lutheran teaching does not differ from the Scriptures or from the Catholic Church "or from the Roman Church, as it is known from the (ancient) authors." The whole controversy with the contemporary Roman Church is here reduced to a dissension over "certain abuses." The sequel to this document, the Apology for the Augsburg Confession, contains an elaborate theological motivation of the tenets held by Lutherans. The Formula of Concord is a large book containing theological reasoning. Whereas the Lutheran documents, in spite of their emphasis on the Scriptures as their sole authority, argue from the early Fathers as well as from Scripture, the corresponding Reformed confessions argue from Scripture alone.

The purpose of some documents from the 16th century was to create unity between various Protestant parties. The Marburg Articles of 1529 were an attempt to unite Luther and Zwingli. The Wittenberg Concord of 1536 aimed at the formulation of a eucharistic doctrine acceptable to Lutherans and the Swiss Reformers alike. The purpose of the Ten Articles compiled at the order of Henry VIII of England was to facilitate his approach to the Lutheran princes in Germany. When such attempts had proved abortive and the schism between the Protestant churches was an irreparable fact, confessional documents of a similar type were occasioned by internal dissensions in the separate churches. The Formula of Concord was a successful attempt to restore unity within the Lutheran Church after three decades of internal struggle over doctrinal questions. The Canons of Dort served a similar purpose in the Dutch Reformed Church. Documents of the last type aim expressly at establishing a norm for the teaching of the church. The same use, however, had been made of the older confessional documents from an early date. The Wittenberg oath required of a doctor of theology included from 1533 onward allegiance to the doctrines of the Augsburg Confession, and so did also the ordination vow in Saxony from 1535.

The titles given to the various Protestant confessions reflect this variety of motives: "confession" (*e.g.*, the Augsburg Confession, the French *Confession de Foi, Confessio Belgica*, the Scottish Confession of Faith, the Westminster Confession), "articles" (*e.g.*, Marburg Articles, Schwabach Articles, the various versions of articles of religion in England), "declaration" (*e.g.*, the Savoy Declaration), "consensus" (*e.g.*, *Consensus Tigurinus*), "concord" (*e.g.*, Wittenberg Concord, the Formula of Concord, the Book of Concord). A few of them bear the name of "catechism," first introduced as a book title by Luther and adopted by Calvin (*e.g.*, *Le Catéchisme de l'église de Genève*) and his followers (*e.g.*, Heidelberg Catechism, the two Westminster catechisms) and even by the Roman Catholic Church (*e.g.*, *Catechismus Romanus*, 1566); before Luther, "catechism" meant oral catechetical instruction. In the Lutheran Church there was a tendency to attribute to the confessional writings (*Bekenntnisschriften*) of the 16th century an authority similar to that possessed by the creeds, and accordingly to call them "symbols" of the church, a name which in earlier times had been reserved for the creeds. It even became customary to

speak of these lengthy theological treatises as the "symbolical books" of the Lutheran Church.

Lutheran Churches.—*The Augsburg Confession (Confessio Augustana).*—This declaration, signed by the Lutheran princes and independent cities in Germany, was presented to the emperor Charles V on June 25, 1530, during the diet of Augsburg. As the emperor needed the support of the Lutheran territories in his war against the Turks, he had decided to overcome the religious schism in Germany through peaceful deliberations. He now wanted to hear both parties. Before the diet the Lutheran elector of Saxony had asked his theologians to prepare a memorandum on the changes introduced in his church, known as the Torgau Articles. In Augsburg, however, the Lutherans were confronted with an accusation of heresy from the Roman Catholic side which compelled them to rewrite and expand their short apology. As Luther was an outlawed person who could not make his appearance at Augsburg, this task fell to Philipp Melanchthon. Melanchthon included matter from the Marburg Articles of 1529 and from the Schwabach Articles, drawn up in 1529 as a basis for a defense union of the Evangelical princes. But to a large extent he had to formulate independently. The draft was sent to Luther and received his full approval.

The Augsburg Confession is extant in a German and a Latin version, both handed over to the emperor. The two original manuscripts are lost. Six printed editions of the German and one of the Latin text appeared while the diet was in session. As these were inaccurate, an official *editio princeps* was published by the author himself in 1531. The confession bears the stamp of Melanchthon's moderation and caution and reveals the threatening situation in which it was compiled. The emphasis is laid on the catholicity and orthodoxy of the Lutheran interpretation of Christianity, especially in the first 21 articles dealing with doctrine. The central ideas of the Lutheran Reformation, however, have received a classic formulation: the doctrine of salvation by faith alone, its relation to good works, the doctrine of the church and the sacraments, the new evaluation of matrimony and of secular society and its laws. In the second part, comprising seven articles on abuses which had been abolished, certain customs and doctrines of Roman Catholicism are criticized in strong terms.

No recognition of the Lutherans by the emperor was attained at Augsburg. The Evangelicals left the diet and had to prepare themselves for the civil war which seemed to be inevitable. In this situation, the Augsburg Confession became the rallying banner of the Lutheran princes and the norm for doctrine in their churches. Melanchthon, however, introduced minor alterations in the new editions of the confession which appeared after 1531, treating the book as his private work. In the edition of 1540 he went so far as to redraft article 10 in order to approximate to Calvin's doctrine of the Eucharist. When the south Germans who had Calvinistic leanings began to quote this edition as authoritative, it was stigmatized in Lutheran circles as the *Augustana variata,* and the use of the "unaltered Augsburg Confession," *Augustana invariata,* was enjoined.

The Lutheran Reformation was at last recognized by the German *Reich* in the Peace of Augsburg in 1555, which acknowledged the coexistence of "the religion of the Augsburg Confession" and "the old religion." Protestant movements which did not conform to this confession were not allowed, but as the peace treaty did not expressly mention the "unaltered" confession there was room for the Calvinizing party, which could make claims to legitimacy by invoking the authority of the *variata.*

Thus historical events gave a unique importance to the Augsburg Confession. It was recognized also in the Lutheran churches outside Germany as an authoritative standard of doctrine (Denmark and Norway, 1574; Sweden and Finland, 1593) and in the 20th century is the doctrinal standard of all Lutheran churches and the unifying bond of Lutheranism. (*See* also AUGSBURG CONFESSION.)

Luther's Shorter and Longer Catechisms (1529).—Both these catechisms, written in the spring of 1529, were produced in order to teach children and adults the elements of Christian faith. For more than two centuries the Shorter Catechism was used as the chief reader in primary schools and even frequently formed the basis for sermons. In the Formula of Concord the two catechisms are called "the layman's Bible" and in the Book of Concord they are given the status of confessional standards.

Schmalkaldic Articles (1537).—These derive their name from the defensive league formed by the Lutheran princes at Schmalkalden in 1531. They were written by Luther for presentation to a projected council Pope Paul III had summoned to Mantua in 1537. The elector of Saxony did not approve the idea of the Evangelicals' appearing at the council, and to clarify their position he commissioned Luther to compile the articles of faith from which he would in no circumstances depart. The tone of the document therefore became particularly anti-Roman. It was subscribed by the Wittenberg theologians. Melanchthon, however, accompanied his signature with a reservation, and he also prevented the document from being signed by the princes as their official declaration. The more militant Lutherans valued the Articles highly and they were included in the Book of Concord.

Formula of Concord (1577).—The Formula was the result of protracted theological discussion arising out of the controversies which rent the Lutheran Church after Luther's death in 1546. The chief authors were Jacob Andreae and Martin Chemnitz, who combined a central position in the internal controversies with a marked hostility toward Calvinism and Roman Catholicism. The Formula is an extensive book which inaugurates the era of Lutheran orthodoxism.

Book of Concord (1580).—In the years of struggle over doctrinal issues the idea of a codification of the authoritative confessions gained support from the Lutheran theologians and princes. The most extensive of these collections was the Book of Concord, published in 1580 and adopted by 51 princes and 35 cities in central and south Germany as the norm for teaching in their churches. The book contains the three creeds (the Apostles', the Nicene and the Athanasian) together with the documents listed above and Melanchthon's Apology for the Augsburg Confession, written during the diet of 1530 and published in 1531.

The Book of Concord was never recognized in Denmark and Norway. When the legislation of these countries was codified in the late 17th century under Christian V only the three creeds, the Augsburg Confession and the Shorter Catechism were declared to be the standards of doctrine. In Sweden, the Synod of Uppsala in 1593 proclaimed the Augsburg Confession to be authoritative, whereas the whole Book of Concord was enjoined by the church law of 1686. (*See* also CONCORD, BOOK OF.)

Reformed Churches.—Within the churches that have received their stamp from Calvin's Reformation a large number of confessions have been promulgated. In these churches, however, confessional documents have not played the same part as the "symbolical books" of Lutheranism. This is partly due to their view of the authority of Scripture, which relegates articles of faith to the position of "subordinate standards," and partly to the historical fact that the Reformed churches have never been united in accepting a common confessional document.

The First Helvetic Confession of 1536, approved by all Evangelical cantons in Switzerland, bears the stamp of a moderate Zwinglianism.

Calvin's Geneva Catechism of 1542 is a short summary of his teaching in questions and answers (*see* CATECHISM: *Reformed*).

The most important Swiss confessions are the *Consensus Tigurinus* of 1549, whereby Calvin and the followers of Zwingli entered on a union, and the Second Helvetic Confession, compiled by Heinrich Bullinger as a private work, but recognized in 1566 by all the Reformed cantons as well as by the elector Frederick of the Palatinate. This confession was for some time regarded as authoritative also in France, Scotland and Poland. Here the Zwinglian doctrine of the Eucharist has been superseded by Calvin's teaching. (*See* also HELVETIC CONFESSIONS.)

In France the Reformed Church formulated its confession of faith at a general synod held at St. Germain in 1559. The draft of this *Confessio Gallicana* came from Calvin's hand. It is distinguished for its elegance and clarity. The doctrine of predestination is lucidly expounded.

The *Confessio Scoticana* of 1560 was compiled in English in four days with John Knox as its principal author. The document was approved by the Scottish parliament. A special feature is the emphasis on church discipline and on the theocratic ideal.

The Heidelberg Catechism of 1563 was due to the initiative of the elector Frederick III of the Palatinate. He had become convinced that the Lutheran eucharistic doctrine was "papistic," went over to the Reformed standpoint and transferred the ecclesiastical allegiance of his territory, in accordance with the generally acknowledged principle of his time that the subjects should follow their prince in religious matters (*cuius regio, eius religio*). He commissioned Zacharias Ursinus, a Melanchthonian, Caspar Olevianus, a moderate Calvinist, and others to compile a confession which received the form of a catechism. The tone is conciliatory toward Lutheranism but polemical toward Roman Catholicism. No express mention is made of predestination. The Heidelberg Catechism was accepted in Switzerland, Hungary and Scotland and is one of the very few Reformed confessions to which reference is made today. (*See* also HEIDELBERG CATECHISM.)

In the Netherlands, a Reformed confession of faith was adopted by a synod held at Antwerp in 1566. The *Confessio Belgica* is the last continental confession of this type.

In the 17th century it fell to the Dutch Reformed Church to formulate the doctrine of Calvinist orthodoxy in the Canons of Dort (Dordrecht). This document was occasioned by a doctrinal controversy over predestination. A liberal minority, named Arminians after their leader Jacobus Arminius, rejected the doctrine of absolute predestination and taught that Christ had died for the whole human race, that the possibility of salvation was offered to all men, that man was in need of God's regenerative grace, but could resist the grace of God, and that he could fall from grace. The majority of theologians and pastors in the Netherlands kept to the strict doctrine of predestination, which declared God's grace to be irresistible and left no room for human liberty in the process of salvation. In 1618 the state authorities summoned a national synod to Dordrecht. It was attended also by theologians from Switzerland and Germany and even by five official representatives from the Anglican Church, at that period reckoned among the Reformed churches. The synod declared the Arminians to be heretics, and in 1619 it formulated the strict doctrine of predestination in 93 canons. The primary religious concern of the Canons of Dort was to proclaim the majesty of God and to safeguard the assurance of salvation. Outside Holland, the canons were formally adopted by the French Reformed Church and received for information only by the other Reformed churches. (*See* also DORT, SYNOD OF.)

The Westminster Confession was compiled during the English Civil War. In 1643 parliament appointed a commission of 121 divines and 30 members of parliament, with the purpose of giving a Presbyterian constitution to the Church of England and of introducing uniformity in doctrine, worship and order throughout the British Isles. The commission held its meetings in Westminster abbey and was therefore known as the Westminster Assembly. The large majority of its members were Presbyterians, Calvinist in doctrinal matters. In 1646 a draft version of a confession of faith was completed and printed privately. It was studied by parliament in detail and published under the title of *Articles of Christian Religion approved and passed by both Houses of Parliament after advice had with the Assembly of Divines by authority of Parliament sitting at Westminster.* In Scotland the Westminster Confession was readily approved by the general assembly in 1647 and by the Scottish parliament in 1649. In England events followed another course. After the ecclesiastical chaos under the Commonwealth, Anglicanism was reinstated in 1660. The Westminster Confession did not become a doctrinal standard in the Church of England.

In addition to the confession, the Westminster Assembly issued two catechisms, the Shorter and the Longer, which are assigned the same degree of authority as the Westminster Confession in the Reformed Churches of Scotland and America. All three documents are remarkable theological works, lucid, precise and dignified in tone.

Other Protestant Bodies.—Congregationalism, according to its fundamental principles, is averse to the idea of establishing a doctrinal norm or of binding consciences to a confession. Such use of confessions "causeth them to degenerate from the name and nature of confessions, and turneth them into Exactions and Impositions of Faith," it was expressly stated when a "meeting of Elders and Messengers," held in 1658 at the Savoy, London, produced their classical *Declaration of the Faith and Order owned and practised in the Congregational Churches in England.* In doctrinal matters, the Savoy Declaration differs only slightly from the Westminster Confession. When the British Congregationalists formed the Congregational union, a new declaration was issued (1833). For the first time it is stated in a document of this official character that the Scriptures "consulted with the aid of sound criticism" should be the final court of appeal in doctrinal questions. On the rare occasions when Congregationalists have published statements on their tenets, they have pointed out that such statements are only a presentation of what is commonly believed in their churches, not a doctrinal law.

The Baptist churches share this attitude to human standards of doctrine. Attacked by their adversaries, however, they felt compelled to produce official statements on doctrine. In 1644 those English Baptists who adhered to the Calvinist doctrine of predestination issued a confession of faith, followed by a similar document in 1677, which was approved by the Federation of American Baptists at Philadelphia in 1742. In 1660 the Arminian wing of the English Baptists produced their own declaration of faith.

The unwillingness to invest such declarations with the authority of articles of faith has always been alive in Baptist circles. In the controversy over liberal theology which broke out among British Baptists in 1887, their great preacher, C. H. Spurgeon, urged the Baptist union to adopt a declaration of faith in the basic truths of evangelical Christianity. His proposal was rejected as being incompatible with the Baptist attitude toward binding articles of faith.

The Methodist churches do not display the same aversion to credal statements. In addition to the Scriptures, they acknowledge the creeds and certain other "standards of doctrine" which are regarded as containing the doctrine of the church. These documents are not, however, articles of faith in the juridical sense. In the detailed legislation of the Methodist Church in America the confessional standards are never defined. The questions put to the candidates for the ministry at their ordination only refer to "the doctrines of the Methodist Church" without further specification. The documents considered as normative are: John Wesley's *Notes on the New Testament* (1755); a collection of 44 of his sermons, called the *Standard Sermons;* and (in American Methodism) Wesley's 25 articles of 1784, an abridgement of the Anglican 39 Articles, which through omissions and the rephrasing of certain expressions have been made more Protestant and at the same time less Calvinist (admitting of Arminianism) and purged from references to general councils or to the establishment. The first two of the above documents differ in literary form and in preciseness from what are traditionally called confessions of faith.

The Quakers refuse to subscribe to articles of faith. When the Society of Friends in England published a statement on their beliefs in 1920, occasioned by the necessity of defining their attitude to the ecumenical movement, it was meant only to be a description of views commonly held by Quakers, not a norm for doctrine. The same character attaches to the three small volumes of representative pronouncements of leading Quakers covering the whole period of their history, which were published by the English Society of Friends (*Christian Life, Faith and Thought in the Society of Friends,* 1921–31).

Attitude of Protestant Churches Toward Their Confessions.—Even in churches which in principle are opposed to confessional obligation the necessity of formulating doctrinal statements has been felt on certain occasions; the attempt has been made, however, to formulate guiding principles without making such statements a binding law. In the churches which consider their confessions as doctrinal standards the confessions have caused some difficulties in modern times.

The juxtaposition of Holy Scripture and confessional documents implies a theological problem which was discussed in the 17th century but could not become acute so long as the two authorities were felt to be concordant. Orthodox Lutheran theology maintained that Holy Scripture was the supreme authority (*norma normans*), while the confessions derived their authority from their concordance with Scripture and were a secondary norm (*norma normata*). This doctrine could not create difficulties to churchmen who were convinced that their own church possessed the only right understanding of the Bible.

In the 18th century, pietism and the enlightenment were both averse to a confessionalism requiring the acceptance of every article of the confessional standards. It became customary to distinguish between fundamental and nonfundamental doctrines and to practise a large amount of individual liberty with regard to confessional documents. Critical exegesis, acquaintance with other Christian traditions and studies in the history of dogma created a spirit of confessional relativism. Toward 1800 there was a considerable liberty of interpretation without formal abolition of confessional obligation for pastors and teachers.

After 1800, and especially after 1830, a wave of confessionalism in the Lutheran and Reformed churches re-established the ideal of loyalty to the church's confession. Representatives of this school tried to check rationalism and liberalism by requiring submission to the confessional standards. On the other hand, biblical scholarship and historical studies revealed the differences between biblical theology and the doctrines of the confessional documents. Theology became to a large extent permeated by a nondenominational spirit, and many churchmen felt difficulties in subscribing to creeds and confessional documents. In the Swiss Reformed churches the problem received a radical solution between 1870 and 1880 when a new ordination vow was introduced, without any reference to the creeds or to the confessional documents. In other churches it was generally accepted that confessional loyalty means loyalty to "the idea and spirit" of the doctrinal standards. In many Lutheran churches the ordination vow was rephrased to the effect that the ordination candidates should promise to teach the Word of God "as it is revealed in Holy Scripture, and as it is witnessed to by our Church in its Confession." In all Lutheran and Reformed churches, there was also a party which required an unconditional acceptance of the doctrines contained in the confessions.

After World War I a renascence of confessionalism could be observed in both Lutheran and Reformed churches, and accordingly a new interest in the classical confessions. The fight of these churches against Nazi dictatorship in Germany strengthened this confessionalism. Loyalty to the church's confession became a catchword and a rallying banner. The fight also occasioned new declarations of a type similar to those of the Reformation era. The German Confessional Church (*bekennende Kirche*) issued a statement known as the Barmen Declaration of 1934, containing theses on the message of the Church (*see* BARMEN, SYNOD OF). In Norway, a document entitled *Kirkens grunn* ("The Church's Foundation") was read from the pulpits in 1942 and was signed by all pastors who were on the church's side in its conflict with the Nazi regime. Such documents were considered as having the authority of confessional standards. But when normal conditions were reintroduced after the end of World War II, subscription to these documents was no longer required. No expansion of the traditional collections of confessional standards took place. *See* also CATECHISM.

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CONFESSOR, (1) a title of honour given to certain Christian saints; and (2) a member of the Christian clergy who receives the confession of a penitent's sins and imparts absolution.

During the persecutions of the 2nd century the title of confessor was given to those Christians who had declared their faith before the Roman tribunals but had not suffered martyrdom. When the persecutions ceased in the 4th century the title and veneration given to confessors were extended first to bishops who had defended the faith of the church against heresy and then to Christians who were judged to have given extraordinary evidence of Christian virtue and thus to have "confessed Christ." Since the middle ages "confessor" has been used in this last sense to designate any canonized male saint who is not a martyr (*see* also SAINT).

For confessor in the second sense, *see* CONFESSION.

(J. W. HE.)

CONFIDENCE GAME, the term popularly applied to any elaborate swindle, particularly one that exploits the cupidity of the victim. Some U.S. jurisdictions have created a statutory offense of this name. Although the elements of the offense are not clearly defined by this legislation, the offense may be regarded as an aggravated form of the misdemeanour known as false pretenses. The essential element of the crime of confidence game is the betrayal of the trust and confidence deliberately induced in the victim by the offender with fraudulent purpose. *See* FRAUD.

(F. A. A.)

CONFIRMATION, a Christian rite by which the relation between man and God established in baptism (*q.v.*) is said to be confirmed. During the first several centuries of Christian history, when most of the accessions to the church were adult converts from paganism, the baptism of these adults and the ceremony admitting them to the full rights of membership (equivalent to, but not yet called, confirmation) probably coincided. Early Christian theologians, therefore, do not accord much special treatment to the rite of confirmation, but closely connect its meaning and effects with those of baptism. But as the baptism of infants rather than of adults came to be customary, a sharper distinction between baptism and confirmation became necessary; and in all those Christian denominations where some sort of confirmation is still observed, its connection with baptism and its distinction from baptism shape both the practice of the rite and the theological interpretation placed upon it.

In the Roman Catholic Church confirmation must be at the hands of a bishop, except in certain exceptional cases where a priest is granted permission to perform the rite. A baptized person who has come to the age of reason (at least 7, though in practice not until age 11 or 12) receives the laying on of hands from the bishop and is anointed with the sacred chrism on his forehead. The bishop pronounces the formula: "I sign you with the sign of the cross and confirm you with the chrism of salvation, in the name of the Father and of the Son and of the Holy Spirit," and he gently strikes the cheek of the candidate as a sign of the spiritual warfare in which he is now to engage as a knight of Christ. According to Roman Catholic doctrine, confirmation is a sacrament instituted by Jesus Christ, and it confers the gifts of the Holy Spirit, grace, strength and courage upon the recipient.

The Eastern Orthodox churches, as well as some of those eastern churches in communion with Rome, permit an ordinary priest to administer confirmation, but with a chrism consecrated by a patriarch or bishop. As a rule, confirmation in Eastern Orthodoxy follows immediately upon baptism, as part of the same service, and is followed in turn by the first communion of the child, who thus receives all three sacraments together.

Controversy between east and west over confirmation dealt principally with the question of who may ordinarily administer the sacrament. The paucity of references to confirmation in the early Christian tradition has aroused controversies also among Roman Catholic theologians as to whether Christ determined in detail the "matter" of confirmation (*see* SACRAMENT), or whether

the apostles or the church added the rite of anointing to the laying on of hands.

Of the communions to emerge from the Reformation, Anglicanism and Lutheranism retained a form of confirmation, but with notable divergences from the early and Roman Catholic rite. The Anglican practice is to restrict the right of administering confirmation to the bishop, who lays hands upon the candidate and says: "Defend, O Lord, this thy child with thy heavenly grace, that he may continue thine forever; and daily increase in thy Holy Spirit more and more, until he come unto thy everlasting kingdom." The problem of the connection between baptism and confirmation and the inconclusive evidence about the early Christian practice of confirmation have been the occasion for theological controversy within Anglicanism over the independent sacramental status of confirmation as "the seal of the Spirit."

Lutheranism, in general, restricts the term "sacrament" to baptism and the Eucharist, and therefore rejects the sacramental definition of confirmation, making of it instead the public profession by the candidate of the faith into which he was baptized as an infant. Confirmation in Lutheran usage, as in Anglican usage, is therefore preceded by instruction in the catechism (*q.v.*).

Other Protestant bodies sometimes use the term "confirmation" for their acceptance of baptized members into the duties and privileges of full membership, including the right to receive the Eucharist.

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CONFISCATION AND EXPROPRIATION, in law, are terms applied to the compulsory transfer of private property to public ownership. Broadly speaking, the distinction between them consists in whether or not compensation is paid to the private owner. Confiscation involves taking without the payment of compensation; expropriation, on the other hand, normally implies such payment.

Confiscation.—The word confiscation derives from the Latin *fiscus* and means literally the adding of private property to the public treasury. The term originated in Roman law; and the practice gained in use as central political organizations acquired strength. The common-law concept of confiscation included three aspects: as a punishment for great crimes, as an act of the sovereign, and as a belligerent right against the property of enemies in war.

In the middle ages, confiscation developed into an important tool in the enforcement of the criminal law; since the criminal was seen as an enemy of society, his goods could rightly be appropriated to the common store. Forfeiture to the crown of the lands of persons attainted (*i.e.*, convicted and sentenced to death) of high treason thus gave rise to this form of confiscation (*see* ATTAINDER). Another example of confiscation in the medieval period was escheat (*q.v.*). Whenever a tenant of land was attainted of felony, his land was said to "escheat" (*i.e.*, fall back) to the feudal lord from whom he held. The doctrine of escheat was founded on the general principle of the feudal system that land should always be in the possession of someone; and an escheat occurred whenever a tenancy came to an end for whatever reason; *e.g.*, on the death of the tenant without heirs. There was a presumption that in the absence of proof to the contrary, the crown was the feudal lord and thus entitled to any land which escheated. With the decay of the feudal system and the disappearance of feudal lordships, this presumption operated more and more frequently, so that the crown became the chief recipient of escheated land. Escheat for felony, together with forfeiture to the crown, was finally abolished in England in 1870. However, although escheat for failure of heirs was also abolished in 1925, an escheat is still possible in certain circumstances.

In the early middle ages, property of subjects of an enemy nation was freely confiscated at the inception of warfare, but this practice declined with the rise of trade and commerce. Magna Carta provided for immunity of property of merchants of enemy nations for a certain period following the beginning of the war, a practice which increased in scope. This concept has since widened to include almost all of society, and international law recognizes extensive restrictions upon confiscation by belligerents. Confiscation is deemed permissible only in the case of goods especially of use for war materials or subsidiary activities. While this standard is seldom met in full, the trend in this direction is evident in the modern practice of seizing private enemy holdings only for the duration of the hostilities. (*See* LAWS OF WAR.)

The use of confiscation as an instrument of government power reached its zenith in the 16th and 17th centuries and has since declined. Its present use is ordinarily limited to the lawful use of the police power. An example is the seizure from private citizens of objects deemed obnoxious to public safety or unable to be put to a lawful use, such as gaming tables, fishing nets being illegally used, etc.

Expropriation.—Expropriation, unlike confiscation, is a flourishing and indeed expanding tool of modern government. The origin of the word expropriation is in the Spanish *expropriacion*, which originally constituted the taking of private land for public use in any fashion. While the term is sometimes applied to the transfer of property from one private individual to another, expropriation is properly only the transfer from private to public hands and, under later usage, is specifically the acquisition of private property under the right of eminent domain (*q.v.*). As such, expropriation implies legal process and just compensation for goods or property taken for public use, with judicial redress as a remedy for inadequate compensation. Expropriation is not ordinarily a method of supplying the common needs of the government but is directed toward the satisfaction of specific government objectives.

The right of the property owner to be adequately compensated for losses incurred by expropriation is recognized in international law and finds constitutional protection in many western nations. In the United States, the 5th amendment to the constitution provides that "no person shall be . . . deprived of life, liberty or property without due process of law; nor shall private property be taken for public use without just compensation." While this only limits the power of the federal government (*Barron* v. *Baltimore*, 7 Pet. 243), the U.S. supreme court has held that the 14th amendment imposes a similar limit on the power of state governments (*Chicago B. & Q. Ry. Co.* v. *Chicago*, 166 U.S. 226). In England, where there is no written constitution and hence no special safeguard against governmental power, there is a strong presumption of law that when an act of parliament authorizes the compulsory acquisition of private property, it is intended that adequate compensation shall be payable. This presumption, however, has not been called into operation, since in practice parliament has invariably provided for compensation in such statutes. The question of what constitutes just and adequate compensation is determined by a variety of factors, but the most common standard in both England and the United States is the monetary equivalent of the owner's loss. (F. H. HE.; T. S. LE.)

CONFLICT OF LAWS (PRIVATE INTERNATIONAL LAW). The law of conflict of laws has to do with the resolution of problems which result from the fact that there exists in the world a multiplicity of different sets of courts and of different systems of private law. As the earth is presently organized, its surface is divided among nations that are independent of each other and that have no world government above them. Each of these nations maintains its own set of courts in complete independence of every other nation, and each nation has its own set of laws, written or unwritten.

While in such countries as France, Sweden, Peru or Japan one single system of law obtains for the whole country, diversity exists in many others, especially nations organized upon a federal pattern, such as the United States of America, or Canada or, to a minor degree, Germany, Switzerland, Mexico or the Soviet Union. The law of Illinois is not the same as that of New York, Louisiana or Indiana; that of Quebec differs from that of Ontario or Newfoundland; that of Chihuahua is not quite the same as that of

Michoacán. In Germany and Switzerland the systems of private law are by and large uniform, but minor differences still exist between the *Länder* or the cantons.

Even in countries whose political structure is of the unitary rather than the federal pattern, differences can be found. In the United Kingdom of Great Britain and Northern Ireland considerable differences exist between the laws of England, Scotland, the Isle of Man, the Channel Islands and Northern Ireland.

Diversity of laws also exists frequently between a country and its colonies. The laws of Mauritius or Malta, for instance, are different from any of the laws prevailing in the United Kingdom, and, while in most other British colonies the laws are more or less patterned upon the model of the common law of England, they are not always exactly the same.

Diversity of laws develops where a country is divided, such as Germany, Korea or Vietnam. Where a new country is formed, or where territory is annexed, legal unity may not be brought about at the same time. After the reannexation of Alsace-Lorraine by France in 1920, for example, German private law remained in effect there for many years; and when Poland was formed out of parts of Russia, Germany and Austria, legal uniformity was not brought about until after the end of World War II.

Diversities of law within one country may also exist on an ethnic or religious basis. Such a situation commonly existed in most countries of the near and middle east; the laws concerning matters of the family, including succession upon death, remain different in India for Hindus, Muslims, Parsees and Buddhists, and in Lebanon or Israel for Muslims, Jews and the various groups of Christians. In the United States and Canada, American Indians are in several respects subject to their own tribal laws.

Because of the spread of western civilization over the entire planet, the laws of modern nations, at least as they are concerned with relations between private individuals, present a considerable measure of uniformity. They are sufficiently different, however, to make it important to know to what situations one ought to apply the law of one country, state, region or group rather than that of another, especially when dealings are carried on between persons of different law units. This question of determining which of the world's numerous laws is the proper one to apply in a particular situation is in itself a legal question. Those rules of law by which such questions of choice of law are determined constitute a major part of that field of the law which is known as private international law or, as it is usually called in the United States, the law of conflict of laws. Other parts of this field of the law are concerned with the problem of jurisdiction—*i.e.*, the problem of determining in what cases the courts of a particular country or state are, or are not, to go into action—and, furthermore, with the problem of stating what weight, if any, is to be given in one country or state to the judgments and other decisions of the courts or other agencies of other countries or states. In countries of the French legal tradition it is customary to regard as parts of private international law also those rules that deal with nationality and with the legal position of aliens and nonresidents. In accordance with Anglo-U.S. usage, however, the present article will be limited to jurisdiction, foreign judgments and choice of law.

Sources of Private International Law in General.—The name private international law seems to indicate that it is a part of international law; *i.e.*, that system of law that is superior to all sovereign states and that, at least in theory, is uniform throughout the world. This view was commonly held for many centuries, and when the name "private international law" was coined in the 19th century it was meant to signify that the supranational body of international law consisted of two parts, public and private international law. While the former would determine the proper conduct of sovereign nations toward each other in both peace and war, the latter would, in a uniform way, tell all nations in what cases their courts ought or ought not take jurisdiction, under what conditions foreign judgments were to be enforced or otherwise recognized, and in what cases the laws of one nation were to be applied rather than those of another.

Since the latter part of the 19th century, however, such a view has been considered an ideal rather than a true description of reality. Today, it is generally recognized that each nation not only determines what its substantive law (*i.e.*, its law of property, contracts, torts, family relations, succession, corporations, etc.) is to be, but also in what cases its courts are to have jurisdiction, under what conditions foreign judgments are to be recognized, and which country's law is to be applied in any particular case.

As on other matters, nations may, of course, conclude treaties, bilateral or multilateral, in which they assume in relations with each other the duty to deal with certain problems in an agreed way. Treaties of such a kind have been concluded between numerous states, especially among countries of Latin America and of continental Europe. The United States is a party to numerous treaties that mutually secure the right of citizens of the United States, on the one part, and of citizens of the other contracting country, on the other, freely to dispose of property owned in the territory of the country of which the owner is not a citizen, and to take such property as legatees, devisees, heirs or next of kin on the death of a citizen of the other country. A treaty providing that the citizens of each contracting country shall, in the courts of the other, be treated in their family affairs and other matters of personal status in accordance with the rules of their own law was concluded by the United States and Iran. United States treaties dealing with other problems of private international law are rare. No treaties at all have been made by the United States on enforcement and recognition of judgments or on jurisdiction of courts.

The United Kingdom and the other countries of the Commonwealth of Nations are parties to numerous treaties among each other and with other nations, concerning foreign judgments and mutual rights of owning, disposing and taking of property, but British treaties on other matters are as rare as United States treaties. Where a practical problem is to be handled, however, it is nevertheless advisable always to ascertain whether or not there is in effect a treaty by which the problem may be affected.

Even in those areas, such as France, Germany or Latin America, in which the bulk of private law is contained in codes and other statutes, the statutory provisions on private international law are fragmentary, and for large parts of the field the law must be sought in the decisions of the courts. In all countries the writings of scholars have been of considerable influence.

In the United States the creation of norms of private law belongs almost exclusively to the domain of the several states. Consequently, conflicts law, too, is by and large state law rather than federal law. While there might exist as many different bodies of U.S. private international law as there are separate states, territories and possessions of the United States, all these state and territorial laws greatly resemble each other. Differences exist, however, in many questions of detail, which are due to divergent judicial decisions or to the enactment of different statutes. In those matters which, as patents or shipping, are regulated by federal substantive law, the pertinent conflicts rules are also federal law. Federal law also obtains insofar as a matter of conflicts law is dealt with in a treaty of the United States. The power of each state freely to shape its private international law by its own statutory enactments and judicial decisions is limited in the constitution of the United States by the "full faith and credit" clause of art. iv, sec. i, and the "due process" clause of the 14th amendment, sec. 1.

In spite of the loosening of the legal ties between the member nations, conflicts law in the commonwealth has preserved a remarkable measure of uniformity. Those rules of private international law that have been and are being developed by the courts and legal scholars of England constitute a common fund of all parts not only of the United Kingdom and its dependencies but also of the entire commonwealth. Divergencies have begun to develop, however, through the conclusion of treaties by the several sovereign nations of the commonwealth and by the enactment of statutes by them as well as by their self-governing dependencies. In all those commonwealth nations that are politically organized upon the federal pattern, such as Canada, Australia and India, questions arise as to whether a certain problem of conflicts law

belongs to the legislative sphere of the central government or of the states or provinces.

Jurisdiction.—If a person wishes to bring a civil lawsuit against another person against whom he believes he has a claim, he might conceivably bring the action in any country of the world. If, however, a citizen and resident of the United States (for example) were to sue a citizen and resident of Canada in Panamá, a judgment obtained in Panamá would be of no use to him unless the Canadian owned in Panamá property which, if he did not pay, the U.S. citizen might attach there, or if the Panaman judgment could be enforced in such other country or countries in which he happened to hold property. For this practical reason the problem of where to bring suit is thus tied up with that of the enforceability of foreign judgments. However, even if a judgment might be of practical value to the plaintiff, he might find that the courts of the country in which he wished to bring his action would not receive it. As a matter of fact, all countries of the earth have limited their jurisdiction; *i.e.,* the scope of actions that they allow their courts to handle. Countries do not wish their courts to deal with lawsuits with which they have no proper contact, which might clog the calendars of their courts, or against which it would be unfair to compel a person to enter a defense on pain of having judgment by default rendered against him. Opinions differ, however, as to when it is regarded proper for a country to hear and decide a civil lawsuit. . This question is determined by each country for itself.

In composite countries, such as the United States of America, the United Kingdom, Canada, Switzerland or the U.S.S.R., rules are also necessary to determine in which of the several constituent states, provinces or other parts a civil lawsuit may be brought. In some states (for instance, the Federal Republic of Germany) this determination is made by the national law. It may be left, however, to each of the constituent states to determine for itself the scope of litigation which it will allow its courts to decide. Such, at least on general principle, is the situation in the United States, where the states' freedom of determination is limited, however, by the "due process" clause of the 14th amendment to the federal constitution, which in effect prohibits the state from exercising civil jurisdiction where it would be grossly unfair to do so. In the United Kingdom and the other countries of the commonwealth, the jurisdiction of its courts is also determined for each constituent part by its own law, but the principles of such determination do not differ widely from each other.

As a general principle, most countries or states agree that a case may be tried in their courts if both parties have consented to their jurisdiction. The plaintiff's consent simply appears from his commencing his action in the state in question; that of the defendant is presumed when, rather than objecting to the jurisdiction, he confesses judgment or begins to litigate on the merits of the controversy. Some countries, nevertheless, close their courts to a litigant whose case has no more substantial connection with them than the parties' consent. French courts, for instance, will not try a lawsuit between foreigners unless it arises out of controversy that has some real connection with France, such as the allegation of a breach of a contract to be performed in France, or a tort committed in France, or title to land situated in France. As another example, the courts of New York regard themselves as an "inconvenient forum" for suits between nonresidents concerning a tort committed outside New York. With few exceptions Anglo-U.S. courts will not try controversies concerning title to, or trespass upon, land situated outside the state.

Generally, however, the problem of jurisdiction does not become acute unless the defendant objects to the case's being tried in the country or state of the plaintiff's choosing, or unless he fails to appear. Different approaches to this problem of jurisdiction are followed in the countries of the civil-law tradition and in those of the Anglo-U.S. common-law tradition. The former start from the idea that the proper place for a person to be sued is his domicile or residence. In civil-law systems, in general, a person may always be sued at his residence and must not be sued in any other place. Many exceptions to the latter principle exist, however. An adjudication of the title to a piece of land, for instance, must be brought where the land is situated. A suit arising out of an alleged tort may be brought in the place where the tort is alleged to have been committed, and a suit based upon an alleged breach of contract may be brought in the place in which it is alleged that the alleged contract was to be performed.

Some countries, for instance Germany, allow an absent defendant to be sued in their courts if he owns within the country any property. France keeps its courts open for suits of any kind brought by a French national against a foreigner. A large number of states, including those adhering to the Anglo-U.S. common-law tradition, allow a civil suit to be commenced by the attachment of property owned within the territory, the enforcement of a default judgment obtained being limited, however, to the assets thus attached.

In their general approach to the problem of jurisdiction, the common-law countries still proceed from the long-obsolete notion that no civil suit could be commenced in any way other than by the defendant's arrest by the sheriff. Consequently, an action can still be brought in any place in which the defendant is personally served with process, even though he may be there only for a few minutes to change airplanes. In modern times it has come to be widely held, however, that personal service upon the defendant is no longer an indispensable requirement of jurisdiction and that an individual may be sued in the state of his residence, even if the summons is not personally pressed upon him. A corporation can always be sued in the state in which it has been incorporated.

In the United Kingdom and other units of the commonwealth, the court may allow the defendant to be served outside the jurisdiction in a number of special situations, especially when the suit is based upon a breach of contract performable within the jurisdiction, or upon a tort committed within the jurisdiction.

Using the "due process" clause of the 14th amendment to the U.S. constitution, which forbids the states to "deprive any person of life, liberty or property without due process of law," the supreme court has held that a state may not exercise jurisdiction against an absent defendant unless the case has such minimum contact with the state that the maintenance of the suit does not offend traditional notions of fair play and substantial justice (*United Shoe Company* v. *State of Washington,* 326 U.S. 310; 66 S.Ct. 154 [1945]).

It is thus required that an honest effort be made to give the defendant actual notice that a lawsuit is about to be brought against him. The mere publication of the summons in a newspaper or at the bulletin board of the court is not sufficient unless the address or identity of the defendant cannot be ascertained upon a reasonable effort.

Quite generally, states of the United States are now coming to allow their courts to exercise jurisdiction in suits arising out of breach of contract to be performed within the state, or out of a tort, especially an automobile accident, that occurred within the state. In many states a corporation may be sued if it is simply "doing business" there, even though the suit in question is totally unconnected with the state.

In both civil- and common-law countries special rules apply for suits in which the plaintiff aims at a judgment *in rem; i.e.,* a judgment which, rather than adjudging a defendant indebted to pay a certain sum of money or ordering him to do, or not to do, a certain act (*e.g.,* deliver a deed to a piece of land, or refrain from using a trade-mark), produces by its own effect a change of the legal situation (for instance, the foreclosure of a mortgage, the removal of a cloud on a title to land, the dissolution of a marriage, the creation of an adoptive parent-child relationship, etc.). Lawsuits aiming at the court's changing the title to a piece of land can universally be brought nowhere but in the state in which the land is situated. Actions arising out of transactions connected with shipping can generally be brought in the port in which the ship in question happens to find itself. For actions for divorce, civil-law countries generally keep their courts open to their nationals even if they reside abroad.

Foreign Judgments.—If a creditor has obtained against his debtor a judgment for $1,000 in Mexico or in Michigan, and his

debtor does not have sufficient property in that country or state, can he enforce it in Illinois, where the debtor owns land, keeps a bank account or owns other assets? If someone has brought and lost a lawsuit in New York, can he start it all over again in California or in Peru? If the marriage of Mr. and Mrs. Smith has been terminated by a decree of divorce of a court in Nevada, or by an act of the parliament of Canada, or by the order of a district governor in Norway, and Mr. Smith wishes to remarry in Wyoming or in South Africa, will he be given a licence? If he remarries will his new marriage be valid or does he have to go to jail as a bigamist? If a citizen of the United States residing in Wisconsin adopts a child of German parents residing in Germany and the adoption has been confirmed by a court of Wisconsin, will the child inherit on the adopter's death a piece of land situated in Indiana or an account in a bank in Germany or in Switzerland?

Unless countries have bound each other by treaty mutually to enforce their civil judgments, each country is free as to whether or not, and, if at all, under what conditions, it wishes to enforce or otherwise recognize foreign judgments. The attitudes of the several countries vary considerably in this respect, and the treatment of the enforcement of money judgments is not the same as that of the recognition of a judgment as a bar to the starting of a new suit all over again (*res judicata* effect), or the recognition of the termination of a marriage by a decree of divorce or of other changes of private legal relationships brought about by judicial act.

If a judgment for money is not promptly paid by the debtor, it is enforced by the attachment and sale of his property, the proceeds being turned over to the creditor. Such enforcement is generally the task of a public officer, such as the sheriff, who is empowered, where necessary, to break resistance with physical force. While a sheriff knows well enough the looks of a judgment of his own state, he cannot be expected, or even allowed, to go into action simply upon the basis of a paper purporting to be the judgment of a foreign state with whose judicial system, language or even script he cannot be expected to be familiar. For the protection of the citizen as well as of himself, it is indispensable that, before the sheriff or other enforcement officer goes into action, the foreign judgment be transformed into a domestic one. Some countries, such as the Netherlands or Sweden, simply limit enforcement to domestic judgments. Even if the creditor has obtained a judgment abroad, he must start regular proceedings all over again, and the only advantage the foreign judgment provides for him lies in the fact that the Dutch or Swedish court will be inclined to regard it as good, although in no way conclusive, evidence of the well-foundedness of his claim. In most other countries, however, a domestic judgment will be supplied by a domestic court without a reopening of the dispute about the merits of the creditor's claim. All the domestic court will inquire into is the regularity of the proceedings in which the foreign judgment was obtained, especially if it is a judgment by default. For this transformation of a foreign into a domestic judgment, the majority of the civil-law countries provide a kind of special proceeding (*exequatur*) which is supposed to be, but is not always, simpler and less expensive than an ordinary civil lawsuit. In the common-law countries it is necessary to bring upon the foreign judgment an action that in outward form is a regular civil lawsuit but that is, at least in the normal case, simple and speedy. In the United Kingdom and the commonwealth a simplified mode of domestication is furnished by agreements and statutes providing, in certain cases, for the simple registration in one law unit of judgments rendered in another. In the United States a similar method exists in the relations between those states that have adopted the Uniform Enforcement of Foreign Judgments act.

Where a foreign judgment is not sought to be enforced by attachment of the debtor's property or similar measures, but where its *res judicata* effect is simply raised as a defense in a domestic lawsuit, or where the question is simply that of recognition of its law-changing effects, such as the termination of a marriage by a decree of divorce, it would seem to be unnecessary to require the formal transformation of the foreign into a domestic judgment by any special proceedings. Some countries (for instance, Italy and, to a more limited extent, France) nevertheless require such formal domestication for decrees of divorce and other judgments purporting to affect the personal status of their nationals.

In the United States the constitution (art. iv, sec. i) provides that "full faith and credit shall be given in each state to the public acts, records and judicial proceedings of every other state." Under this clause the states, and by statute the territories, are obliged mutually to enforce their money judgments and to recognize the *res judicata* and law-changing effects of their judicial acts, provided the state by which the judgment was rendered was acting within the scope of its jurisdiction as defined by the supreme court of the United States. The only other defenses that might be raised are grave irregularity of the proceedings in which the judgment was obtained and, in certain cases, lack of finality.

Where the judgment in question is that of a foreign country, a U.S. court will follow the general principles of the common law under which a foreign judgment is willingly enforced and otherwise recognized unless (1) the country by which it was rendered lacked jurisdiction according to the notions prevailing in the place where recognition is sought, or (2) the proceedings in which the judgment was obtained were tainted with fraud or were otherwise grossly unfair, or (3) the recognition or enforcement of the foreign judgment would seriously interfere with an important public policy of the state where recognition or enforcement is sought. In addition to these requirements, most civil-law countries (except, of course, those few in which foreign judgments as such are not enforced at all) also demand that reciprocity with the country whose judgment is sought be recognized. In many civil-law countries a foreign judgment concerning a matter of personal status of a citizen also will not be recognized unless the foreign court has observed certain rules of the substantive law of the country where recognition is sought.

Nowhere will a foreign judgment be enforced or recognized unless the state by which it was rendered had jurisdiction to do so under the notions obtaining where recognition is sought. These limits are sometimes wider, however, than those which a country will concede to others for the exercise of their jurisdictions. While France, for instance, holds its courts open for all suits of a Frenchman against a foreigner, a U.S. or English court will not recognize a default judgment obtained in such an action unless the defendant was served with process in France, or was a resident of France or had some other contact with that country which justifies his being sued in France.

In matters affecting personal status, especially divorce, civil-law countries generally recognize judgments rendered by the courts of the country of which the parties are nationals. Under the common law of England a decree of divorce will not be recognized unless it was rendered by the state of the domicile of the husband. After World War II, however, there were enacted in some parts of the commonwealth statutes under which a wife living separately from her husband might also sue for divorce in the state of her residence, and a decree thus obtained is likely to be recognized in the other parts of the commonwealth.

In the United States the supreme court has determined that a divorce granted in one state must be recognized in all others if the state by which it was granted was the state of the true residence of the plaintiff (*Williams* v. *North Carolina,* 317 U.S. 287; 63 S.Ct. 207 [1943]) or if the defendant actually participated in the proceedings without contesting the plaintiff's allegation of residence (*Sherrer* v. *Sherrer,* 334 U.S. 343; 68 S.Ct. 1087 [1948]; *Johnson* v. *Muelberger,* 340 U.S. 581; 71 S.Ct. 581 [1951]). Since the courts of certain states (for instance, Nevada) tend to take as true the unproved and uncontested allegations of the plaintiff as to cruelty or other grounds for divorce, the supreme court of the United States has thus rendered it possible for the residents of all states of the union to obtain a divorce by mutual consent, although that kind of divorce is not provided in the official law of any of the states. Where a divorce has been obtained by one spouse without the co-operation of the other, recognition may still be denied upon the ground that the state by which it was granted was not that of the true residence of the plaintiff (*i.e.,* the state in which he in-

tends to live indefinitely), even though he actually may have been within it for six weeks or longer (*Williams* v. *North Carolina*, 325 U.S. 226; 65 S.Ct. 1092 [1945]).

Even though a state may have jurisdiction to terminate a marriage, it does not necessarily also have jurisdiction to order the defendant to pay alimony or child support, or to terminate a husband's duty to pay separate maintenance. In order to have jurisdiction in such latter respects, the party adversely affected must either have participated in the proceedings or must have been a resident of the state or must have been personally served with process within it.

Choice of Law: General Problems and History.—Ordinarily the courts of Illinois decide the civil cases coming before them under the law of Illinois, those of Scotland under the law of Scotland and those of Belgium under the law of Belgium. Occasionally it happens, however, that a court of New York decides a problem in accordance with the norms of the law of Illinois, Quebec or Thailand, or a court of the Philippines under the law of Indonesia, Victoria or Massachusetts. Those rules that tell the court of a country or state under what circumstances it ought to decide a problem not under the law of its own state or country but under that of another and, if so, of which other, constitute the choice of law part of that state or country's law of conflict of laws or private international law.

The notion that the courts of a state should ever have to decide problems under foreign law rather than invariably deciding all problems coming before them under the law of their own state is by no means self-evident. It has its rationale mainly in the thought that it would be unjust to the parties concerned if a problem were decided under a law of which they had not thought at the time of entering the transaction out of which their litigation arises.

However, the necessity to apply the law of a foreign state or country constitutes an inconvenience to the court and the parties. While judges are familiar with the law of their own state, they cannot be expected to be familiar with that of the whole world. Foreign law must therefore be specially pleaded and proved, often at considerable inconvenience and expense.

The problem of the choice of law, of course, arises only where the laws of the states in question are different. In the Roman empire it was avoided, although the laws of its numerous communities were, it seems, widely different from the law of the city of Rome as well as among themselves. Side by side with the law of the city of Rome (which, as the *jus civile* or *jus quiritium*, was the privilege of the citizens of the dominant city), the jurists of the late republic and the early empire synthesized another body of law, which they believed to constitute an amalgam of the laws of all nations and which, as the *jus gentium*, was applied by the Roman authorities in litigations between citizens of different communities. In the later empire this *jus gentium* practically came to swallow up the *jus civile* and thus to be, at least officially, the uniform law of the empire. (*See* ROMAN LAW.)

Problems of choice of law also do not arise where courts, while applying no law other than that of their own state, refuse to take jurisdiction in cases in which decision under that law would be inappropriate. For many centuries this approach was followed by the common-law courts of England, which could assemble a jury from no county other than that within which there had occurred the events out of which the cause of action had arisen. Cases arising out of transactions of international trade were decided by such bodies as the courts merchant, the admiralty or the council, which, looking to the law merchant, applied a law that was more or less uniform throughout Christendom. In consequence of the Revolution of the 17th century, the judicial activities of these bodies were curtailed and, if serious denials of justice were to be avoided, the common-law courts had to assume jurisdiction in supra-English cases. They did so in a typical common-law fashion: The plaintiff would allege that Honfleur, Hamburg, Calcutta or any other foreign place where a contract was made or a tort had occurred was situated in the county of Middlesex, Eng. The defendant was not allowed to "traverse" this strange geography, a jury was then convened from Middlesex and the case would be decided by the English court, which, of course, applied the common law of England. Injustice was, however, to arise until, in the middle of the 18th century, the English judges discovered that on the continent suits having supraterritorial contacts had for centuries been handled in a different method; *i.e.*, that of choice of law.

This method is generally said to have been developed in the cities of northern Italy, when, from the 11th century on, trade among them assumed considerable proportions and the common law of the Holy Roman empire was altered and supplemented by numerous local statutes. Which statute was to apply to a contract made between citizens of different cities or to other intercity transactions? The problem attracted the attention of the students of the newly revived science of law, especially at the central seat of medieval legal learning, Bologna. The most celebrated of these "statutist" scholars was Bartolus de Sassoferrato (1314–57), whose influence remained considerable into the 19th century. From Italy, the centre of conflict of laws learning shifted in the 15th century to France (D'Argentré, 1519–90; Dumoulin [Molinaeus], 1500–66) and in the 17th to Holland. A short article of the Dutch jurist Ulrich Huber, entitled *De conflictu legum diversarum in diversis imperiis* ("On the conflict of the different laws of different empires," 1700), which may have become known in England through Lord Mansfield, came to be enormously influential on the lawyers and judges of England as well as upon Joseph Story, an associate justice of the supreme court of the United States, who wrote the first major treatise on the subject in English (1834). Story's work was of far-reaching influence not only in the common-law countries but, through the German jurist Friedrich Karl von Savigny, also in the countries of the civil law (the latter's treatise, *System des heutigen römischen Rechts,* vol. 8, was published in 1849).

Building upon the foundation laid by Story, Anglo-U.S. courts decided a vast variety of cases in typical case law fashion, while in the civil-law countries the field was dominated by scholars whose fertile thoughts greatly helped to develop the field but whose exaggerated conceptualism sometimes created unnecessary difficulties and inappropriate rules. Their doctrines were discovered in the common-law countries just when they had spent their force and the continental European scholars, especially of Germany, had begun to develop a new, vigorously realistic method. In the United States, conceptualism was carried to an extreme by Joseph Henry Beale in the American Law institute's *Restatement of the Law of Conflict of Laws* (1934). This work, which was intended to be an authoritative guide to a field in which U.S. lawyers still do not feel fully at home, was so severely criticized that in 1954 a complete revision of the *Restatement* was undertaken by the American Law institute so as to bring it into better accord with practical needs.

As is the case with the law on jurisdiction and on foreign judgments, the law of choice of law is a part of the national law of each country and, in the United States, of state law. Efforts of the supreme court of the United States through the "due process" or the "full faith and credit" clauses of the constitution to control the states in their choice-of-law rules have been sporadic and inconsistent.

The nature of the problems and the common origin of the field have led to the result that the choice-of-law rules of the earth's several law units do not differ very much from one another. The choice-of-law rules of the common-law countries present a particular measure of uniformity. Enough differences exist, however, to disturb international and interstate relations.

Its Several Rules.—The impracticability of much of the effort of the scholars of the late 19th and early 20th centuries was caused by their attempt to reduce the whole field of choice of law to a few principles that could be expressed in a small number of highly generalized maxims. Since the problems of choice of law are almost as manifold as those of substantive private law, these efforts turned out to constitute oversimplifications. Mid-20th century writers and courts regarded it as their task patiently to elaborate those detailed rules of narrow application that are necessary to do justice to the infinite variety of actual life. The

results of these efforts can be found in the works listed in the bibliography. Here no more can be done than state some over-all approaches; these must not be regarded, however, as rules of immediate applicability.

As to problems concerning an individual's personal status (*e.g.*, whether or not he has capacity to marry; what are the mutual rights between a husband and his wife, or between parent and child; or whether or not one individual is the legitimate child of another), it is universally held that they are to be decided under the law of that unit to which the individual in question "belongs." Under the view prevailing in most, but not all, civil-law countries, a person "belongs" to that country of which he is a national. This approach is of little help where a person is a national of a country, such as the United Kingdom or the United States, that does not have a uniform system of private law. In the common-law countries "belonging" is thus expressed in terms of either "domicile" (United Kingdom) or "residence" (United States). Difficult choices or combinations have to be worked out for cases involving relations between persons "belonging" to different law units. As to the formalities required for the conclusion of a marriage, observance of those of the place of celebration is widely held sufficient and in many laws is even required.

Legal problems concerning title to land are universally held to be determinable under the law of the place where the land is situated. The application of the situs principle to movables meets with difficulties because of their movability. In common-law countries, problems of succession to property upon death are also referred to the law of the situs insofar as land is concerned. In civil-law countries a tendency exists, however, to decide such questions under the law of the country of which the decedent was a national. That law is also applied in civil-law countries to problems concerning succession to movables, while common-law countries in this respect look to the law of the decedent's domicile or residence. Special rules apply, however, to the making of a will. As to the formalities required, it is widely held to be sufficient that the testator has observed those that are stated in the law of the place where he executed the instrument. As to interpretation and construction of a last will, detailed choice-of-law rules are necessary to take care of the great variety of possible situations.

Problems of the law of torts are almost universally referred to the law of the place where the tort is alleged to have been committed. But where is that place when a person acting in one state injures a person in another state, as, for instance, when *A*, canning spoiled food in state *Z*, injures the health of *B*, who bought the can in *Y*, ate the contents in *X*, fell sick in *W* and died in *V*; or where a defamatory speech is broadcast over a powerful transmitter and heard over a wide area of different states?

The greatest difficulties have arisen in the field of contract. Many courts and writers, especially in the United States, have held that problems of the law of contract are generally to be decided under the law of the place where the contract was made. Under a refinement of this theory, problems concerning performance are to be decided under the law of the place where the contract was to be performed. But where is a contract made when it was concluded by the exchange of letters between San Francisco and Chicago, or New York and Paris? Where is the contract of sale to be performed when the seller has to obtain the goods in New Orleans and ship them from New York to Amsterdam, and the buyer, a business firm in Oslo, has to pay the price at a bank in London? Furthermore, what intrinsic connection with the parties' relationship does the place of contracting have at all, if, as frequently happens, the contract was made at a place at which quite accidentally the parties' minds met. Should Utah law really be applied to a contract concluded by a New Yorker and a Californian while they were flying over Utah in an airplane?

The view most widely followed by the courts of both civil-law and common-law countries is that problems concerning an alleged contract are to be decided in accordance with that law which the parties expressly agreed to be applicable, or which is recognizably that law upon the basis of which the parties negotiated and made their contract. Theoretical objections to this practical view still carry some weight, especially in the United States. Where no particular law can be discovered as the one upon the basis of which the parties transacted their business, detailed differentiations must be made depending on the kind of contract in question (sale, insurance, transportation, contract for services, suretyship, etc.) and on the particular problem to be decided. Although the field of contract is the most important for interstate and international trade, it is the one beset with the most uncertainties as to choice of law. Fortunately, the substantive laws do not widely differ from each other, and business has learned to avoid many of the difficulties through resorting to arbitration and appropriate drafting. Through skilful draftsmanship the experienced international lawyer can prevent many of the difficulties which can so easily arise under private international law.

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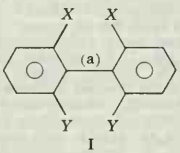
CONFORMAL REPRESENTATION: *see* Analysis, Complex.

CONFORMATIONAL ANALYSIS. Conformational analysis may be described as the correlation of the preferred shapes or conformations of organic molecules with their chemical and physical properties. Frequently it is possible to assume a preferred conformation from the molecule and thus to deduce something of its chemical and physical properties.

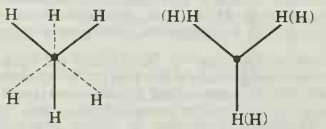
The true nature of an organic molecule is defined only when its constitution, its configuration and its conformation are known. The first indicates the order in which the constituent atoms are joined together. The question of the configuration of a molecule arises only when there is a centre of asymmetry present, such as a saturated carbon atom attached to four different groups or a double bond asymmetrically substituted by two or more different groups. By assuming free rotation about all single bonds and restricted rotation about double bonds J. H. van't Hoff in 1874 deduced that the number of isomers (*see* Isomerism) arising from the presence of n centres of asymmetry would be 2^n. Much experience has proven the correctness of this theory. The number 2^n represents, in principle, stable molecular entities having the same constitution but differing in configuration. Each different configuration is, of course, nonsuperposable on any other.

Evidence that the assumption of free rotation about carbon-carbon single bonds required modification first appeared when it was shown that certain 2:2′:6:6′-tetrasubstituted diphenyls (I; X and Y = substituents) could be resolved into stable optical isomers. J. Kenner and E. E. Turner postulated in 1926 that the asymmetry was produced by restricted rotation about the single bond (a) in I due to the bulkiness of the substituents X and Y.



I

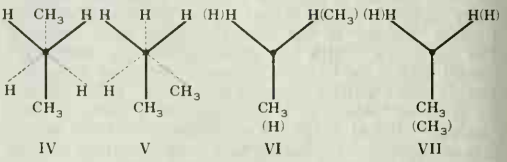
In 1936 the methods of chemical physics showed that restriction of rotation about single bonds was common to all organic compounds and that certain arrangements of bonded atoms in space were preferred. It is convenient to use the word conformation (W. N. Haworth, 1929) to describe an arrangement in space of the atoms of a molecule of defined configuration which is not superposable upon any other. From this definition it follows that an infinite number of conformations are possible even for as simple a molecule as ethane, $CH_3—CH_3$. However, only two extreme conformations, shown in II and III looking down the carbon-carbon axis, need be discussed. In II, the staggered conformation, the hydrogen atoms are as far away from each other as possible and the energy of the system is at a minimum, whereas in III the



II III

hydrogen atoms are as close as possible and the energy is at a maximum. The energies of the infinite number of conformations which lie between these two extremes are also intermediate. Thus ethane at normal temperatures will exist mainly in the staggered low-energy conformation but as the temperature of the gas is raised, *i.e.*, energy is introduced into the system, then an increasing proportion of it will adopt conformations of higher energy.

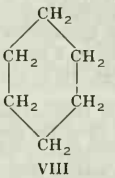
In n-butane ($CH_3—CH_2—CH_2—CH_3$), there are four limiting conformations shown in IV, V, VI and VII. That of lowest energy is IV in which the methyl groups are as far apart as possible, next comes the staggered arrangement V in which the methyls are fairly close together. Of the high-energy arrangements VII, in which the methyls are opposed, is less stable than VI, in which methyl is opposed to a hydrogen. Thus it can be seen that, in general, the preferred conformation is that in which the largest groups are farthest apart; this is due to the interaction of the non-bonded atoms whose electron atmospheres repel each other.



IV V VI VII

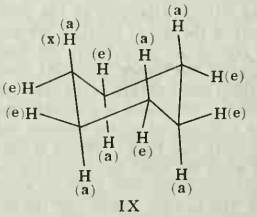
The barriers to free rotation in ethane, n-butane and related molecules are only of the order of a few kilogram calories per mole. Although this is sufficient to ensure that the molecules exist in the preferred staggered conformations it is far too small to allow the separation of stable isomers.

In 1890 H. Sachse pointed out that, if the valency angles of carbon were retained at the natural tetrahedral angle of 109° 28′,



VIII

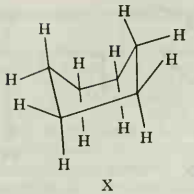
then cyclohexane (VIII) could exist in two conformations free of angle strain. These are usually designated the chair (IX) and boat (X) conformations. In IX all the bonds are staggered with



IX

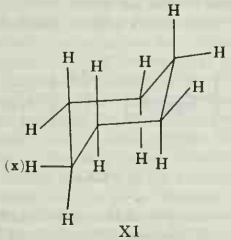
respect to their neighbours, whereas in X there are six pairs of opposed interactions. Thus it would be expected that the chair conformation (IX) would be the more stable. This has, in fact, been established experimentally beyond question, a direct physical proof being provided by the electron diffraction work of O. Hassel (1948) and supported by statistical mechanical studies (K. S. Pitzer, 1948).

In IX it can be seen that two geometrically distinct types of carbon-hydrogen bond are present. Six of the bonds are parallel to the threefold axis of symmetry of the ring and are called axial bonds (D. H. R. Barton, Hassel, Pitzer and V. Prelog, 1954).



X

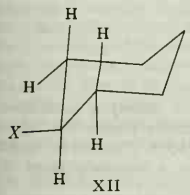
The other six carbon-hydrogen bonds, placed in an equatorial belt around the molecule, are called equatorial (e). The conformation IX can be inverted to the alternative, but in every way



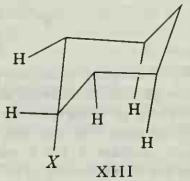
XI

equivalent, chair (XI) simply by movement of all carbon atoms through a plane. In this process an axial hydrogen—say (x) in IX—becomes equatorial ([x] in XI) and vice versa. The energy to effect this process is only a few kilogram calories and therefore it is not possible to isolate boat and chair conformational isomers in cyclohexane or its derivatives.

Monosubstituted cyclohexanes can, in principle, have the substituent in the axial or equatorial arrangement, the two alternatives being different conformations of the molecule. In fact, it is the equatorial orientation which is favoured except in exceptional circumstances. In the equatorial conformation (XII) the substituent *X* is close enough in space to interact only with the two equatorial and two axial hydrogens on the methylene groups proximate to the C—*X* bond; *i.e.*, four 1:2 H:*X* interactions. Note that the geometry of the molecule is such that all 1:2 H:*X* interactions are identical. Similarly in the axial conformer (XIII) the substituent interacts with the two equatorial hydrogens on the



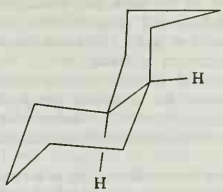
XII



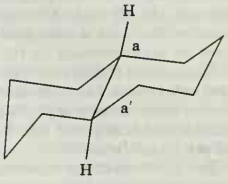
XIII

adjacent carbon atoms and with the two axial hydrogens on the next but one carbon atoms; *i.e.*, two 1:2 H:*X* and two 1:3 H:*X* interactions. When H:H interactions are considered it is found from models that the 1:2 hydrogens are the same distance apart as the 1:3 axial hydrogens and thus have the same repulsive energy, but if any substituent larger than H is introduced then the 1:3 axial distance is smaller than the 1:2 distance which will therefore have a smaller energy of interaction.

So it may be said that, in general, substituted cyclohexanes tend to exist mainly in the conformation in which the largest group is in the equatorial position or, if more than two substituents are present, with the largest number of groups in the equatorial positions. This general rule does not always hold when the substituents have appreciable dipole moments for, in these cases, the dipoles tend to be oriented in opposite directions and this may be in opposition to placing the maximum number of substituents in equatorial orientations.



XIV

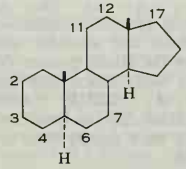


XV

In compounds of the decalin series two cyclohexane rings are fused together. By arguments such as those discussed above it can be predicted that cis-decalin (XIV) is less stable than the trans isomer (XV). In XIV conversion of equatorial to axial substituents is again possible by inverting the conformation. However, in XV this is impossible since the bonds, a and a′, are equatorial with respect to the other ring and to make them axial would give rise to an impossibly strained ring. In the case of XIV these corresponding bonds are axial and equatorial respectively and the inversion of conformation would merely change them to equatorial and axial respectively. Thus in polycyclic systems where one or more rings are trans-fused the axial and equatorial isomers are not interconvertible. It is in these cases where the rigidity of the molecule prevents there being any ambiguity about the orientation of substituents that conformational analysis has made its most important contributions. The fundamental tenet of conformational analysis is that the preferred conformation of a molecule can be related to its physical and chemical properties. This was first shown in polycyclic systems in 1950 by Barton, mainly with examples from the steroid field.

The most important applications of the above theory may be divided into two classes—first, molecular properties which may be equated directly to a preferred conformation, and, second, molecular properties resulting from the interplay of conformational preferences and the geometrical requirements of the transition states of organic reactions. In the first class may be grouped such properties as specific bands in the infrared or ultraviolet spectrum of a compound. For example in α-halogenocyclohexanones if the halogen is equatorial, the infrared maximum of the carbonyl group is displaced but if the halogen is axial the frequency remains unchanged. In the ultraviolet spectrum the opposite holds true; thus in an axially substituted α-haloketone there is a displacement of the ultraviolet maximum but not in the corresponding equatorial compound.

Direct correlations are also seen between chemical properties controlled by steric compression such as acylation and ester hydrolysis rates and preferred conformations. Since it is known that the greater stability of equatorial over axial alcohols is due to steric overcrowding in the latter it would be expected that acylation of a hydroxyl in the equatorial position would be less hindered and thus proceed more rapidly than in the case of the axial analogue. Similarly it would be predicted that hydrolysis of equatorial esters would occur more rapidly than in the case of the corresponding axial compounds. This has been amply proven in the case of various steroidal alcohols where the axial and equatorial pairs were examined with hydroxyl groups at the positions numbered in XVI. That the equatorial alcohol is more stable



XVI

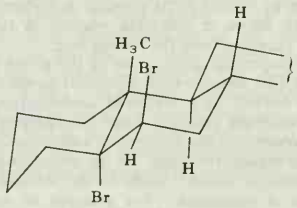
than the axial has also been demonstrated in these steroidal alcohols, mainly by reduction of the corresponding ketone with sodium and an alcohol to a mixture of the axial and equatorial isomers. In all cases the equatorial alcohol preponderates and must be the more stable since reduction under these conditions gives an approximation to the equilibrium mixture.

The greater stability of the equatorial over the corresponding axial substituent has been demonstrated for numerous groups in various environments, especially in rigid fused ring systems such as steroids and triterpenes where the configuration of a substituent defines its conformation.

This ability to define unambiguously the conformation of a compound is particularly important in the second way in which conformational analysis is applied; *i.e.*, the analysis of reaction mechanisms. Although flexible compounds such as substituted cyclohexanes usually exist in one preferred conformation this does not mean that they have to react in this form. For example, cyclohexylbromide exists mainly as the equatorial conformer but it is almost certain that when it is dehydrobrominated to cyclohexene the form which reacts is the axial isomer. It is thus in rigid systems where the conformation can be rigidly defined that conformational analysis can be applied most fruitfully.

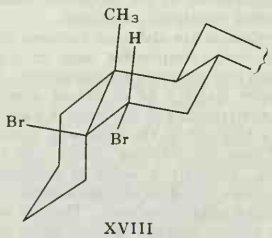
The transition state of lowest energy for an ionic bimolecular elimination requires that the four centres involved be in one plane. This requirement is fulfilled (the two joined carbon atoms with their attached substituents) by trans-1:2-diaxial substituents in conformationally rigid cyclohexane systems but not by trans-1:2-diequatorially substituted compounds or by either of the cis (equatorial axial) isomers.

For example, 5α:6β-dibromocholestane (represented in partial formulation by XVII) has two axial bromine atoms. It is debro-



XVII

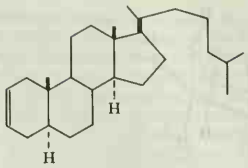
minated by iodide ion much faster than its 5β:6α-isomer (XVIII) where both bromines are equatorial. As a corollary to this rule



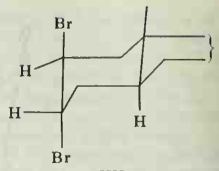
XVIII

it has also been established that electrophilic addition to double bonds gives the trans diaxial product; in most cases this is the thermodynamically less stable one. Thus cholest-2-ene (XIX) gives mainly the diaxial 2β:3α-dibromocholestane (XX). Similarly, it has been shown that epoxides, such as cholest-2-ene α-epoxide (XXI), give the diaxial product (*e.g.*, XXII) on ring opening although they could conceivably give the more stable diequatorial products; *e.g.*, XXIII. Conversely it has been shown that the diaxial halohydrins on treatment with alkali reform the epoxide ring much more rapidly than do the corresponding diequatorial compounds.

Although conformational analysis can be more favourably ap-

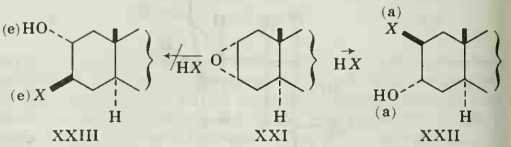


XIX



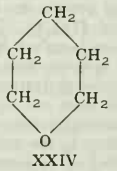
XX

plied to rigid systems it has also been widely and fruitfully used in aliphatic and heterocyclic systems, and also in large and small ring compounds though the latter do not have the symmetrical perfection of the cyclohexane ring. The substitution of hetero atoms such as nitrogen and oxygen for one or more of the carbon atoms of a cyclohexane ring causes only a slight distortion of chair



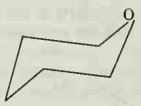
XXIII XXI XXII

conformation. In consequence the generalizations that have been found pertinent in cyclohexane chemistry can be carried over in main part to heterocyclic analogues. Thus tetrahydropyran



XXIV

(XXIV) may be represented by the conformation XXV. Many of the compounds of carbohydrate chemistry contain the tetrahydropyran ring and it has been shown that the chair conformation



XXV

(XXV) is adopted wherever possible.

Although conformational analysis is mainly a qualitative interpretation of observations, quantitative studies are beginning to be of interest. It was first shown by S. Winstein in 1955 that the rate constant k for a reaction of a monosubstituted cyclohexane can be expressed as

$$k = k_a N_a + k_e N_e$$

where k_a is the rate constant for a pure axial conformer, k_e the constant for the equatorial conformer and N_a and N_e represent the mole fractions of axial and equatorial conformers present ($N_a + N_e = 1$). Winstein and also E. L. Eliel initiated studies on the validity of this equation.

This quantitative approach assumes, of course, that the reactivity of the molecule can be defined in terms of 1:2- and 1:3-interactions (*see* above). The rates of certain condensation reactions of steroid and triterpenoid ketones have been investigated (Barton, 1955 and later) keeping the 1:2- and 1:3- interactions constant. It is found that the rates of reaction vary in a remarkable manner for remotely placed substituents. This has been regarded as due to conformational transmission; *i.e.*, the transmission of the effects from one ring to another through the whole

molecule. *See* also ISOMERISM; STEREOCHEMISTRY: *Conformational Analysis.*

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CONFUCIANISM is, and has been for more than 2,000 years, the dominant philosophical system in China and the controlling factor in many aspects of Chinese culture. Understanding of it is basic to any understanding of traditional Chinese civilization.

HISTORY

The Confucian school owes its name to Confucius (551–479 B.C.), the most revered person in Chinese history. In Chinese it is called *Ju* ("weaklings"), referring to a group of specialists on the six arts of ceremonies, music, archery, charioteering, history and numbers, of whom Confucius was one. Because of his strong sense of social responsibility and dedication to social and political reforms, however, Confucius transformed the *Ju* of the weak into the *Ju* of the strong. He and his followers traveled from one state to another trying to persuade the feudal lords to carry out social reforms. Though they had no rigid program they did have what they called the Way, or the "one thread," that runs through Confucius' teachings. This is the Way of *jen* ("humanity" or "love"). They wanted the individual to be a "superior man"—that is, a man of perfect virtue, who, wishing to establish his own character, also helps others to establish theirs. They wanted the family to be harmonious, the state to be well ordered and the world to be at peace. In short, they taught moral self-cultivation and social and political order through moral efforts. They were not only teachers, however, but people primarily devoted to reforms.

Confucius' followers, though they adhered to his fundamental doctrines, were by no means unanimous in their thought. In the 5th century B.C. two clearly divergent tendencies developed. One, represented by the *Great Learning* (*Ta-hsüeh*), was social and political in character. This short classic, the text of which has been attributed to Confucius and its commentary to his pupil Tseng-tzu (505–436 B.C.), aims at "manifesting one's clear character, loving the people, and abiding in the highest good." This is to be accomplished through the eight steps of (1) investigation of things, (2) extension of knowledge, (3) sincerity of the will, (4) rectifying the mind, (5) cultivating the personal life, (6) regulating the family, (7) ordering the state and (8) bringing peace to the world. The other tendency, represented by the *Doctrine of the Mean* (*Chung-yung*), written probably by Confucius' grandson Tzu Ssu (483–402 B.C.), was religious and metaphysical, interpreting Confucius' doctrine of the mean to be central harmony—that is, the full realization of the self through the harmony of the emotions, and the development and operation of all things in their harmonious relationships. Underlying all this is sincerity, which, as the Way of all existence, is absolute, intelligent and indestructible. Only those who are absolutely sincere can develop fully their own natures, the natures of other people, the nature of things and finally partake in the creative work of Heaven and Earth.

The *Great Learning* did not exercise much influence until the 11th century, but the *Doctrine of the Mean* seems to have been influential almost from the beginning. Certainly Mencius (*q.v.*) elaborated on the idea of sincerity and carried the doctrine of human nature to new heights. To him, human nature is originally good, and therefore the way to achieve perfection is to "nourish the mind" and "fully develop one's nature." In this respect he was diametrically opposed by Hsün-tzu (*q.v.*), who insisted that human nature is evil and needs to be disciplined through ceremonies and music, religious rites, law and "rectification of names." Mencius understood Heaven to be the highest spiritual and mystical power, but Hsün-tzu took it to mean nature. The idealistic Mencius and the naturalistic Hsün-tzu, who have been compared with Plato and Aristotle, thus represented another twofold development in ancient Confucianism. Nevertheless, their aims were the same as those of Confucius: a perfect, moral individual and a harmonious social order. Like Confucius, too, they dedicated themselves to political reforms; Mencius traveled and advised kings, and Hsün-tzu was once a magistrate. Generally speaking, Mencius was closer to Confucius in both thought and action; Hsün-tzu's naturalism brought him close to Taoism, and his emphasis on discipline helped to prepare some of his pupils to become leaders of the Legalist school.

Mencius and Hsün-tzu, though they were the two most outstanding Confucianists in ancient China, were not the only prominent philosophers. In fact, the Confucian school was but one of the so-called "100 schools," and probably not the most influential one. It was attacked by Taoists, Moists (or Mohists) and later by Legalists. Obviously in its stress on activity and reform and on ceremonies and government it came into collision with the quietistic Taoists, who believed in "taking no action" and leaving things alone. Earlier Taoist hermits had chided Confucius, and Chuang-tzu (d. *c.* 300 B.C.) made him a favourite object of ridicule. Mo Ti (470?–391 B.C.?), founder of Moism, accused Confucius of insincerity. The Moists, moreover, preached a radical doctrine of universal love that would have destroyed the foundation of Confucian ethics, so that Mencius had to take it upon himself to refute Moism and defend his school lest the light of Confucianism be extinguished. To Confucius and his followers *jen,* though ultimately it meant love for all, in actual practice must begin with love for one's own parents; *jen* must grow from filial piety as a tree must grow from its roots.

In opposition to this teaching of love with distinctions, the Moists vigorously advocated love without any gradation or discrimination. Mencius' bitterness clearly indicates that Confucianism was on the defensive: "Mo's doctrine of universal love means that no peculiar affection is due a father. To acknowledge no father is to be a beast."

Later Confucianism came into strong conflict with the Legalists also. Confucianists had always condemned force as a way of life and profit or advantage as standards of value. In this they stood in direct opposition to the Legalists, whose goal was power and control, and as the Legalists grew in strength, the standing of Confucianism correspondingly declined. Eventually the Legalists helped the state of Ch'in to defeat its rivals, united China as an empire and established a dictatorship from 221 to 206 B.C.

Confucianism as the State Cult.—In order to control thought, the Ch'in in 213 B.C. burned all books except those in the imperial archives and works on medicine, divination and agriculture. The Confucian school, along with others, was almost wiped out, leaving the Legalists the sole arbiters of ideas. But the Ch'in dictatorship lasted only 14 years. The next dynasty, the Han (206 [202] B.C.–A.D. 220 [221]), though it at first favoured Legalism and Taoism, finally turned to Confucianism. One of the reasons for this change was that the ancient classics, copies of which had been hidden to escape the burning, had reappeared; since the Confucianists were authorities on the classics, their prestige was high. Furthermore, as experts on ceremonial, they instituted ceremonies that greatly pleased the Han emperors. In addition, the emperors found pleasing Tung Chung-shu's modifications of Confucian thought, which led to glorification of the ruler. Tung incorporated into Confucianism the Yin Yang philosophy, which considers everything as the product of the interaction of the negative cosmic force, *yin,* and the positive cosmic force, *yang.* The result was Tung's famous theory of correspondence between nature and man, in which every human event has its counterpart in nature and vice versa. In this scheme of things the ruler corresponds to Heaven, both being *yang;* the emperor, the father and the husband became the "standard" of the *yin* forces, the minister, the son and the wife, respectively.

In 136 B.C. Confucianism was proclaimed the state doctrine, and in 124 a national university was founded with departments corresponding to the classics. Soon these became required texts in all education, and eventually government officials were selected on the basis of their knowledge of them. Confucianism had achieved supremacy and had become a state cult.

This cult is not to be understood in the religious sense, for Confucianism was not regarded as a religion. Though it promoted the traditional worship of Heaven, the sacred mountains and rivers, and

ancestors, its supremacy lay in the secular realm. The Confucianists instituted rites and created musical systems for the Han; they formulated social and moral concepts; they controlled education; with some exceptions they monopolized the government; they wrote histories and interpreted history in their own light. Their domination in these fields was to last until the 20th century. In the spheres of metaphysics and religion, however, Confucianism was overshadowed by Taoism and Buddhism up to the advent of Neo-Confucianism in the 11th century.

For centuries after Tung Chung-shu there was no significant development in Confucian philosophy. Confucian talents and efforts were directed chiefly to textual criticism and literature, in which remarkable achievements were made. In the field of philosophy only two developments deserve mention. One was a crude cosmology arrived at by borrowing ideas from Taoism and from the Yin Yang and Five Elements schools. Briefly speaking, the universe is conceived to have originated from a prime force called One or Origination. This force expresses itself in material force (*ch'i*), both positively as the *yang* and negatively as the *yin* and also through the five elements or agents of metal, wood, water, fire and earth. The material force that is pure forms the heavenly bodies, while the material force that is turbid forms the earthly bodies. Rocks, grass and plants, insects and animals, and finally man emerged in succession in the ascending scale of balance of the elements and harmony of *yin* and *yang*. Man is the most intelligent because his endowment by nature is the best and most harmonious. This cosmology was not refined further because the Confucianists were satisfied with it: it was sufficient to support their ethical and political doctrines, for man and nature obey the same laws.

The other philosophical development was the growing concept of human nature. Many theories were offered—that man's nature is good, is evil, is neutral, is both good and evil, is good in some people but evil in others, or is divided into three grades of good nature, neutral nature and evil nature. The general conclusion was that nature is good, thus reaffirming Mencius; evil was explained as a result of imbalance of the emotions.

These developments serve to remind us of the intense moralism and humanism of Confucianism. Philosophically, however, they are trivial in comparison with Taoist and Buddhist thought of the 3rd and 4th centuries. At that time the Neo-Taoists evolved a new metaphysics, conceiving reality as "originally undifferentiated" or "nonbeing." Later, from the 4th to the 8th century, several Buddhist philosophical schools were introduced from India, and Chinese Buddhists developed a metaphysics and epistemology at a level never before reached in the history of Chinese thought. In the field of art, too, the Taoists developed landscape painting and the Buddhists developed sculpture and religious painting, while Confucianism contributed little save in poetry and literature, although many painters were Confucianists. In religion, both in popular practice and in thought, first the Taoists and then the Buddhists were the organizers, promoters and leaders. The Confucianists were ignorant of Buddhist literature and ideas and had little contact even with Buddhist scholars. They considered popular Taoist and Buddhist religious practice as befitting only the ignorant, condemned the belief in transmigration as nonsense and the acceptance of heavens and hells as motivated by selfishness and fear.

In spite of Confucian control of government and society, both Taoism and Buddhism, especially the latter, continued to grow. One factor contributing to this was their support of such Confucian institutions as ancestor worship; another was their ability to influence the government. In time they attracted many adherents and controlled much land, threatening the national economy and the security of Confucianism as the state cult. Eventually the greatest Confucianist of the T'ang period (618–906), Han Yü, issued a call to "make the Buddhists and Taoists human beings again and burn their books." Han was fighting to defend the Confucian Way—which was, as he put it, "to sustain the life of one another" and "to order the state and regulate the family"—against the Buddhist and Taoist Way, which was the Way of "having no activity and of "silence and annihilation." Eventually, during the 9th century, Buddhism was persecuted, and with its decline other organized religions declined also. But by this time Taoist and Buddhists metaphysics and epistemology had penetrated Confucianism and changed it. The result was Neo-Confucianism.

Neo-Confucianism.—By the 11th century Confucianists had become tired of textual criticism and flowery compositions. Though they refused to accept the "strange doctrines" of Taoism and Buddhism, they could not resist their attraction. Thus some of the tenets of the other two systems came to be incorporated into Confucianism, and in the process Confucianism was made new.

This new movement, called Neo-Confucianism in the west, is called the School of Li ("principle," "reason") in Chinese. Essentially the Neo-Confucianists of the Sung period put Confucian moral and social teachings on a new metaphysical foundation. They replaced the Buddhist void, which was to them vague and negative, with Principle (*li*), which they considered concrete and positive. Principle is the Great Ultimate of existence, absolute, eternal, the form according to which all things have their being and the source and totality of goodness and truth. It operates through the material force (*ch'i*) that gives individual things their individual form and character through the interaction of *yin* and *yang*. Man is the greatest embodiment of Principle; at its best, human nature is identical with Principle. The traditional Confucian doctrine that human nature is good was now provided with a metaphysical foundation.

Among several Neo-Confucian schools, two, Ch'eng-Chu rationalism (named after Ch'eng I-ch'uan, also called Ch'eng I, and Chu Hsi) and Lu-Wang idealism (named after Lu Hsiang-shan and Wang Yang-ming) were most prominent. Their differences are best shown by those between Chu Hsi (*q.v.*) and Lu Hsiang-shan. To Chu Hsi, Principle and material force are sharply different; to Lu, they are one. To Chu Hsi the mind is the function of Principle, but to Lu it *is* Principle. Principle is to be discovered, for Chu Hsi, in things; for Lu, in the mind. As the way of life, Chu advocated "following the path of inquiry and study," while Lu advocated "honouring the moral nature." Both of them bitterly attacked Buddhism, but the Neo-Confucian emphasis on Principle and on the mind betray direct borrowing from it, for Chinese Buddhist philosophers had for centuries been building their philosophy on these two foundation stones.

Chu's rationalistic Neo-Confucianism has dominated Chinese thought ever since its inception. Gradually the school became rigid and dogmatic, and opposition arose, especially in the person of Wang Yang-ming, whose idealistic Neo-Confucianism was the strongest philosophical current in the Ming dynasty (1368–1644). His doctrine of innate knowledge of the good and of innate ability to do good, as well as his doctrine of unity of knowledge and action, gave Confucianism a fresh vigour, but eventually overemphasis on the mind led his school to become too Buddhistic for other Neo-Confucianists, and his later followers, in the name of free will, became politically and morally irresponsible. Reaction was inevitable. Neo-Confucianists of the early Ch'ing period (1644–1912) opposed both Chu Hsi's rationalism and Wang's idealism, and blamed the latter's disciples for the Manchu conquest of China. Influenced by western knowledge introduced by Jesuit priests, they emphasized practical application of knowledge and the use of the scientific method. They criticized Chu Hsi's two-fold division of Principle and human desire as well as Wang's identification of Principle with the mind. They stressed the primary importance of learning through practice and the actual demonstration of moral values. Outstanding thinkers such as Yen Yüan (1635–1704) and Tai Tung-yüan, also called Tai Chen (1723–77), were all strong in this critical and empirical spirit. But this scientific temper was expressed almost exclusively in book study, especially higher criticism and historical research.

DOCTRINES AND INSTITUTIONS

These three phases—rationalism, idealism and the critical and empirical trend—indicate that Confucianism after the end of the 1st millennium A.D. was by no means static. Two aspects, however, characterize all these new waves: First, the developments took

place within the Confucian tradition, with fewer and fewer fresh ideas from outside; second, while philosophical theories superseded one another, the major concepts of ethical value and social institutions remained faithful to the original ideas of Confucius. These doctrines and institutions are summarized below.

Philosophical.—As remarked above, controversy surrounded the problem of Principle and material force. In general, the dualism of the Ch'eng-Chu rationalistic school was dominant from the 12th through the 15th century. In the 16th century it was challenged and almost replaced by the idealistic school of Wang Yang-ming, which insisted that Principle and material force were one. As Wang's school declined in the early 17th century, the Ch'eng-Chu school regained its strength. Thereafter, as thinkers reacted against both the rationalistic and idealistic tendencies, more and more importance came to be attached to material force, regarded as the primary element in existence. No doubt the increasing emphasis on facts and action ran against speculation on either Principle or the mind.

Another problem in which controversy was carried on for several hundred years was that of "investigation [*ko*] of things." In large measure divergence on this issue paralleled that on the question of Principle itself. The Ch'eng-Chu school interpreted *ko* to mean investigating Principle in all things in which it inheres, either inductively or deductively. Wang Yang-ming and his followers, on the other hand, took *ko* to mean rectifying—that is, rectifying the incorrectness of the mind, on the premise that Principle is identical with the mind. The majority of Neo-Confucianists, however, including those who regarded material force rather than Principle as the ultimate element, favoured the objective study of things. It is this tradition of rationalism that has distinguished Confucianism most clearly from the intuitive approach of Buddhism and Taoism.

In ethics the Neo-Confucianists continued the classical doctrine that human nature is good and that the greatest moral value is *jen* ("humanity"). But they took important steps forward. Instead of explaining evil in terms of feelings, they ascribed it to an imbalance in the endowment of physical nature. Superficially, this theory is as fatalistic as that associating evil with feelings, since both feelings and physical nature are natural endowments. The great difference with the Neo-Confucianists is that through moral efforts man can transform his physical nature and restore its balance. Once this is done, the originally good nature can be fully developed, and the old Confucian saying that all people can become sages like the legendary Yao and Shun is once more reaffirmed.

As to the doctrine of *jen*, the central basis of Confucian moral philosophy, there was a long course of evolution, during which *jen* was extended to include the entire universe, in addition to the original Confucian meaning of a perfect individual and an ordered society. Before Confucius' time *jen* was understood as kindness of rulers to their subjects. It was gradually broadened to mean benevolence, still a particular virtue but no longer restricted to rulers. Confucius changed it to connote perfect virtue, which includes all particular virtues and applies to all men. Mencius and the *Doctrine of the Mean* went on to say that "*Jen* is *jen*"—that is, *jen* is the distinguishing characteristic of man. During the Han period, it was generally interpreted as love, and Han Yü in the T'ang period stressed it as love for all mankind. Under the influence of Buddhism, which extended its compassion to include not only all men but all things as well, the Neo-Confucianists of the Sung and Ming dynasties similarly extended *jen* to mean "forming one body with Heaven, Earth and all things." This thought was common to both the rationalistic Ch'eng-Chu and the idealistic Lu-Wang schools. Some Sung Neo-Confucianists, however, took *jen* to be a state of consciousness. Chu Hsi called it "the character of the mind and the principle of love," and Wang Yang-ming equated it with the "clear character" of innate knowledge. All these were too quietistic and too Buddhistic for the 17th- and 18th-century Neo-Confucianists, who went back to an early Han commentary on an ancient classic that defines *jen* as "people living together." The new emphasis thus was on the social and active aspects of *jen*. All Neo-Confucianists agreed, however, that *jen* or humanity is a moral quality imparted by Heaven, and since the "great characteristic" of Heaven and Earth is to produce and to reproduce, so *jen* is characterized by production and reproduction; that is to say, it is life-affirming and life-giving, not only active but creative. Under the influence of western science in the late 19th and early 20th centuries, modern Confucianists likened *jen* to electricity and ether, an all-pervasive substance and a dynamic force.

Thus, in a long series of developments, the philosophical basis of Confucianism acquired new meanings from time to time. But all Confucianists, ancient and modern, assert in unison that *jen* is the sum total of all virtues and that its demonstration must begin with love for one's own parents.

Ethical.—The man of *jen* is none other than the Confucian "superior man," a man of humanity, wisdom and courage, the three "universal virtues" of Confucius and his followers. Mencius taught humanity, righteousness, propriety and wisdom as the "four beginnings" of the moral life. Later Confucianists added faithfulness and called them the "five constant virtues." They also regarded propriety, righteousness, a sense of integrity and a sense of shame as the "four bonds" for the nation. All these are norms for the thoughts, words and deeds of the superior man. He is devoted to righteousness instead of to profit, and he worries about the moral law rather than about poverty.

The starting point of all these, however, is filial piety, the root of all moral life because parents give their children their lives, their care and their bringing up; because the relation between parents and children is the first relationship and a natural one; and, most important of all, because no one can be good to anyone else unless he is good to his parents.

A number of institutions have grown up around this central concept. As expressions of genuine love for parents, children are obliged to serve, support and obey them. After the parents' death they are to be honoured in regular ancestral rites and their graves are to be well taken care of. The teaching of obedience may suggest submission of the son to the father, but in fact obedience should be neither blind nor unconditional, and a son has a moral responsibility to admonish the father for wrongdoing. Furthermore, while the son should be filial to his father, the father should be lovingly kind to him.

Nevertheless, though the moral obligation is mutual, there can be no denial that the Confucian ethics of filial piety has resulted in such practices as parental choice of spouses for their children, parental decision in all family matters, property-holding in the name of the father and ancestor worship (*q.v.*), practices that have been strongly opposed and largely rejected in modern times. Though these customs have changed, however, the basic belief that parents and children have special obligations to each other has remained.

Confucian ethical teachings in general and the doctrine of filial piety in particular have exercised tremendous influence over Korea, Japan and to some extent Annam. One important deviation is to be noted in the case of Japan, where the traditional respect for the sword has combined with some Confucian ethical ideas to form the code of Bushido (*q.v.*), or the Way of the Warrior. This would have been utterly impossible in China, where the superior man is not a man of the sword but of moral nobility; he is never a fighter but a scholar-gentleman.

Social.—Of all social institutions, the family is most important in Confucianism, partly because it is the natural ground for moral training and partly because it is the bridge between the individual and society. In Confucian China it has served as an economic, social and political unit, since members of the family have participated as a group in economic, social and political activities. It has been held together by common blood, property, prestige and responsibilities and, above all, common ideals. Wealth, honour, happiness, a large number of sons and longevity are family ideals, but the greatest of all is love of virtue. According to Confucian teachings there are five human relations in society: "Between father and son there should be affection, between ruler and minister, there should be righteousness, between husband and wife, there should be attention to their separate functions, between

elder and younger brothers, there should be order, and between friends, there should be good faith" (Mencius). Three of these relations are found within the family.

To help bring about the realization of these ideals of human relations, Confucianists have advocated two important social doctrines: rules of propriety and "rectification of names." By propriety is meant, in the narrowest sense, details of etiquette and ceremonies and, in the broadest, proper attitude and expression. Both a proper state of mind and correct conduct are necessary for a perfect social order. From the time of Confucius himself, Confucianists have taken propriety most seriously.

The doctrine of rectification of names, which also came from Confucius, means that the ruler should be a true ruler, the father a true father, etc.; in other words, no father should be so called unless he acts like one, and no ruler deserves his position unless he truly fulfills his function. Applied to society in general, the doctrine means that rank and status must be clearly distinguished and their corresponding responsibilities sharply defined; applied to logic, it means that names must correspond to actualities; applied to metaphysics, it means that reality and function must correspond to each other. Though the logical theory of rectification of names and the metaphysical theory of correspondence of reality and function are both important features, the doctrine of rectification of names is primarily ethical in character. At best it has led to insistence on sincerity, truthfulness and actuality in all things; at worst it has led to an undue regard for status. However, the emphasis on individual worth and the belief in the possibility of anyone's becoming a sage have prevented a rigid social stratification in China. Confucian moral and social teachings contributed in no small degree to the downfall of feudalism in the 3rd century B.C. and to the emergence of a "classless" society. Chinese nobility, aside from the emperor and his relatives, was based no longer on birth but on merit. Titles and ranks were determined not by heredity but by ability. The highest honour has gone to the scholar-gentleman.

All this does not disguise the fact that Confucianism championed a double standard for men and women. By "attention to their separate functions" is meant that the husband's responsibility is outside and that of the wife inside the home. In this sense they are equal; as the Confucian saying has it, "To be a *ch'i* [wife] is to be *ch'i* [equal]." But the husband is also the "standard" of the wife. A man could divorce his wife, could remarry and could have more than one wife, but similar rights were denied to women. In the name of moral integrity, Sung Neo-Confucianists imposed a specially rigid code of morals for women, who were required to protect their chastity under all circumstances and to swear complete loyalty to their husbands, living or dead. Modern reforms have done away with these inequities, but the central Confucian conviction that social relations should be morally determined has been maintained.

Political.—A similar moral concern is found in Confucian ideas about government deriving chiefly from Confucius and Mencius. The state is looked upon as an enlarged family headed by a sovereign who should be like a father, benevolent and devoted to the welfare of his people. There should not be two kings in the land any more than there should be two suns in the sky. As everything in the family belongs to the father, so all territory and all citizens belong to the sovereign. Such a system is obviously paternalistic and absolutistic. In the state, however, in contrast to the family, the people are considered to be more important than either the ruler or the territory. According to Confucian teachings, the sovereign should rule only by the mandate of Heaven. Whether or not the mandate is carried out is to be judged by whether or not "those who are near are happy and those far away desire to come." A ruler failing in the mandate should abdicate in favour of a virtuous man, or he should be overthrown, by revolution if necessary. This doctrine of revolution has never been abandoned by Confucianism. Founders of new Chinese dynasties usually have claimed that they had the mandate of Heaven to rule and have made some efforts, in the beginning of the dynasty at least, to prove it by promoting the welfare of the people. Japanese Confucianists, while they exaggerated the teaching of loyalty to the ruler to a point unacceptable to Chinese Confucianists, never propagated the doctrine of revolution.

According to the Confucian standard, a ruler should rule by moral example and not by force. There must be laws, but only good men can make good laws, and governmental measures should be few and punishment light. In short, government should be in the hands of the educated and the virtuous. To implement this ideal, the system of civil service examinations was established. In the Han period officials were required to study the Confucian classics. Later, officials were recommended, and then promoted, on the basis of their knowledge of the classics. From A.D. 606 until 1905, they were selected largely through competitive examination on these classics, which was open to all without any discrimination because of colour, sex, age, social station or religious belief. The number of men who rose from humble circumstances to political prominence in this way was large, though inevitably the privileged minority had an advantage. After operating for nearly 1,300 years, the system finally became corrupt and decadent, ceased to meet the needs of the country and was abolished. Whatever its shortcomings, it provided social and political leadership for China; it kept alive the Confucian ideal of government; it subordinated military officers to civil officials; it offered an opportunity for ambitious and able persons to rise socially; and it gave China cultural homogeneity and continuity. Further, it reinforced the Enlightenment movement in 18th-century Europe, where it exercised appreciable influence.

Educational.—Through such devices as the civil service examination Confucianism had almost complete control of education in China for nearly 2,000 years. Until 1905 the educational system, texts and ideals were all Confucian. Fundamentally the Confucian objectives of education were to develop the individual human nature and to bring about a good society through investigation of things and cultivation of personal life, as taught in the *Great Learning*. The door was open to all; as Confucius said, "In education there should be no class distinction." Of course the number of persons who attended schools was necessarily small, for in an agricultural society literacy was not a necessity and most people were too poor to send their sons to school. But every community had a school—a result in large part of the Confucian idea that a major function of government and family was to educate the young—the immediate purpose of which was to impart knowledge and train character, the broader objective to provide leadership for the government by preparing students for the civil service examination. The central focus was a liberal education for the development of the whole man. In actual operation, however, study was confined to the classics, and this narrow scope and unchanging curriculum led to provincialism on the one hand and conservatism on the other. In time emphasis came to be placed almost exclusively on memorization and the writing of flowery compositions, thus discouraging intellectual curiosity and creative and critical thinking. By the 20th century it was clear that Confucian education was inadequate to meet modern needs, and the western type of education was adopted in its place.

The school, however, was only one part of the Confucian educational process. The home and the community were equally important. Many prominent Neo-Confucianists wrote moral codes for the home and "community compacts" for the clan to inculcate Confucian virtues. Very often imperial edicts, letters to children, community announcements and wills taught moral lessons. Some of these documents have been adopted as models and still have a strong hold on society.

Religious.—Basically Confucianism regards religion as a form of education; in Chinese the word for both religion and education is *chiao*, "to educate." To the Confucianist religion exists for the purpose of moral cultivation. This does not mean that religion as understood by Confucianists is devoid of spiritual or supernatural aspects; Confucian humanism is not without a religious character. Confucius himself avoided discussion of spirits and life after death, and taught people to "respect spirits but keep them at a distance," not because he was irreligious but because he wanted men to direct their own destiny rather than allow the spirits to do so. He knew the mandate of Heaven; he prayed; he

declared that Heaven was grand. Because of its religious tendency Confucianism has promoted ancient religious rites, including the worship of Heaven, the honouring of ancestors and the commemoration of great men, ever since it achieved supremacy. Traditionally the emperor, on behalf of the people, performed annual rites at the Altar of Heaven to give thanks and to pray for a good year. Ancestral rites have been regularly performed, and Confucian doctrine dictates that they be performed sincerely, not because ancestors will give rewards and punishment but in order to continue the human relationship, which should not be terminated with death. Temples were built for great men and seasonal rites performed for them, not in the belief that they had become gods but as expression of respect. Confucius was, of course, the greatest of the great, and a Confucian temple could be found in every prefecture. The great sacrifice was offered him, and the titles of duke and king were conferred on him from time to time. But with rare exceptions, he was never deified. Instead, the Chinese have called him "Great Perfection, Ultimate Sage and Foremost Teacher."

Confucianism has no sacred scripture, church, clergy or creed and is therefore not an institutional religion. It is religious, however, not only in its promotion of traditional rites but in its own philosophy. It does not condone belief in heavens and hells. Its theory of immortality is purely humanistic—that is, the immortality of virtue, wisdom and achievement. It believes in a naturalistic law of retribution according to which good and evil deeds will bring their own consequences. But to Confucianists the highest spiritual reality is Heaven. He is not anthropomorphic and "does not speak," as Confucius said; but he is superhuman, purposive, the source of truth and goodness, completely overwhelming and mysterious. Confucianists call their Way the "Way of Heaven" and Principle the "Principle of Heaven." In other words, Heaven is the ground of all principles and the source of the moral law.

Historical.—The moral law operates not only in society but in history also. As Confucianists see it, the passage of historical events demonstrates unmistakably that goodness leads to happiness, prosperity and peace, whereas evil invites suffering and chaos. As early as the Han, Confucianists began to interpret Confucius' *Spring and Autumn Annals*, a brief historical record of his own state, as embodiment of "subtle words and great principles," that is, hints and suggestions as to how moral principles are revealed in historical happenings. As to the meaning of history itself, Confucianists have held various theories. Some, following Mencius, believed that history consists of a series of order and chaos, one following the other. Others, taking their theme from the ancient *Book of Rites*, saw history as an unfolding in three stages, the Epoch of Chaos, the Epoch of Small Peace and the Epoch of Great Harmony; whereas families and nations remain distinct though in concord in the Epoch of Small Peace, they will all become one in the Epoch of Great Harmony, in which universal peace will prevail. Most Confucianists, however, have held the cyclical theory: the golden age lay in the past, the present age is one of decline, and a sage will appear to save the world and to usher in the golden age once more. Hence Confucianists have always looked to ancient sages as models, especially the legendary emperors Yao and Shun, represented by Confucius and all his followers as examples of perfect virtue and wisdom. Such backward-looking naturally intensified the conservatism of Confucianism.

It would be naïve, however, to conclude that Confucianists were merely backward-looking. When Confucius repeatedly offered Yao and Shun as standards, he was presenting concrete cases in history, which he might have manufactured himself, to show that his ideas were not "empty talks." He and his followers were seeking precedents, of course, but more than that, they were trying to demonstrate by actual past events the practicability of their doctrines and the way in which the moral law works. If they moaned the degeneracy of the age, it was to call attention to the urgent need for reform. The element of status quo in Confucianism has been strong, but there has been a good number of famous reformers.

The Confucian concept of history has produced two characteristics in the Chinese people. One is a strong sense of history, as evidenced by detailed records going back to ancient times and by frequent reference to history in discussions on all subjects. The other is the belief in a future utopia on earth. The Chinese have strongly criticized the Buddhist and Taoist belief in a heavenly paradise as representing lack of faith in history.

Scientific.—The great respect for facts, plus the general spirit of humanism and naturalism in Confucian philosophy, should have helped it to develop natural science in China. Confucius admonished his pupils to acquaint themselves with the names of birds, beasts, plants and trees. The whole Confucian tradition is strongly imbued with the spirit of skepticism, which should be a stimulus to scientific inquiry. The ancient doctrine of investigation of things, which became an essential tenet of Neo-Confucianism, is essentially scientific in outlook and procedure. The Neo-Confucianists taught that even a blade of grass should be investigated, and that the investigation was to be both inductive and deductive. When Chu Hsi lectured on a hill and incidentally came upon some fossils, he studied them objectively and concluded that the top of the hill was once the bottom of a sea, thus discovering the nature of fossils several hundred years before it was done in Europe. But Confucianism never developed natural science, even after the Jesuit priests introduced western scientific knowledge into China in the 17th century. Among many possible explanations, the chief probably are that the Confucianists were primarily interested in social and moral problems, that they did not cherish the ideal of knowledge for its own sake and that as time went on they were increasingly involved in book study. They directed their objective inquiry to the study of texts, in which they did remarkably well but at the expense of mastery over nature. One of the outstanding ideas in Hsün-tzu was the control of nature. Had he instead of Mencius been dominant in Chinese history, Confucianists might have been attracted to science. But the supreme role was played by Mencius, whose chief concern was moral principles, and Chinese Confucianism has followed him.

Artistic.—Preoccupation with moral and social problems also characterized the Confucian approach to art. Early Han Confucianists seized upon the saying "In poetry, have no depraved thoughts" to moralize on ancient poetry and music and to insist that art must teach a moral lesson. They said that literature was to "embody the Way," that is, the moral law. Neo-Confucianists, most of whom were stern moralists, carried on the tradition and strengthened it. Hence Confucianism has been strong in historical writing, prose and poetry but weak in dance and music. When these were turned into social and religious rites their growth was checked. As to calligraphy and painting, particularly landscape painting, much of their inspiration came from Taoism, but since these are primarily literary arts, using the brush and ink, they have become arts of the literary man, who is inevitably a Confucianist. Needless to say, according to the Confucian standard the function of calligraphy and painting is not to entertain but to purify and harmonize the emotions. Since the drama and the novel often play upon vulgar emotions, they have been frowned upon by Confucianism.

CONFUCIANISM IN MODERN CHINA

For 2,000 years Confucianism retained its hold on Chinese thought and culture. While it became more and more conservative, losing thereby its vitality, its spirit of rationalism, humanism and moralism never weakened. In the 19th century these characteristics became even stronger. The advent of empiricism, in reaction to earlier speculation, led to increased emphasis on action and practice, an inevitable development demanded by China's degenerate condition. It was also a natural revolt against excessive emphasis on textual criticism and flowery compositions, and the internal growth of Confucian thought gave it further impetus. In the 19th-century Modern Script school the Confucian classics were interpreted as an embodiment of "subtle words and great principles." This theory was advanced not to fortify Confucian speculation but, on the contrary, to criticize current conditions and to call for action, Confucius being characterized by the school as a man who tried to apply great principles to put society in order. The whole tenor of the school was for reform. At the same time, China's defeats in wars and the introduction of western technology

further convinced the Confucianists that China had to change. Yet they were still loyal to Confucianism. The obvious way out was a synthesis that came to be expressed in the famous slogan "Chinese studies for the fundamentals and western studies for practical use." The consensus of 19th-century Confucianists was that western knowledge could and should be used to build railroads and manufacture arms but that for moral and spiritual values Confucian teachings remained superior to those of the west. Thus there were two prevailing tendencies: the demand for action and the firm loyalty to Confucianism.

These two currents met in the person of K'ang Yu-wei, the latest outstanding Confucianist, who was the brain behind the radical but abortive reform of 1898. The philosophical basis for the reform was that Confucius was a reformer, that he conceived history to be progress in three stages toward the Epoch of Great Harmony, but that the world was then ready only for an Epoch of Small Peace. Attempts were made to reorganize the civil service examination system; establish modern schools, translate western works, encourage publication, promote labour and agriculture, build railroads, open mines, etc. In concept the reform was strictly Confucian, although in practical measures it was western.

The reform failed miserably, and a long series of Confucian setbacks followed. The civil service examinations were terminated in 1905. The monarchy, with which Confucianism had been identified over 2,000 years, was overthrown in 1911–12, and with it the Confucian religious rite of sacrificing to Heaven. The annual official sacrifice to Confucius in the temple in his native place was also discontinued in 1928. Although the empress dowager, in an attempt to salvage the crumbling Manchu empire, raised the traditional sacrifice of the middle order to Confucius in 1906 to the sacrifice of the first order, which had been reserved for Heaven, and made Confucius "counterpart of Heaven," there was no enthusiastic response. Likewise, the movement by K'ang and his followers to establish Confucianism as the state religion in 1913 found no support. At the same time, age-old Confucian institutions were in the process of disintegration. The arranged marriage system was gradually giving place to free choice. Equality of the sexes slowly supplanted the traditional double standard. The authority of the father was seriously weakened. Ancestral rites became less and less popular. Few temples, if any, were built for Confucius or great men in history. The Confucian classics were ignored. All these developments dealt a blow to the Confucian system that was almost fatal. The New Culture movement that began in 1916 virtually gave it the *coup de grâce*, for intellectuals, old and young, condemned Confucianism as incompatible with modern life, attacking particularly the fundamental Confucian doctrine of filial piety as exploitation of the son and its doctrine of feminine integrity as enslavement of women. The general cry was "Take down the sign board of Confucianism!" It appeared that the end of Confucianism had arrived.

While its institutions were toppling and its doctrines were being rejected, however, forces were already at work to give Confucianism new standing. In 1913 the draft constitution of the republic declared that "in the education of citizens the doctrines of Confucius shall be regarded as the basis of moral cultivation." Four or five years later, at a moment when many prominent intellectuals were demanding that the "old curiosity shop of Confucius" be destroyed, Sun Yat-sen, leader of the Nationalist revolution, was enunciating his theory that "it is easy to act but difficult to know." This theory is important not so much because of its own merits as because Sun dared to revive and preach a major Confucian doctrine, one that was part of the unbroken Confucian heritage. The ancient *Book of History* stated that "It is not difficult to know but difficult to act." Confucius and Mencius always insisted that words and action must correspond to one another, and Wang Yang-ming identified knowledge and action as one. Sun, a rebel, was now carrying on a tradition of an unpopular system. In 1923 he went a step further and declared that the time-honoured Confucian virtues of loyalty, filial piety, humanity, love, faithfulness, righteousness, harmony and peace were of the highest merit and necessary for a modern Chinese nation. In 1921 Liang Shu-ming, an intellectual and a leader of the New Culture movement, contended that Confucianism, in emphasizing the mean, had avoided the extremes of Indian and western civilizations, and urged the Chinese to uphold and develop the Confucian *jen* as a dynamic, firm and strong force for a new life. His tremendously popular lectures did much to turn the tide away from contempt for Chinese civilization in general and for Confucianism in particular. A foremost leader of the New Culture movement, Hu Shih, also defended Confucianism as favourable to the scientific spirit and instrumental in reforms. In 1928 the traditional civil service examination system was modified and incorporated into the Nationalist governmental structure as one of its five main branches, and in 1934 the Nationalist government decreed that a national holiday be observed on Confucius' birthday, as Teachers' day. In the field of philosophy, in the 1930s Fung Yu-lan reconstructed rationalistic Neo-Confucianism with western logical concepts, while Hsiung Shih-li transformed idealistic Neo-Confucianism by utilizing Buddhist terminology. (*See* CHINESE PHILOSOPHY.)

When the Communists gained control of China in 1949, Confucianism faced an uncertain future. The national holiday on Confucius' birthday was abolished. Old traditions, of which Confucianism formed a substantial part, were cast aside; the Communists do not look to past sages for sanction, they have not felt the need for a mandate from Heaven. The family system, the central Confucian institution, has been minimized. Nevertheless, the Confucian temple in his native place has been well kept, Confucian classics and commentaries have been published, and Communist leaders have said that they should learn from Confucius as they should learn from other great men and that they should absorb the "democrat elements" of Chinese civilization, which means largely Confucian civilization. Regardless of what the Communist government may do, Confucianism has shown its strength to weather all kinds of storms. It has survived both benevolent and ruthless regimes in China. In Japan it withstood the Meiji restoration, which raised Shinto to the supreme position and suppressed other systems, as well as the military decades of the 20th century, and has retained its influential status in Japanese family and society. In the meantime, the national holiday on Confucius' birthday continues to be observed in Formosa, where also the doctrine of filial piety is propagated with new vigour. In the west more and more study is devoted to Confucianism. Confucianism is changing, but it is reasonable to believe that it will remain essentially Confucian. *See* CONFUCIUS; CHINA; CHINESE PHILOSOPHY. *See* also references under "Confucianism" in the Index volume.

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CONFUCIUS (551–479 B.C.), China's most famous man, was a teacher, philosopher and political theorist whose ideas have deeply influenced the civilization of all of eastern Asia. The ultimate success of his doctrines was so great that it is difficult to believe that he was in fact a frustrated (though never embittered) man who never realized any of his dearest ambitions. The real story of his life and work has almost been lost in the wealth of legend that has grown up about his name. Careful investigation, however, has been able to separate the truth about the man from the posthumous glorification of the sage. Little is reliably known about his life. His ancestry is unknown, but he probably descended from impoverished nobility. His family name was K'ung; "Confucius" is a Latinized version of K'ung Fu-tzu, "Master K'ung." As a young man he was poor, and once made his living by keeping accounts. He was largely self-educated, but so diligent that he appears to have become the most learned man of his day.

Learning was not, however, his greatest interest. He was deeply distressed by the misery that he saw on every hand. China was only nominally united; the king was a puppet, and even the various feudal states were in effect divided between powerful nobles who did as they pleased. The aristocrats made war as a pastime, and taxed their subjects, exhausted them with forced labour and oppressed them at will. In bad years starvation was common.

Confucius dedicated his life to the attempt to relieve the sufferings of the people. He believed that the solution must be fundamental: a reform of the government that would make its objective not the pleasure of the rulers but the happiness of their subjects. To this end he advocated such measures as reduction of taxation, mitigation of severe punishments, and avoidance of needless war (which was often pleasant and profitable for the aristocrats). The rulers of his native state, Lu, paid little attention to his admonitions. His lifelong objective was to occupy a commanding administrative post in which he could put his ideas into practice. It is not surprising that he never obtained one; from the point of view of the rulers his ideas must have seemed dangerous.

BY COURTESY OF THE MUSEUM OF FINE ARTS, BOSTON

CONFUCIUS, 17TH-CENTURY SCREEN PAINTING BY THE JAPANESE MASTER KANŌ TANYŪ

While waiting for his opportunity, which never came, he talked to younger men about his principles. Gradually a group of them formed about him, as disciples who recognized him as their teacher. Since Confucius was unable to apply his principles, he laid increasing emphasis on teaching them to younger men for whom, when he considered them sufficiently educated, he sought posts in the government. He was remarkably successful in placing his students in positions of real authority, in which some of them proved extremely capable. But those who were most successful were more compromising than their teacher, and his doctrines had little practical effect in his own day. Eventually Confucius was given a post with an impressive title, probably for the sake of appearances, but when he realized that he had no actual authority he resigned in disgust. Although then in his fifties, he set off on what proved to be a decade or more of arduous and sometimes dangerous travels through various states, seeking a ruler who would confide to him the administration of his state. Finally, at 67, he responded to the invitation of some of his disciples to return to Lu. There he continued his teaching until his death at 72.

Teacher and Scholar.—Before Confucius, aristocrats had had tutors and government officials had instructed their subordinates in the necessary techniques. But Confucius seems to have been the first private teacher in China, and the first to use his teaching as an instrument of reform. His methods were quite informal. There is no record that he lectured; rather he conversed with his students in small groups or individually. He studied the character of each disciple, and sought to develop the total man. His prime insistence was upon sincerity, and his whole teaching was based upon ethics. He regarded statecraft as the application of ethics in a broader field. To furnish and deepen his students' minds, he had them study history, poetry and music. To equip them to act effectively in the world he schooled them in the theory and practice of human relations, and taught them how to conduct themselves in a wide variety of situations. His teaching was not dogmatic or authoritarian; he was not affronted if his students disagreed with him, and sometimes acknowledged that they were right. Typically he merely asked questions, and insisted that they find the answers for themselves. He said, "If, when I point out one corner of the subject, the student cannot work out the other three for himself, I do not go on." While Confucius did not advocate revolution, his educational activities were profoundly revolutionary in two senses.

By emphasizing the right and duty of every individual to make basic decisions for himself, he undermined the foundation of authoritarian government. By accepting as students even the poorest and humblest individuals, if they were intelligent and earnest, he destroyed the monopoly which the aristocracy had enjoyed in its control of the techniques of government.

The activities of Confucius as a scholar have been greatly exaggerated. He was learned and he used books in his teaching, but his interest in books as such was distinctly subordinate to his passion for reform. Although a great number of books have been ascribed by tradition to his authorship, it is improbable that he composed any of the books that have come down to us, and it is not even certain that he edited any of them.

His Religion and Philosophy.—Although Confucianism has sometimes been called a religion, Confucius was not a religious leader in the usual sense. He was undoubtedly a religious man, in that he felt that there was somewhere in the universe a force on the side of right. He also took a good deal of aesthetic pleasure in religious ritual. But he considered a large part of the religion of his day to be sheer superstition, and condemned many of its practices. His philosophy was not founded upon supernaturalism in the slightest degree. Chinese philosophy has given relatively little attention to metaphysics, epistemology and logic. In this it reflects the tendencies of Confucius, who may fairly be called its founder. It does not follow that he was a disorderly thinker because he did not stress logic. Rather, he was doubtful that one could learn about the real world merely by manipulating words together. His theory of knowledge had some resemblance to that which underlies modern science, in that it was nondogmatic and empirical. He said, "No doubt there are those who find it possible to act without first understanding the situation, but I am not one of them. To hear much, select what is good, and follow it; to see much and take careful note of it; these are the steps by which one ascends to understanding."

Humanity was central in his philosophy. "Virtue," he said, "is to love men. And wisdom is to understand men." The concept of the family has always been the pivot of Chinese culture, and Confucius regarded mankind as one large family. It was one of his disciples who said that "within the four seas all men are brothers." Sincerity and reciprocity, then, should be one's guiding principles. "The truly virtuous man," Confucius said, "desiring to be established himself, seeks to establish others; desiring success for himself, he strives to help others succeed. To find in the wishes of one's own heart the principle for his conduct toward others is the method of true virtue." In accord with these ideas he believed that the state should be a wholly co-operative enterprise. This belief was completely at variance with the theory then in vogue. Aristocrats were believed to be descended from divine ancestors, and to rule by virtue of the authority and the powerful assistance of their ancestors. Confucius completely ignored this idea; eventually it disappeared in China, and Confucius was certainly in part responsible for its going. The right to govern, Confucius held, depended upon the ability to make the governed happy. And this in turn depended upon the possession of virtue and ability. Thus anyone possessed of virtue and ability might properly govern, and no one without them had the right to power. Confucius interpreted this in practical terms as meaning that the hereditary rulers should confide all administrative power to ministers who should be selected for their ability and virtue.

These qualities Confucius did not intend to leave to chance. He believed that, while individuals undoubtedly vary in their inherent virtue and abilities, these may be greatly developed by means of proper education. Therefore he laid very great stress on education designed to develop abilities and to strengthen character. While he did not advocate advanced education for all, he did believe that some education must be given even to the humblest citizens, for two reasons. First, since ability does not depend on birth, only a wide dissemination of education can ensure that all of the most capable will be given the opportunity to develop themselves, for their own good and that of society. Second, since the state is a co-operative enterprise an enlightened citizenry is necessary to permit it to operate effectively. Thus, while he considered war an evil, he believed that when it must be prosecuted this should be done vigorously, and he believed that the prime necessity for success in war was an army entirely clear as to why it was fighting and thoroughly convinced of the justice of its cause.

His Influence.—The difference between the ideas of Confucius and some aspects of what has later been called Confucianism is so great that one may be tempted to question the extent of his in-

fluence. It is the common fate of great men to have their ideas distorted by posterity. Yet if we look at the form of Chinese government, as it existed from the Han dynasty (202 B.C.–A.D. 221) onward, the large outline is strikingly reminiscent of the ideal of Confucius. In theory and very largely in practice the administration was controlled by ministers; and these ministers were selected, for the most part, not for their ancestry but for their personal qualities, so that a man of very humble origin could and sometimes did rise to wield the paramount power over the entire Chinese empire. In many other ways, also, the ideas of the obscure teacher of Lu have exercised such a formative influence upon the culture of China, and of much of the far east, that Confucius must be counted one of the most influential men in world history.

See also references under "Confucius" in the Index volume.

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CONGÉ D'ÉLIRE (Norman-French for "permission to elect") signifies the English sovereign's permission for the dean and chapter of the cathedral of a vacant bishopric to proceed in regular chapter to a new election. Before the Norman Conquest it was the king's prerogative to appoint bishops to vacant sees. This later came to be contested by the popes, though the sovereign was usually successful in securing the appointment of his nominees. The appointment of bishops was vested in the crown by the Annates' Statute (1534) of Henry VIII (*see* ANNATES). The statute provided that when the king's *congé d'élire* was sent to the dean and chapter a "letter missive" accompanied it in which was given the name of the person to be elected. In the event of a delay of 12 days to elect, the king might appoint to the see by letters patent; if, however, the dean and the chapter delayed more than 20 days to elect in accordance with the "letter missive," they became liable to the penalties of praemunire. Another act was passed (1547) providing for nomination by letters patent in all cases, but this was repealed under Mary Tudor. The 1534 act, reinstated by the act of supremacy (1559), has operated in the Church of England ever since. (J. W. L.)

CONGLETON, a municipal borough of Cheshire, Eng., 31 mi. E. of Chester by road. Pop. (1961) 16,823. It is in a deep valley on the banks of the Dane. Mentioned as Congeltone in Domesday Book, the borough was incorporated by a charter of Henry de Lacy in 1272, and later the right to hold fairs and a weekly market was granted by Edward I. A general market is held weekly on Saturdays and a cattle market on Tuesdays. In the town centre modern shops blend comfortably with traditional black and white timbered buildings. There is a public park and an open-air swimming pool.

In 1751 the silk industry was introduced to Congleton and prospered until its decline in 1824. After a period of acute unemployment, the fustian and velvet cutting industry was introduced in 1867. Textiles remain the principal industry and include the manufacture of hosiery, knitwear, cotton garments, tablecloths, bedspreads and ribbon. Other industries include the production of mineral waters (soft drinks), cardboard, cattle foods, electrical equipment and television antennas.

CONGLOMERATE, in petrology, is the term used for a coarsely fragmental rock consisting of rounded pebbles or boulders set in a finer-grained matrix. The name is from the Latin *conglomerare*, "to form into a ball." If the pebbles are angular, the rock is termed breccia (*q.v.*). Conglomerate is thus merely consolidated gravel or boulder beds. The coarser constituents have become rounded by weathering and by attrition during transport by streams and the waves of the sea. Their size varies considerably; they may be 10 or 20 ft. in diameter, but are commonly a foot or less. Quartzites, cherts and flints and vein quartz, being among the hardest and most durable of all rocks, are especially abundant in conglomerates, but granite, gneiss, sandstone and limestone also occur. Conglomerates are less likely to be formed where chemical weathering predominates, as in many tropical areas, and in comparison to finer-grained sediments they occur in more restricted areas or belts. The matrix in which the pebbles or boulders are embedded is usually sandy material cemented by a siliceous, ferruginous, calcareous, dolomitic or clayey bond. Conglomerates commonly indicate breaks in the laying down of sediments and may give evidence of arid or cold climates or of glaciation. They may have a world-wide distribution in rock formations laid down during or following periods of crustal deformation and mountain building, as in the earlier strata of Pennsylvanian or Upper Carboniferous Age (Pottsville Conglomerate, Millstone Grit, etc.) or in the Triassic of northwestern Europe, North America and New Zealand. For crush conglomerate, *see* BRECCIA; *see* also SEDIMENTARY ROCKS. (C. K. WE.)

BENJAMIN M SHAUB

PUDDINGSTONE CONGLOMERATE FROM ENGLAND

CONGO (REPUBLIC) (RÉPUBLIQUE DU CONGO), a state of equatorial Africa, a member of the French Community (former Territory of the Middle Congo or Moyen-Congo, French Equatorial Africa). Area 134,749 sq.mi. Pop. (1962 est.) 864,679. The Republic of Congo is bounded on the north by Cameroon and the Central African Republic, on the east and the south by the Democratic Republic of the Congo (formerly Belgian Congo) and the Angolan exclave of Cabinda, and on the west by the Atlantic ocean and Gabon.

Physical Geography.—The country belongs to the Congolese basin, of which it makes up only a small part. In the east, on the right bank of the Ubangi and the Congo, lies a plain, formed from the Quaternary alluvium of the centre of the basin and crossed by a series of black-water rivers and swamps. The branches of these rivers often intermingle and they multiply and divide before flowing into the Ubangi or the Congo. Among them are the Motaba which enters the Ubangi at Dongou, the Likouala, the Sangha (Sanga) and the Alima, all of which are often navigable. The Congo-Ubangi is navigable for over 1,500 mi. above Brazzaville. The alluvial plain rises in the west and gives way to a plateau of reddish Secondary sandstone and white Tertiary sandstone. The valleys are sunk into it, as is the Congo upstream from Stanley pool. In the west these sandstones rest on the rocks of the Archean core, which are extremely varied and give greater complexity to the relief. On the granites of the Monts du Chaillu rest the sandstones and schists of the Franceville basin and of Mayombé (Mayumbe), or schists, limestones and conglomerates. Between hills of hard rocks, the valleys widen on the schists formation, in particular the valley of the Niari, which is the principal way of penetration. It is closed on the west by the massif of Mayombé (2,411 ft.), which is formed from granites and quartzites, where the Niari is enclosed in wild gorges. On the south it is dominated by the sandstone escarpment of the "Plateau of the Cataracts" which surrounds the Congo downstream from Stanley pool. The Mayombé massif borders a coastal plain, formed chiefly of clayey Pliocene sandstones and closed by a coastal belt which isolates lagoons.

As the equator runs through the republic, the climate is on the whole equatorial, though the thermal equator is farther to the north. The rain forest extends only across the plains except to the north of the equator. Savanna appears on the Central African Republic frontier where there is a dry season, in the country of Bateke because of the sandstone, in the valley of the Niari sheltered by Mayombé and in the coastal plain which is freshened by the Benguela current. (J. D.)

History.—Prehistoric sites have been discovered at Brazzaville and in the Niari valley. Three levels have been distinguished: Lower Paleolithic (coarse bifacial tools), Sangoan (bifacial tools and flakes) and Lupemban (pointed and tranchet tools).

The Pygmies, the early inhabitants, appear to have come from the Ubangi. Of the Kongo, who seem to have arrived from the Kwango (Cuango) about the 15th century, the Vili group occupied the coast while the Sundi group crossed the river farther east. These groups founded the two kingdoms of Loango and Kakongo,

which were nominal vassals of the great kingdom of the Congo. The Stanley pool region was occupied by the Teke (the kingdom of Anzico) whose king, the makoko, was elected by the chiefs and wore a great collar of flat copper and a panther skin. To the northeast were the Mbochi, who lived in fortified villages, and then the marshes of the Likouala and Sangha, occupied by the "water people" and Pygmies. (*See* AFRICA: *Ethnography* [*Anthropology*]: *West Central Africa.*)

In 1482 the Portuguese Diogo Cam discovered the mouth of the Congo. In the 18th century the coastal kingdoms received a superficial Christianity which disappeared with the departure of the missions. The slave trade was carried on through the ports of Cabinda, Loango and Mayoumba (Mayumba). The *pomberos,* former Portuguese slaves, traveled as far as the pool and returned with cargoes of slaves procured by the Teke, while the coastal chiefs levied dues in the form of guns and loincloths. The suppression of the slave trade in the 19th century hastened the collapse of the kingdoms.

In 1877 H. M. Stanley (*q.v.*), traveling down the Congo, discovered Stanley pool and then with difficulty reached the coast through the river's rapids. Pierre Savorgnan de Brazza (*q.v.*), who ascended the Ogooué, was in 1878 repulsed by the Furu on the Alima, but in 1880 he reached the pool and made a treaty with the makoko by which the latter ceded his rights to France. A post established at Ntamo (Brazzaville) was entrusted to the Senegalese sergeant Malamine who prevented Stanley from taking possession. Brazza reconnoitred the Niari-Kouilou route to the coast, which avoided the rapids. He also occupied Loango and Pointe-Noire (*q.v.*). Treaties made in 1885 and 1887 fixed the frontiers with Portuguese territory and the Congo Free State. In 1891 the colony of French Congo was created. Various missions made their way up the Sangha and a treaty in 1894 fixed the Cameroun frontier northward of Ouesso. In 1898 Brazza, who had been appointed commissioner general, was recalled to France and large concessions were granted. Brazza in 1905 accepted a mission to investigate charges of exploitation of the natives in the colony, and the concessions were restricted. The Franco-German agreements of 1911, which ceded to Germany the Sangha valley as far as the Congo, were annulled by World War I. Brazzaville became in 1910 the capital of French Equatorial Africa.

In 1940 the Congo rallied to Free France. Gen. Charles de Gaulle and the governor general, Félix Eboué, in Feb. 1944 held the conference at Brazzaville which heralded France's new colonial orientation. In 1946 Congo became an overseas territory of France, with representatives in the French parliament and an elected territorial assembly. The "cadre law" of 1957 gave it an elected government. In Nov. 1958 Congo became a republic of the French Community (*q.v.*). The priest Fulbert Youlou was elected president, and after some sanguinary incidents between Kongo and Mbochi, a coalition was formed. On Aug. 15, 1960, the independence of the republic was proclaimed. (HU. DE.)

People.—Of the total population in 1962, about 10,000 were nonnatives. The density was 6.4 per square mile. Some peoples seemed to be decreasing in number; *e.g.,* the Likoual, whose birth rate was 25 per 1,000, mortality 30 per 1,000. The principal tribes are Congolese in the northeast, like the Bangi, pushed back by the Teke who occupy the centre of the country. In the south, between Brazzaville and the coast, live related tribes, the chief of which are the Kongo and the Vili. All speak languages of the Bantu group. Besides Brazzaville (*q.v.*) and Pointe-Noire, towns of importance are Impfondo, Fort-Rousset, Dolisie and Djambala.

The Economy.—The forest has been partially cleared and has been damaged almost everywhere. Cassava is grown as the main subsistence crop. Two regions, however, the valley of the Sangha and that of the Niari, are suitable for the cultivation of products for export. In particular in the valley of the Niari, which is close to the Congo-Océan railway, there are plantations devoted to the cultivation of cassava, and also peanuts, fibre plants and sugar cane and to stock raising, all of which developed after World War II.

An agricultural post was set up to improve the maize and sugar cane crops, together with research institutes for oil and oleaginous products and for fibre plants. On the slopes of the Monts du Chaillu plantations of Hevea and oil palms were being developed during the 1960s. In Mayombé there are deposits of gold and diamonds and at Mfouati and Mindouli, near the railway, lead ores have been discovered, in addition to the already known copper ores. Processing industries have been developed at Brazzaville and Pointe-Noire. In the 1960s it was planned to build a dam on the Kouilou (the lower reaches of the Niari), 55 mi. across country from Pointe-Noire, which would provide 7,000,000,000 kw.hr. for industry, including the aluminum industry at Pointe-Noire.

Communications.—The Republic of Congo has no natural outlet to the sea, so that transporting exports and imports presents great difficulties. The Congo, while navigable above Brazzaville, is not so downstream where it is, moreover, in former Belgian territory. The solution has been provided by the Congo-Océan railway, from Brazzaville to Pointe-Noire, which makes use of a deepwater port. The railway was begun in 1921 and finished in 1934 in spite of great difficulties; it is 321½ mi. long and equipped with diesel locomotives. This railway is supplemented by a river system, which is good on the Congo and the Ubangi and poorer on the Sangha, and by a road network, uneven in quality, of 4,878 mi. Air transport is used for valuable cargo, the main airport being at Maya-Maya 2½ mi. from Brazzaville. Exported products are principally wood, oils, lead, gold and cocoa and imports are food products and tools. (J. D.)

CONGO, a district (capital, Carmona) in the northwest part of the Portuguese overseas province of Angola, west Africa. Pop. (1960) 503,178. Area 35,741 sq.mi. Along the coast lie the *concelhos* (counties) of Santo António do Zaire and Ambrizete. These areas produce palm oil, palm kernels and timber, and Ambrizete also produces cotton and fruits.

Other *concelhos* (Zombo, Pombo and Damba) and circumscriptions (Nóqui and Cuango) have been little explored. São Salvador do Congo is rich in oilseeds and oil fruits, fruits (mainly oranges) and timber, which are exported through Matadi, where the only recognized king in Angola lives. The *concelho* of Uíge is the richest in the district, although its wealth comes almost entirely from coffee, which is cultivated by Africans. From the Bembe area copper is exported. A railway from Luanda to Matadi was begun in the late 1950s. (A. A. G. P.)

CONGO, DEMOCRATIC REPUBLIC OF THE (RÉPUBLIQUE DÉMOCRATIQUE DU CONGO), formerly the Belgian Congo, an independent country of Equatorial Africa, occupies the major part of the basin of the Congo River and a small part of the basin of the Upper Nile. Area 905,562 sq.mi. (2,345,408 sq.km.). Bounded on the west and southwest by Angola, it has a coastline of only 25 mi. (40 km.), extending north from the mouth of the Congo to the Angolan exclave of Cabinda; the southern bank of the Congo River mouth is in Angola. The republic is bounded northwest and north by the Congo (Republic) and the Central African Republic (formerly parts of French Equatorial Africa); northeast by Sudan; east by Uganda and Tanzania; and southeast by Zambia. Northeast of Lake Tanganyika are the Kingdom of Burundi and the Republic of Rwanda.

This article contains the following sections and subsections:

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I. PHYSICAL GEOGRAPHY

The country generally comprises a plateau about 1,000 to 3,000 ft. (300 to 900 m.) above sea level covered with dense tropical rain forest in the north centre, and in the south covered mainly by park savanna with some forests in the valleys.

1. Geology.—The geology of the Congo is as yet incompletely known; the rocks are often very decomposed superficially and fossils are generally few or nonexistent. Two main unities can be recognized, the underlying and the covering formations. In addition, between Boma and the coast is a narrow littoral band of Secondary and Tertiary marine formations, with occasional bituminous seepage. The lower formations are often metamorphic and are of Precambrian Age, the oldest being more than 3,320,000,000 years old. They sometimes enclose granite masses. Rocks of the basement crop out especially on the periphery of the Congo Basin, in Lower Congo and Mayumbe, south of the former Kasai, Katanga, and Kivu provinces, and the northern regions. In southern Katanga folded Precambrian limestone and sandstone formations contain ores of copper, cobalt, uranium, lead, cadmium, and zinc. In northern Katanga and in Maniema the older formations contain cassiterite. Gold is found chiefly in the provinces of Kibali-Ituri, Nord-Kivu, and Kivu-Central.

Covering layers occupy vast surfaces. They include sands, clays and sandstones and are almost always of continental origin, though there are traces of a marine invasion in the Cretaceous Period on the edge of Kasai, and in the Jurassic in the Stanleyville region. They were deposited from the end of the Primary Era (strata of the Lukuga series in Katanga enclose a little coal of low quality); their formations are chiefly Secondary (the Lualaba and Kwango series) and Tertiary (polymorphous sandstones and ochre sands belonging to the Kalahari System). More recent formations (late Tertiary and Quaternary) cover the centre of the basin and often show lateritic agglomerations near the surface.

The Congo Basin began to be formed in the Cretaceous Period. During the Tertiary, risings and sinkings formed the mountains and depressions of the eastern region. The volcanic manifestations of the region of Lake Kivu began at the close of the Tertiary and have continued until modern times.

2. Physical Features.—The Congo River (*q.v.*) flows through a vast basinlike plateau not exceeding 1,015 ft. (309 m.) above sea level at its central part, around Lakes Tumba and Léopold II. The river is 2,716 mi. (4,371 km.) long and drains an area of about 1,425,000 sq.mi. (3,690,750 sq.km.), of which two-thirds are within the republic. It leaves its basin by a gorge cut by rapids through a variegated region of crests and plateaus, often exceeding 1,500 or even 2,000 ft. (460 or 600 m.), and trending northwest to southeast. In this gorge are the Inga Rapids, one of the last cataracts of the Livingstone Falls, 25 mi. above Matadi. On the right bank below Matadi stretches the hilly region of Mayumbe. Southern Congo contains the plateau of Kwango (3,300 ft.) near the Angola border, and the Kasai and Katanga plateaus. The latter include the lesser plateaus of Elisabethville (3,600 ft.), Manika (4,800 ft.), Kundelungu (5,100 ft.), and Kibara (5,600 ft.) and enclose such depressions and plains as Kamalondo-Upemba, the Lufira Plain, Mweru Lake (Lac Moero), and the Luapula Valley. In the north low plateaus divide the Congo Basin from those of the Chad and the Nile. In the east, the edge of the basin has been steeply raised. A veritable mountain chain runs along the edge of the depressions which form part of the western Great Rift Valley. In these depressions are, from south to north, Lakes Tanganyika, Kivu, Edward, and Albert (*qq.v.*). To the north of Lake Kivu the volcanic cones of the Virunga rise above great fields of lava. Between Edward and Albert lakes the Ruwenzori Range (*q.v.;* the "mountains of the moon"), a horst of metamorphic rocks on the border with Uganda, forms the highest point of the region (Mt. Stanley, 16,763 ft. [5,109 m.]), the summit being covered by perennial snow. The central basin is a region of low plateaus and terraces, with little cliffs overhanging the sometimes marshy valleys.

3. Climate.—On and about the Equator the temperature varies little from day to day, the mean annual figure at Eala (0° 5′ N) is 77° F (25° C), the hottest month being February. Greatest rainfall occurs in April–May and October–November, and the annual precipitation at Eala averages 71 in. (1,800 mm.). Southward the temperature increases in range and average, the double maximum of rainfall is strongly marked and January and February tend to be less wet. There is a dry season (June, July, August). In the coast region washed by the cool Benguela Current and the southeast highlands there is a dry season from June to October; July and August are the coolest months. Farther south on the Katanga Plateau there is a wider range (16° F [9° C]) of temperature and a lower annual temperature (mean 68° F [20° C]); total rainfall may be 55 in. (1,400 mm.); little rain falls between May and September, but there is no double maximum.

4. Vegetation.—Rain forest occupies the north-central part of the basin between latitude 4° N and 4° S and extends to the western and eastern boundaries. Describing the forests of the Maniema country, David Livingstone wrote:

> Into these primaeval forests the sun, though vertical, cannot penetrate, excepting by sending down at mid-day a thin pencil of rays into the gloom. The rain water stands for months in stagnant pools made by the feet of elephants. The climbing plants, from the size of a whipcord to that of a man-of-war hawser, are so numerous, that the ancient path is the only passage. When one of the giant trees falls across the road it forms a wall breast high to be climbed over, and the mass of tangled ropes brought down makes cutting a path round it a work of time which travellers never undertake.

Extensive forests also occur, to the north and south of the main forest, that are almost entirely composed of arborescent Leguminosae called *limbali,* about 100 ft. high, and in the basin of the upper Ituri-Aruwimi are vast stretches of Uganda ironwood. By the banks of the rivers occur the "gallery" formations.

In the equatorial forests an abundant variety of trees includes some deciduous ones among the evergreen. Up to 180 ft. or more in height, they are hung with lianas, while epiphytic mosses and lichens cling especially to the topmost leaves and branches where there is light. In the darkness below there is little undergrowth. The great mixture of trees includes the African oak, mahogany, red cedar, and walnut, the silk-cotton tree, and other economically valuable kinds. Among the climbing vines are Landolphias, which produce rubber. Where the original forest has been cleared, for food or timber, secondary forests arise. Typical of these are the oil palms with other small trees and undergrowth. In the lower courses of most rivers and other parts flooded during heavy rainfall, the forests consist of silk-cotton, copal (*Copaifera*), and evergreen leguminous trees; in the swamps and permanently flooded areas, they are largely composed of euphorbias.

Another type of forest is found in the south of Kwango and in Katanga: this is forest with little undergrowth, where the trees are smaller and more spaced and lose their leaves in the dry season; most of the trees belong to the legume family and include acacias, *Brachystegia, Isoberlinia,* and *Berlinia.* Other trees include *Uapaca, Monotes,* and *Sterculia.* On the higher lands of the east, and especially on the slopes of the Ruwenzori, there are ranged in tiers shade-loving mountain forest, dry forest, grasslands, subalpine formations, and alpine grassland. These mountains are well known for their tree heathers, tree lobelias, and giant groundsel. The low banks of the Congo Estuary bear red mangroves.

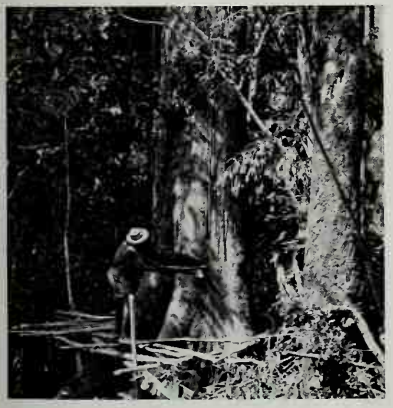
The equatorial forest is surrounded by a ring of savannas and steppes. The edge of the forest is much indented; toward the south it spreads into the valleys. Lower Congo, Kwango, Kasai, Katanga, and the northern regions are covered by vast savannas. The most frequent grasses are tall, like elephant grass. These savannas are dotted with low trees and stunted shrubs with knotted trunks, such as *Hymenocardia acida,* which is widespread.

5. Animal Life.—A distinction may be made between the animals of the forests and those of the open savannas and grasslands. Others inhabit both the dry forests of the Katanga and the eastern mountains. The forests are particularly the home of anthropoid apes and of many kinds of monkeys; chimpanzees are found in the equatorial forests, gorillas in the mountains of Mayumbe and Kivu, and baboons in the more open country. Among rare animals peculiar to the forest or scrub regions are the okapi, giant wild boar, pygmy elephant in the swamps, and white rhinoceros and giraffe in the northeast. Lions are found

Barges hauling lumber down the Congo river to Brazzaville, for transshipment by railway to the ocean port of Pointe-Noire

Brazzaville, capital of the Republic of Congo, situated on the right bank of the Congo river below Stanley pool. Léopoldville, capital of the Democratic Republic of the Congo, lies on the opposite bank

Rapids on the Congo river, which is an active commercial waterway. Nonnavigable sections, such as this one, are circumvented by railroads



Felling a tree in Mayombé. Wood is one of the principal exports of the Republic of Congo

The harbour at Pointe-Noire. The main outlet to the Atlantic ocean, it is the principal port of the Republic of Congo

VIEWS OF THE REPUBLIC OF CONGO

PHOTOGRAPHS, HOA-QUI

CONGO, DEMOCRATIC REPUBLIC OF THE

Wagenia (Enya) fishermen checking their traps in the Congo river at Stanley falls, above Stanleyville. The handmade willow traps are operated by a pulley made of liana ropes

A Mangbetu woman. The Democratic Republic of the Congo is peopled by over 200 different tribes

Tropical rain forest in the Ruwenzori range, in the northeast, at the Uganda border. The forest is a hunting ground for elephant, buffalo and antelope

Léopoldville, capital of the Democratic Republic of the Congo, seen from Stanley pool with high sandy plateaus in the background

Copper smelting in Katanga province, which is rich in mineral resources

VIEWS OF THE DEMOCRATIC REPUBLIC OF THE CONGO

PHOTOGRAPHS, (TOP LEFT AND RIGHT) SHELL PHOTOGRAPHIC UNIT, (CENTRE LEFT) UNITED PRESS INTERNATIONAL, INC., (BOTTOM LEFT) PATELLANI—PIX FROM PUBLIX, (BOTTOM RIGHT) DALMAS —PIX FROM PUBLIX

in Katanga and in the grasslands and scrub surrounding the great forest, leopards everywhere, and cheetah, zebra, wild dogs, and the black rhinoceros in Katanga. Elephants, wildcats, tiger cats, buffaloes, antelopes, and wild hogs are found in both wooded and open country. Hyenas, jackals, and civets are abundant, especially in the east. Smaller animals include porcupines, squirrels, rats, hares and rabbits, pangolins, and bats. Hippopotamuses and crocodiles are common in the rivers and huge manatees in the Lower Congo. Whales and dolphins are found off the coast.

The country, when administered by Belgium, had three national parks: in the north the Garamba near the Sudan border; the Upemba in Katanga; and in Kivu the Parc National Albert, the richest and most picturesque, which includes the Virunga (Birunga) volcanoes, the Ruwenzori, and the Semliki Plain. (*See* NATIONAL PARKS AND NATURE RESERVES.)

Bird life is abundant, though few of the birds are peculiar to the Congo. Pelicans frequent the larger rivers; cormorants, cranes, storks, herons, geese, ducks, vultures, eagles, owls, and bustards are more or less common, as are also the weaver and the whidah bird, cuckoos, pigeons, swifts, and the oxpecker. The spur-winged plover is the companion of the crocodile. There are more than 20 species of sunbirds and three or four species of parrots, the gray parrots being extremely common. Reptiles include pythons, the tree cobra, puff adder, and other vipers among snakes; tortoises, lizards, and chameleons. Lakes and rivers are well stocked with fish: catfish, electric eels, tiger fish, and many others.

Insects, including bees and wasps, beetles, butterflies and dragonflies of gorgeous colouring, are innumerable, as are centipedes (up to eight inches long), scorpions, and spiders. Termites and ants, including the driver ant, are common, and the "ant hills" of the termites are a characteristic feature of many parts of the country. Ticks and mosquitoes, often carriers of disease, are plentiful and include the disseminator of malaria; tsetse flies that carry sleeping sickness are also widely distributed. (HE. NI.)

II. THE PEOPLE

The people of the Democratic Republic of the Congo are subdivided into a great variety of well over 200 tribes, many of which may be grouped together into larger culture clusters. Most of the tribes speak various Bantu languages (*q.v.*) but in the northern Congo there are also Sudanic and Nilotic speakers (*see* AFRICAN LANGUAGES). Moreover, up to 300,000 Pygmies, who live in close contact with Bantu or Sudanese, whose languages they adopted, are dispersed throughout the Central Congo rain forest. The Congo tribes have widely different origins and many of them are culturally and historically linked to different groupings established in the neighbouring territories. The larger tribes include the Kongo, Luba, Lunda, Mongo, Nandi, Zande (Azande), Babwa, Lega, Kuba, Kumu-Bira, Ngbandi, Bwaka, Pende, and Tetela. All tribes are subdivided into many territorial and kinship groups and exhibit widely different cultural features.

Except for the greater part of the Pygmies, all Congo tribes now practise shifting hoe cultivation; more intensive agricultural systems have been introduced. The staple crops are bananas, manioc (cassava), maize (corn), millet, peanuts, yams, and beans. Palm groves cover large tracts of the Congo forests. Food gathering and hunting are still very important among the Pygmies and many Central Congo tribes, for whom hunting remains socially and ritually prominent. Fishing, too, is done on a considerable scale on the Congo River and its main tributaries, the great lakes, and the swamps. Most economic activities are shared by men and women according to a rigid pattern of labour division. Some eastern Congo people are sedentary pastoralists. Ownership and usage of land are generally controlled by local lineage groups, but eminent domain on land may reside with divine kings. Generally, individuals have secure title to land usage. Pottery, basketry, weaving, carving, and ironwork are highly developed. The use of gourds as vessels and of bark cloth and skins as clothing is widely distributed. Fine carvings in wood, ivory, and bone of masks, statues, seats, headrests, ceremonial axes, doors, etc., are known from many southern tribes.

The descent systems are of the patrilineal or matrilineal type; but double-descent systems and non-unilineal descent groups occur among some tribes; relationships based on affinity, complementary filiation, friendship, and various alliances are also common. Marriages are usually established by means of small or high marriage payments, but exchange marriages, elopement marriages, and replacement of wives do occur. Polygyny is common and widow's inheritance (brother's wife; father's wife; mother's brother's wife) is much practised. Preferential marriages, *e.g.*, between cross-cousins, and different forms of ritual marriages are permitted by some tribes. Formal age sets only exist in a few areas; closed associations, corporations, and cult groups have a large distribution. The political structures range from elementary band organization and small autonomous kinship groups to elaborate segmentary structures, and from petty chiefdoms to large states with a feudal or military character and federative monarchies. Most Congo tribes practise ancestral cults and worship different kinds of spirits; there is also a general belief in a supreme being. In most societies special status is ascribed to twins, diviners, medicine men, rain-makers, and different kinds of specialized priests and shamans. Oral literature (myths, proverbs, legends, songs, tales, and epic cycles) is extremely rich, as are dancing and some other dramatic representations. About 4,000,000 Congolese now live under urban and semiurban conditions, but many of them have preserved close links with the people of their tribal region. (*See* also AFRICA: *Ethnography* [*Anthropology*]: *West Central Africa.*)

Prior to independence there were in the Congo about 580 Roman Catholic missions with more than 3,000 European and 780 African priests; there were also about 2,600 European and 750 African nuns. The number of African Roman Catholics was estimated at 4,220,440. Protestant missionaries belonging to many denominations exceeded 2,500 (about 1,500 European and 1,000 African). The number of Protestants was estimated at more than 800,000. There were also about 100,000 Muslims. (D. P. BI.)

III. HISTORY

The history of the region prior to its becoming an independent republic in 1960 is to be found in the articles BELGIAN CONGO, and in AFRICA: *History: Central Africa.*

The resolutions of a Belgian-Congolese round-table conference on independence (January–February 1960) in Brussels were approved by the Belgian Parliament and from April 26 to May 16 an economic conference met there to agree on economic, financial, and social cooperation. The provisional constitution was signed on May 19, 1960, by King Baudouin (for details of the constitution see *Administration*, below). In the subsequent elections the Congo National Movement, led by Patrice Lumumba, emerged as the strongest party in both central and provincial assemblies and had the support of 74 out of the 137 seats in the House of Representatives. The first national government was formed on June 24, with Lumumba as prime minister. His political rival, Joseph Kasavubu, was elected head of state. On June 30 King Baudouin proclaimed in Léopoldville the independence of the new state.

Confusion developed almost at once in many areas and the situation became rapidly more serious with the mutiny of the Congolese Army. Moise Tshombe, provincial president in Katanga, declared Katanga independent on July 11 and Belgian forces arrived there to protect Belgian mining interests. On July 14 the United Nations Security Council acceded to Lumumba's request to send a UN force to the Congo. Although there was a ready response to the request of the secretary-general, Dag Hammarskjöld, for military help, the UN force was handicapped by his insistence that, in accordance with the Charter of the UN, it must not become a party to internal conflict or influence the constitutional issues. Lumumba, therefore, could expect no help against the secessionist Katanga Province or any other rebels. When he then sought and received aid from the Soviet Union, Pres. Kasavubu on Sept. 5 dismissed him and appointed Joseph Ileo in his place. Lumumba might still have rallied widespread support if Radio Léopoldville had not been closed down by UN forces, for on Sept. 13 Parliament voted him full powers. On Sept. 14 the Army leader, Col. Joseph Mobutu, seized power with UN approval and

dismissed the president and both prime ministers, though he later came to a working agreement with Kasavubu. Parliament no longer operated effectively and on Dec. 1 Lumumba was arrested by Mobutu's forces. He was later transferred to Katanga and it was announced on Feb. 13, 1961, that he had been killed after escaping.

The end of 1960 saw the Congo divided into various rival regions. Kasavubu and Mobutu held an uncertain authority in the provinces of Léopoldville and Equator; Antoine Gizenga, who had been deputy prime minister to Lumumba and had proclaimed himself Lumumba's successor, exercised from Stanleyville some influence over Eastern and Kivu provinces; Tshombe claimed to be head of the independent state of Katanga; and Albert Kalonji in South Kasai also refused to obey either Kasavubu or Gizenga. The original, centralized constitution had thus been rendered totally ineffective.

Tshombe was in a particularly strong position. Although the official Belgian forces had withdrawn at the request of the UN, Tshombe's own troops were still led by Belgians and other foreign officers; he had behind him, too, the wealth of the province's mining resources and the support of the mining company Union Minière, and he knew he could rely upon the sympathy if not the active support of Belgium, Britain, and France. At the end of January 1961 Kasavubu, in an attempt to win over some of the other provinces, summoned a preliminary conference at which he called for a united Congo with greater autonomy for the regions. Unsuccessful, he again tried (Feb. 9) to demonstrate the republic's stability by forming a new government with Ileo, one of his strongest supporters, as prime minister. Any hope of a *rapprochement* was, however, immediately shattered by the news of Lumumba's death.

Several Congolese leaders met in Madagascar in March and it was thought that some understanding had been reached between Ileo's government and Tshombe, and there were hopes also of establishing friendly relations with Gizenga. Later Tshombe claimed that Kasavubu had betrayed the agreement reached in Madagascar by his willingness to cooperate with the UN. Tshombe was therefore arrested (April 28) on the order of Kasavubu's government during a conference in Equator Province and was detained for nearly two months until he agreed to reunite Katanga with the republic. Having safely returned to Katanga, however, he went back on his word and did not attend the Parliament reassembled in Léopoldville in July. Nevertheless, Kasavubu was able to name a new government, with Cyrille Adoula as prime minister, which obtained UN approval.

In August UN forces attempted to undermine Tshombe's position by disarming Katangan soldiers and police. Tshombe resisted and Hammerskjöld, while on his way to meet Tshombe at Ndola, in Northern Rhodesia (Zambia), to try and reach an agreement, was killed (Sept. 18) when his plane crashed. A cease-fire was agreed to on Sept. 21, but on Nov. 2 Mobutu launched an attack to try to end Katanga's secession. Later in the month a Security Council resolution demanded the reunification of Katanga with the rest of the republic, but Tshombe responded with preparations for all-out war. On Dec. 5 fighting broke out in Elisabethville between UN and Katangan forces but another cease-fire arranged on Dec. 18 was followed by a visit to Kitona by Tshombe for talks with Adoula.

This meeting, like several held in 1962, came to nothing owing to Tshombe's unwillingness to cooperate wholeheartedly with Adoula's government. Faced by an apparently endless deadlock, the acting UN secretary-general, U Thant, proposed a three-phase plan to reunite Katanga with the rest of the country. All taxes, duties, and mining royalties would be divided equally between Katanga and the central government and the armies of Katanga would be united with those of the republic within two months. If this failed, U Thant proposed a trade ban on Katanga and, finally, if all other measures proved unsuccessful the UN command would be authorized to end Katanga's secession. Once again, however, Tshombe refused to cooperate, confident that he had the sympathy of some of the most powerful governments and financial interests in Europe.

In December 1962 UN forces undertook military action against Katanga with the approval of the United States. After initial stubborn military resistance, Tshombe's opposition suddenly collapsed and he agreed (January 1963) to give up his secessionist claims. The situation was still far from settled, however, for the UN forces were a heavy financial burden on UN revenues and a scaling down of operations seemed inevitable. Continued opposition to Adoula in Parliament also presented the government with serious problems and finally on Sept. 30, 1963, Kasavubu dissolved the legislature and appointed a commission to draft a new constitution. On Oct. 1 Adoula's government was given full legislative powers but its position was weak. The economy had never been worse; the Army needed drastic reorganization; and the pro-Lumumbist critics of the government were untiring in their opposition. The UN therefore agreed to retain some forces in the country (the last troops withdrew on June 30, 1964) and Kasavubu tried to deal with the financial situation by devaluing the franc. In March 1964 the constitutional committee recommended a new constitution which would reduce the powers of both prime minister and Parliament while increasing those of the head of state; however, the referendum (June–July) which was claimed to have approved the new constitution was extremely suspect and Adoula's new government was incapable of controlling the increasingly widespread disorders.

In July 1964 Kasavubu asked his old opponent, Tshombe, who had recently returned from self-imposed exile in Europe, to form a government. This appointment alienated any sympathy which most of the African countries might previously have had for the problems of the central government, and Tshombe's appeals to them for military aid to face the rebellions organized by the anti-Tshombe "National Liberation Committee" met with no response. The United States sent arms and equipment, and when this was followed by Belgian military intervention to rescue Europeans held as hostages by the rebels, hopes for reunification of the republic under Tshombe lessened. (K. I.)

IV. POPULATION

The Democratic Republic of the Congo is one of the most sparsely populated countries in Africa. The total population was estimated in 1964 at 15,449,000, with an average density of 17 per square mile. The indigenous population was estimated at 10,353,900 in 1941, and at 13,540,182 in 1958; but while in 1941 more than 91% lived in native settlements, in 1958 this proportion was 77%; thus by 1958 more than 3,000,000 Africans lived either in towns or industrial areas, or on European plantations.

The European and nonindigenous population of the former Belgian Congo was well over 100,000 in 1958, more than four times that in 1939, Belgians accounting for 76% of the 1958 figure. However, it showed a marked decline after independence.

Just within the mouth of the Congo is the harbour of Banana. It is the oldest trading station in the Congo, European merchants having been established there since the 16th century. On the north bank of the estuary is Boma (*q.v.*), formerly the administrative capital. It is the port of the Mayumbe country, with which it is connected by railway and road. Farther up the river and 93 mi. (150 km.) from Banana is Matadi, the farthest point reached by ocean-going ships and the port for the greater part of the country. From it a railway runs past the cataract region to Stanley Pool, where stands Léopoldville (*q.v.*), the capital, with a population (1960 est.) of 402,492. About 750 mi. (1,200 km.) from Léopoldville is Stanleyville, capital of the former Eastern (Orientale) Province (now chief town of Haut-Congo Province; pop. [1958 est.]: 74,936 Africans and 5,015 Europeans); roughly midway between Léopoldville and Stanleyville is Coquilhatville (at the Ruki-Congo confluence), chief town of the Cuvette-Centrale Province (36,156 Africans and 1,431 Europeans); Bukavu (formerly Costermansville), on Lake Kivu (28,960 Africans and 4,308 Europeans), is the chief town of Kivu-Central Province; Elisabethville (*q.v.*) (168,775 Africans and 13,863 Europeans) of Katanga-Oriental Province; and Luluabourg (56,432 Africans and 3,103 Europeans) of Luluabourg Province. Jadotville (*q.v.*) (69,814 Africans and 4,664 Europeans) is an important centre in Katanga-

Oriental. The former European sections of the principal towns have many of the conveniences of modern cities, including electricity, sanitary facilities, public water systems and running water, ice plants, well-built houses, good food supply, newspapers, hotels, cafes, social and sports clubs, and motion picture theatres. The population of Congolese towns has considerably increased since independence.

V. ADMINISTRATION

The administration under the Belgians was the responsibility of the minister for the Belgian Congo and Ruanda-Urundi. His representative in Africa was the governor-general, who was responsible for the conduct of the government, assisted by one or more deputy governor-generals. Each of the former six provinces (*see* below) was directed by a governor. The provinces were subdivided into districts and territories. Each territory comprised several native sectors or circumscriptions under an African chief, whether the traditional chief or one appointed by the administration. These chiefs tried certain offenses according to the customary law and were responsible for implementing government decisions. Belgian rule, however, left the country with few able native administrators. By a law promulgated in August 1962, the number of provinces was increased to 21: Kongo-Central, Kwango, Kwilu, Mai-Ndombe (former Léopoldville Province); Cuvette-Centrale, Moyen-Congo, Ubangi (former Equator); Kibali-Ituri, Haut-Congo, Uele (former Eastern); Kivu-Central, Maniema, Nord-Kivu (former Kivu); Lomami, Luluabourg, Sankuru, Sud-Kasai, Unité-Kasaïenne (former Kasai); Katanga-Oriental, Nord-Katanga, Lualaba (former Katanga). Léopoldville town was a separate administrative unit. Provincial government became the responsibility of the president and six ministers.

1. Constitution.—In May 1960, by the constitution (La Loi Fondamentale) created by the Belgian Parliament, two legislative assemblies were established: a Chamber whose members were elected in principle by direct universal male suffrage, and a Senate whose members were nominated by the provincial assemblies, themselves elected by direct or indirect suffrage. The president was elected by both assemblies in joint session, requiring a two-thirds majority. He had power to appoint and dismiss ministers; any act of his required countersigning by the appropriate minister. This last provision was abolished by a new constitution favouring a strong presidential form of government, promulgated in August 1964. The new constitution also created a Constitutional Court, charged with verifying the legality of the election of the president. General elections were held in 1965.

2. Education.—Education was for long in the hands of the Christian missions, and until the 1950s there was practically nothing except primary schools. The majority of missionary schools (about 20,000) were operated by Catholic missions and most of the remainder (about 9%) by the Protestant missions. State education was developed after World War II. At the mid-1960s there were no reliable school statistics available. The republic has three small universities; the state university at Elisabethville, the Lovanium Catholic University at Kimuenza near Léopoldville, and the University of Stanleyville.

3. Defense.—The Congo possessed under the Belgian administration a *Force Publique* of more than 23,000 African noncommissioned officers and soldiers, with 990 European officers and noncommissioned officers. Belgium also equipped military bases at Kamina (in Katanga), Kitona (in the Lower Congo region), and a naval base at Banana (at the mouth of the Congo); these were ceded to the republic in March 1964. In the first period after independence the lack of trained Congolese officers was one of the factors responsible for the Army mutinies, the breakdown of discipline, and the subsequent political confusion. Following the refusal of certain African countries in August 1964 to send troops to assist the Armée Nationale Congolaise in its fight against the rebels, white mercenaries were recruited for this task. Late in 1964 a controversial program to rebuild the Congolese Army, involving Belgium (which would provide instructors) and the United States (which would pay for equipment and supplies), was begun.

VI. THE ECONOMY

Under Congo Free State rule, no distinction was made between the state as administrator and as trader and landlord, whether the estates were worked directly or through concessionaires. Great efforts were made to obtain the maximum output of the two products most easily available, namely rubber and ivory, but the needs of transport and of bringing the country under control entailed the raising of large loans. During that period 75% of the revenue was derived from rubber, and much of the remainder from ivory. Commercial prosperity subsequently came with the development of the extremely varied mineral wealth, and during the colonial period (1908–1960) the administration consistently maintained favourable annual trade balances. The economic situation after independence was precarious, although a UN report of May 1964 noted "slow but perceptible progress toward recovery."

1. Agriculture.—Under colonial administration the abandonment of the compulsory collection of wild rubber by the Africans coincided with a fall in prices in Europe; and later plantation rubber from Malaya and the Netherlands Indies very largely supplanted wild rubber. While wild rubber continued to be collected to a diminishing extent, rubber plantations were started. Sugarcane planting began in 1926 in the region between Matadi and Stanley Pool and gave good promise; coffee cultivation began about 1920 in the Kivu and Uele districts and proved a success. Large palm-oil plantations were created by various companies, which also exploited the wild oil palms. Africans developed the cultivation of bananas, which were exported from Mayumbe, and also of peanuts and (in northern Kasai) coffee. The Belgians introduced cotton cultivation in Katanga, Kasai, and the northern regions. Subsistence crops are mainly cassava, maize (corn), rice, peas, bananas, and beans.

Rough and dressed timber were exported in significant quantities. The most important timber-producing region is in Uele, especially Mayumbe and the area around Lake Léopold II. Veneer leaves and plywood were also produced.

Cattle raising, undertaken first by settlers in Katanga, expanded rapidly in the 1920s and spread to the region of the great lakes, eastern Kasai, and the Lower Congo. Goats and sheep are also raised by Africans.

2. Mining and Industry.—The Katanga area, which produces large quantities of tin, also has uranium (and radium), manganese ore and zinc, and ore sufficient to control the world's supply of cobalt. But it is chiefly famous for its copper and is the main source for hydroelectric power. Sud-Kasai produces industrial diamonds. Tin and gold are mined in the Kivu area, and gold in Kibali-Ituri. In February 1965 an agreement was negotiated between the Belgian government and the Democratic Republic regulating the control of mineral production and transportation.

Industrial and commercial products include cement, gunpowder and explosives, sulfuric acid, beer, peanut oil, margarine, textiles, leather shoes, cigarettes, bricks and tiles, bottles, metal and enamel containers, garments, and haberdashery.

3. Foreign Trade.—During World War II and after, exports exceeded imports. Machinery, fuels, textiles, and foodstuffs predominated in the imports, while minerals and agricultural products comprised the bulk of the exports. Prior to independence Belgium supplied more than one-third of the imports and took nearly half of the exports of the Congo followed by the United States and the United Kingdom. In the early 1960s Belgium remained the Congo's chief outlet for exports (over 50%); the United States supplied 33% of imports in 1962.

4. Finance.—The monetary unit in the Republic is the Congolese franc (FC), nominally an independent currency and formerly at par with the Belgian franc, but on Nov. 9, 1963, devalued from FC 65 to FC 180 for U.S. $1. The financial position of the country was satisfactory up till independence; and, especially after World War II, the budgets usually had surpluses. With independence, the shortage of trained civil servants and the haphazard methods of tax collection were persistent factors in an unbalanced budget. In addition foreign companies remaining in the Congo paid almost no taxes. In 1963 public expenditure reached FC 28,700,000,000, leaving a deficit of FC 16,500,000,000 over income.

5. Transport and Communications.—By agreement the government gained control of all transport facilities in February 1965. There are 8,518 mi. (13,708 km.) of waterways (*see* Congo River), 3,016 mi. (4,854 km.) of railways, and 90,430 mi. (145,530 km.) of roads. A part of the rail system was designed as supplementary to the navigable rivers, which are often interrupted by cataracts and rapids. The Office d'Exploitation des Transports Congolais (OTRACO) operates the Kivu line (58 mi. [93 km.]) and the Mayumbe railway (84.5 mi.) connecting the port of Boma northward with Tshela in the forest region. It also controls river transport and operates the Matadi-Léopoldville line (254 mi.), which bypasses the rapids of the Lower Congo. There are also other railway lines or networks previously operated by private companies. The Nouvelle Cie. du Chemin de Fer du Bas-Congo au Katanga or B.C.K. operates: (1) the Katanga Railway (441 mi.) serving the copper-mines district between Bukama and Sakania on the Rhodesian frontier, passing Elisabethville and linking with the Rhodesian railways; (2) Port-Francqui-Bukama line (698 mi.) connecting the copper-mines district with the Lower Congo through the Kasai River; (3) the Tenke-Dilolo line (324 mi.) connecting the same district with the Benguela Railway and the Portuguese port of Lobito.

The Chemins de Fer du Congo Supérieur aux Grands Lacs Africains or C.F.L. operates 674 mi.: Stanleyville-Ponthierville, Kindu-Kabalo (the first line, and in part the second, bypass the rapids of the Lualaba or Upper Congo); Kabalo-Albertville which connects the Congo with Lake Tanganyika and by lake traffic with the British railway from Kigoma to Dar es Salaam on the Indian Ocean. The Kabalo-Kamina Railway has connected the C.F.L. and B.C.K. systems since 1956. The narrow-gauge railway (522.5 mi.) of the Vicicongo Company in the north connects the Middle Congo from Aketi (on the Itimbiri River, a tributary of the Congo) via Paulis to Mungbere, with a branch line from Komba to Bondo (on the Uele River).

The country has four ports accessible to ocean steamers: Banana, Boma, Ango Ango, and Matadi. Matadi is the main port with Ango Ango serving as a petroleum port near it. Lobito in Angola is an important outlet for Congolese exports.

The airports at Léopoldville, Stanleyville, and Elisabethville have international connections (principally via Brussels and Johannesburg) and internal routes are operated by Air Congo, the national airline.

Radiodiffusion Congolaise at Léopoldville, with regional stations at the main centres, broadcasts in French and the Congolese languages.

See also references under "Congo, Democratic Republic of the" in the Index. (He. Ni.)

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CONGO FREE STATE: *see* Belgian Congo.

CONGO RIVER, the second longest river in Africa, its length of 2,716 mi. from the source of the Chambezi in Zambia to its mouth at Banana (Banane), Democratic Republic of the (former Belgian) Congo, being exceeded by that of the Nile, 4,157 mi. The Congo's drainage basin, with an area of about 1,425,000 sq.mi., and its mean discharge (into the Atlantic) of 1,400,000 cu.ft. per second are, however, much greater. Its vast basin lies astride the equator in west central Africa (*see* map), and it includes almost the whole of the Democratic Republic of the Congo, most of the Congo Republic (formerly Middle Congo), the western part of Zambia and the northern part of Angola.

In both the Congo republics the main stream and its tributaries are valuable commercial waterways; they were of first importance in opening up an enormous region that was largely unknown to Europeans until the end of the 19th century. But the inland waterways are cut off from the Atlantic as far as navigation is concerned by the Livingstone falls where the river drops 886 ft. in 215 mi. Materials are carried inland to Stanley pool above the falls by two railways. One, constructed by the French, runs from Pointe-Noire to Brazzaville; the other, built by the Belgians, links Matadi at the head of the Congo estuary to Léopoldville.

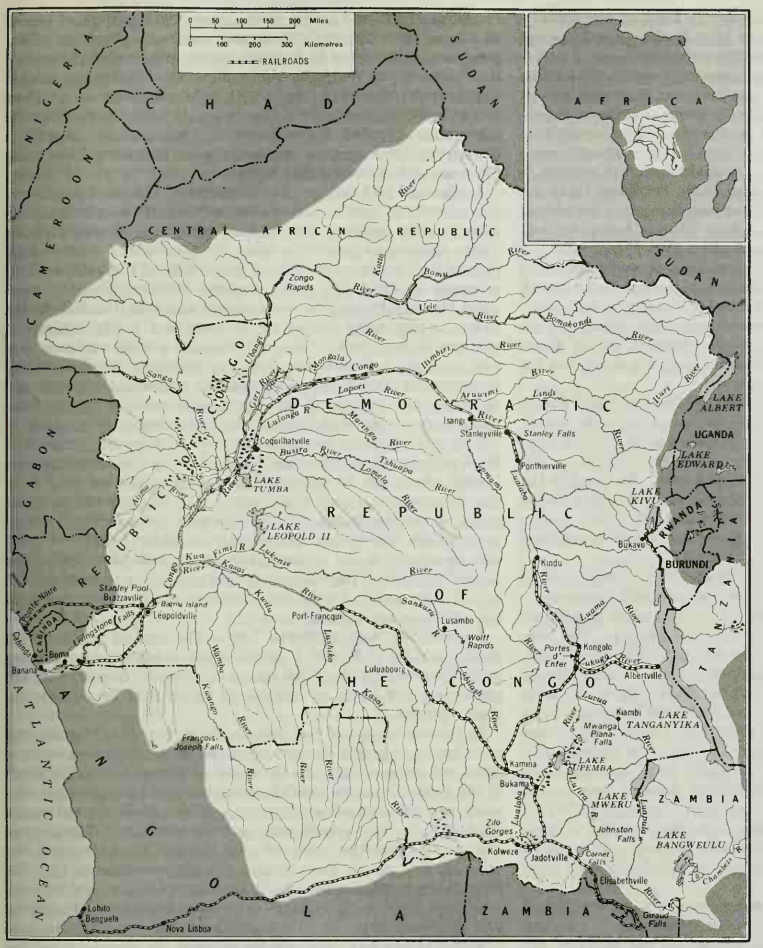
Congo River System.—The headstreams of the upper Congo flowing north from the plateaus of northeastern Angola and Katanga include the Lualaba in the east; this is usually regarded as the Congo main stream. It receives tributaries flowing west from the high plateaus of Zambia and western Tanganyika (Tanzania), and the highlands bordering the western section of the Great Rift system and leads their waters by a great arc north of the equator to Stanley pool and then via a narrow gorge across the Crystal mountains to the Atlantic. It is joined by several other great rivers in the middle Congo basin, notably the Ubangi (*q.v.*) bringing the waters of the area to the north, between the Cameroon highlands and the region west of Lake Albert, and the Kasai river (known as the Kwa in its lower course) draining the southwestern part of the basin.

Because of the distribution of its tributaries on both sides of the equator, the lower Congo is well supplied with water at all seasons. In July when the flow of the southern tributaries dwindles, the northern tributaries are flowing strongly; in January the position is reversed. The ratio between the mean maximum discharge of about 2,500,000 cu.ft. per second and the mean minimum flow of about 800,000 is unusually low, especially for an African river.

Upper Congo.—The easterly headstreams are generally regarded as marking the true course of the river. The most remote of these is the Chambezi which rises in the highlands between Lakes Nyasa and Tanganyika and flows southwest across the gently sloping plains of Zambia. After skirting Lake Bangweulu it is known as the Luapula. Already it is a large river with a mean discharge at the Giraud falls of 2,000 cu.ft. per second and a flood discharge of ten times that amount. For 300 mi. it defines the frontier between Zambia and the Democratic Republic of the Congo. Below the Johnston falls it is navigable for small boats for 100 mi. to Lake Mweru (*q.v.*). On the shallow lake, traffic is impeded by papyrus and other swamp plants and farther downstream the river, known as the Luvua, is interrupted by falls. These were harnessed 30 mi. above Kiambi at Piana-Mwanga to generate electricity for the mines at Manono and Kitotolo. Below the falls the river is navigable for 100 mi. to its confluence with the Lualaba at Ankoro.

The Lualaba rises near Musofi at about 4,600 ft. and descends rapidly to the Biano plateau where it flows across an ancient lake bed at about 4,000 ft., most of which is under cultivation. It cuts deeply into the plateau edge to form the narrow gorges of Zilo and in 45 mi. descends 1,500 ft. to the floor of the Kamolondo trough. The mean discharge of the river is more than 3,000 cu.ft. per second and the drop is utilized at the Delcommune falls where electric power is generated on a large scale. To maintain the dry season flow, a dam 215 ft. high was constructed above the falls to hold up a lake covering 39 sq.mi.

The Kamolondo trough, like the depression where Lake Mweru lies, is the outcome of downfaulting in late geologic times. The gradient of the river is gentle and downstream from Bukama it is navigable for 400 mi. Several large lakes occupying the floor of the trough are linked by channels to the Lualaba and the largest of them, called Upemba, receives the waters of the Lufira river. Rising south of Jadotville the Lufira was dammed below that town to form a lake with an area of 160 sq.mi. to provide storage for a power station on the Cornet falls. Traces of an ancient lake bed remain where it skirts the Kundelungu mountains below Lukasu. At the Kuibo falls the Lufira descends more than 100 ft. and traverses the Bia mountains in a deep gorge to join the Lualaba via Lake Upemba. Navigation farther down the Lualaba is hindered by papyrus and floating islands of vegetation where



CONGO RIVER BASIN

Congo gradually becomes sluggish and is unbroken by rapids for more than 1,000 mi.

Middle Congo.—From a width of about half a mile at Stanleyville the river widens to more than a mile and its banks decline in height as the confluence with the Lomami is approached. At Isangi the Congo enters that central part of its basin occupied several thousands of years ago by a great shallow lake. The bed widens and near the mouths of tributaries its banks are as much as 9 mi. apart. The average width is about 4 mi. and navigation is limited in February, July and August to boats drawing less than 5 ft. of water. The shifting channels threading between sandbanks have been buoyed and with dredging it is usually possible to maintain a passage six or seven feet deep throughout the year. After crossing the equator at Coquilhatville, the river is joined by the Ubangi which forms a delta 9 mi. wide that concealed from the explorer H. M. Stanley the fact that this was the confluence of the Congo and its largest right-bank tributary.

Farther downstream the river is littered with sandbanks and large islands and spills over its low banks to flood flat forested country on both sides for distances of 5 or 6 mi. Its average slope remains less than five inches to the mile and for 300 mi. down to Stanley pool boats drawing ten feet of water can operate throughout the year. Near Lukolela the Sanga river enters from the north and provides access to the Cameroons. At Bolobo the river narrows to less than 1½ mi.; rock outcrops on the floor of Sandy Beach pool, and immediately downstream the Channel begins. There, in spite of its great volume, the Congo for 125 mi. is only a mile wide and overlooked on either hand by steep sandstone bluffs. It runs 100 ft. deep and even more near Kwamouth where the waters of the Kasai enter the main stream. Suddenly the steep banks decline and the Channel widens out into Stanley pool, a shallow lake 22 mi. long and 14 mi. wide, with deep navigable channels leading either side of Bamu Island to the ports of Brazzaville (*q.v.*) on the north shore and Léopoldville (*q.v.*) on the south which are the terminals of inland navigation.

Lower Congo.—At the western end of the lake, the waters of the Congo topple over a rocky sill, and from a height of 908 ft. at Stanley pool the river drops to 630 ft. at Manyanga over a distance of 83 mi. Beyond the pool begin a series of 32 cataracts known collectively as the Livingstone falls which extend between Léopoldville and Matadi. The tributaries from the Crystal mountains to the north and south enter by high falls and electricity is generated at the Sanga falls on the Inkisi for Brazzaville and Léopoldville, the capitals of the two Congo republics lying on either side of the river. For 87 mi. to Isangila, relatively weak calcareous schists outcrop and there are only a few minor rapids. Then more very tough rocks form a barrier and the river falls

the river widens out to form Lake Kisale, and the expense of maintaining a channel there, 150 ft. wide and 5 ft. deep, is considerable. The river route on the upper Lualaba is duplicated by the railway from Kamina to Kabalo.

Below Kongolo the Lualaba has cut a very deep gorge, in places less than 100 yd. wide, called the Portes d'Enfer. A concrete bridge carries the railway from Kindu to Albertville across the gorge. This line follows the valley of the Lukuga, the river linking Lake Tanganyika (*q.v.*) and its catchment to the Lualaba. For a stretch of 68 mi. downriver from Kasongo the river is again navigable, but more rapids and waterfalls interrupt its course at Kibombo. Below Kindu the river flows between rocky bluffs 50 to 60 ft. high, and in periods of low water its depth is reduced by rock bars to about 3 ft. Nevertheless it is utilized by boats for 190 mi. between Kindu and Ponthierville where the Stanley falls commence. Seven cataracts, extending for 60 mi. along a great westward curve of the river and giving a total fall of about 200 ft., are circumvented by rail and road by which goods are carried between Ponthierville and Stanleyville, at the head of navigation on the Middle Congo. Stanley falls mark the end of the Lualaba and the beginning of the Congo proper. Below Stanleyville the

from 560 ft. to 25 ft. near Matadi at the head of the estuary. At the Inga falls, about 25 mi. above Matadi, the potential power has been estimated at 25,000,000 to 30,000,000 kw.

Matadi, standing a little way downstream of the lowest falls on the river, has one of the largest ocean harbours in central Africa. Its water front, cut out of granite, is about a mile in length. Growth of the town is restricted by the steep hills overlooking the river. In the upper estuary the Congo has cut a channel more than 100 ft. deep into solid rock, and although the current is generally no more than three or four miles per hour, there are several turbulent passages of which the best known are the violent eddies and whirlpools of the Chaudron d'Enfer below Matadi. Below Fetish rock the river opens out into a pool 12 mi. wide, but near Boma sediment has accumulated to form several islands and the channel has to be dredged to allow ocean-going vessels to reach Matadi. At Boma (*q.v.*) the tidal range is less than a foot, compared with about six feet at the seaward end of the estuary, 92 mi. below Matadi. In this seaward section downstream of Boma mangrove swamps cover recent sediments along the shore, but the central channel cuts down very deeply.

At the mouth, between Pointe Padrao on the south and Pointe de Banane on the north side, where the river is 6 mi. wide, soundings of 1,450 ft. have been obtained, and the course of the Congo is prolonged offshore as a submarine canyon cut in places 4,000 ft. below the level of the surrounding sea floor. So great is the discharge of the river that brownish-coloured fresh water lies at the surface about 50 mi. from the coast and the Congo waters can still be distinguished by their olive-green colour more than 300 mi. out to sea.

The Congo as an Inland Waterway.—The Congo and its tributaries form a magnificent system of navigable waterways, and nearly 8,000 mi. of river routes are in regular use in addition to the lake routes on Kivu, Tanganyika and Mweru. The non-navigable sections are circumvented by railroads (Matadi-Léopoldville, Stanleyville-Ponthierville, Kindu-Kongola). Port-Francqui on the Kasai river is an important transshipment point for Katanga copper ores and the terminus of the railroad from Bukama. Tugs, barges and other boats comprising about 500,000 tons of shipping make connections between the various railroad and highway systems serving the interior. The larger boats were formerly stern-wheelers, fired by wood and drawing about three or four feet of water, but following Mississippi experience, boats propelled by diesel engines were introduced along with tugs designed to push trains of barges carrying thousands of tons of cargo. Illuminated buoys, to allow movement by night, were installed, and some ships carry radar.

In the 1950s the water hyacinth *Eichornia crassipes* appeared on the Congo and spread with remarkable speed to form a serious obstacle to navigation. The plant invaded all the banks of the river and several tributaries, including the creeks between the islands in the main stream. It has become necessary to treat thousands of square miles to eradicate the plant.

Hydroelectric Power.—The floor of the Congo basin stands for the most part more than 1,000 ft. above sea level. More than half of the basin is at 1,500 to 3,000 ft. and about a quarter is above 3,000 ft. Combined with the high rainfall (50–70 in.) over the basin and consequent great discharge of the river, this high elevation makes the Congo an enormous potential source of water power. Of the total potential, which probably exceeds that of the United States, only a small fraction had been harnessed by the 1960s. Development had been confined mainly to the Katanga (*q.v.*) mine fields region, but grew rapidly in many centres after mid-20th century due to an apparent lack of oil or good quality coal as alternate sources of power.

The Evolution of the Relief of the Congo Basin.—The ancient rocks of Africa outcrop round the rim of the Congo basin; they form the mountains on either side of the Livingstone falls; they build the Cameroon highlands and underlie the lower country north of the Ubangi and Uele rivers. In the eastern highlands they have been let down between faults and thrust up as blocks. In Katanga they are highly mineralized and yield copper and other ores. Among the Pre-Cambrian sedimentary rocks are formations of glacial origin, and in the southeastern highlands traces persist of a much later Upper Carboniferous mountain glaciation. Coal measures accumulated in Permian times, and toward the end of the Paleozoic era the rocks give indication of increasing aridity. Continental sediments accumulated in Mesozoic times but there was at least one marine incursion in the Jurassic period when the sea probably spread across from the Indian ocean. Later, in Cretaceous times, marine sediments were laid down both along the coast and in the interior basin.

In the mid-20th century the evolution of the relief and drainage pattern in most areas was the subject of speculation. Research in the southern part of the Democratic Republic of the Congo appears to provide a basis for establishing a chronology for much of southern Africa. A great deal of the basin is characterized by extensive, gently sloping, dissected plateaus, separated from each other by escarpments and with the falls in the rivers corresponding to the escarpments and to the outcrop of resistant beds of rock. These plateaus are erosion surfaces, covered in places by sediments, and they appear to be the outcome of successive periods of planation under subaerial conditions, and following rejuvenation of the rivers as a result of repeated accentuations of the basin form of the Congo region as a whole.

It is interesting to note that the northward-flowing streams of the Kasai system may once have drained to the Chad basin and the Ubangi above the Zongo rapids may have continued to flow in that direction until quite a late stage. The Lualaba and its tributaries above the Portes d'Enfer probably belonged in Tertiary times to the Nile system or ran into the Indian ocean. A great lake developed in the central basin as a result of downwarping toward the end of the Pliocene period and this was later drained into Stanley pool. The Livingstone falls on the lower course of the river are undoubtedly youthful.

Vegetation and Animal Life.—The central parts of the basin, between 4° N. and S. of the equator, experiencing a heavy rainfall and only a short dry season, are largely covered with the great trees and lianas of rain forest, which is often marshy and always humid.

In the headwaters of the Aruwimi-Ituri river live Pygmies who have remained peculiarly untouched and retain their ancient character and mode of life. To the north of Ubangi and to the south of the lower Kasai the rainfall diminishes and becomes more seasonal, and although tall gallery forest persists along the waterways the interfluves are covered with savanna woodland. Leguminous species are abundant, especially in the south, and toward the drier margins of the basin thorny acacias predominate. As the altitude increases, the savanna trees diminish in size and number, and above 5,000 ft. the uplands are largely grass-covered and provide good pasturage. At still higher levels the vegetation is characterized by bamboos, and near the crests of the mountains bordering the Rift appear strange treelike heather, lobelia and giant senecio. In spite of the low population density over most of the Congo basin, the vegetation has been altered over very wide areas by cultivation and burning and in such areas as the mine fields of Katanga few traces of the original plant cover remain. Many cultivated plants have been introduced from other parts of the world; cassava, maize (corn) and several others were brought from South America by the Portuguese; others, such as sugar cane and citrus trees, are of oriental origin.

The fauna is exceedingly rich and is of great interest because many species persist in the Congo basin which have been eliminated from more heavily settled parts of the continent. Some animals such as elephant and leopard are found in both savanna and forest in most parts of the basin, but the distribution of many species is related to the vegetation pattern. Lion and zebra for example are confined to the grassy savannas in such areas as the upper Uele and Katanga; gorilla live in the bamboo forests of the mountains. During the Belgian colonial era many of the rarer animals such as the rhinoceros, okapi and zebra were protected and could not be shot; licences were required to hunt several others. In reserves and in national parks, such as Upemba, hunting was completely prohibited. More than 1,000 species of fish have been identified from the waters of the Congo system; among the best

known is the lungfish *Protopterus* which may weigh 100 lb.

Exploration.—In contrast to the Nile, there are practically no classical associations with the Congo, and except for its estuary the river remained unknown until the journeys of David Livingstone and H. M. Stanley (*qq.v.*) in the latter half of the 19th century. The Portuguese Diogo Cam (*q.v.*) discovered the mouth of the river in 1482 and erected a marble pillar on the left bank. The river was first called Rio del Padrao (Pillar river), but it soon became known as Zaire, corrupted from the native name *Zadi*, meaning "great water." Colonies were founded on the banks of the lower Congo by the Portuguese, and in the 16th century a kingdom with its capital at São Salvador in Angola flourished on the left bank of the river. Portuguese visited this colony regularly, and in 1591 Duarte Lopez published the story of his travels there. After 1627, when Europeans were expelled from the kingdom, little was done to explore the river until the British admiralty dispatched Capt. J. K. Tuckey at the head of a well-equipped mission in 1816. Tuckey managed to push up the Congo as far as Isangila beyond the lowest series of rapids, but sickness broke out and the commander and 16 other Europeans died. For 60 years no other Europeans reached even as far as Isangila. Tuckey's expedition had been prompted by the suggestion that the Congo was identical with the Niger, but a few years later Hugh Clapperton's expeditions to the western Sudan made this seem unlikely, and eventually the Congo system was mapped by explorers working down from its headstreams. Following in the tracks of Arab traders based on Zanzibar, Richard Francis Burton and J. H. Speke (*qq.v.*) reached Lake Tanganyika (1857–59). David Livingstone had already crossed the headstreams of the Kasai and Kwango in the early 1850s, and in 1868, having explored Lake Nyasa, he entered the Congo basin, discovering the Chambezi and Lake Bangweulu. In March 1871 he reached the town of Nyangwe on the Lualaba which was also reached by V. L. Cameron (*q.v.*). Livingstone died (1873) while endeavouring to trace the headstream of the Lualaba, which he believed to be the Congo. "I have no fancy," he once said "to be made into 'black man's pot' for the sake of the Congo." But by 1872 geographers were able to affirm, from Livingstone's own reports, that the great river system he had explored must belong to the Congo and not to the Nile. In 1876 Stanley arrived at Nyangwe from Zanzibar and, having assembled the boat that was carried overland from Zanzibar and bought 20 canoes, he navigated the river more than 1,600 mi. to Isangila. Stanley's great journey had demonstrated the identity of the Lualaba with the Zaire of the Portuguese, and had provided the key to the opening up of the interior. His services were enlisted by Leopold II of Belgium, and in 1880–82 he opened up a road to link the estuary of the Congo at Viva, opposite Matadi, to Léopoldville and built a steamer, the "Forward," to sail on Stanley pool. Further explorations continued, and the Rev. George Grenfell (*q.v.*) did much to add to the exact knowledge of the river and its tribuaries. At the time of the expedition in search (1887–89) of Mehmed Emin Pasha (*q.v.*), Stanley visited the Aruwimi and Ituri; in the same years the Ubangi, Mongala and Uele were traced; four successive expeditions explored the southern part of the basin, under the leadership of P. Le Marinel in 1890–91, W. G. Stairs in 1891, A. Delcommune in 1891–93 and E. Bia-Francqui during the same period. Detailed mapping of the basin continued, making the most rapid progress in areas with important mineral resources. The Congo basin is discussed further in AFRICA: *Physical Geography;* CONGO, DEMOCRATIC REPUBLIC OF THE; CONGO (REPUBLIC); BELGIAN CONGO. *See* also references under "Congo River" in the Index.

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(A. T. GR.)

CONGREGATION, an assembly of persons, especially a body so assembled for religious worship, or habitually attending a particular church, and hence the basis of the religious system known as Congregationalism (*q.v.*).

Old Testament and Judaism.—Although the word congregation occurs more than 350 times in the King James version of the English Bible, only one of these occurrences is in the New Testament (Acts xiii, 43). All the other instances of the word are renditions of Hebrew words, of which the two most important reflect the ambiguity in the concept "congregation": one of the Hebrew terms refers to the entire Israelitic community, the other refers to the gathering or assembly of the people. Thus "congregation" means either a group of persons gathered for public worship or a permanent religious and social institution. In modern Judaism the term is sometimes used as an equivalent of the postbiblical Hebrew word *knesset* in its religious sense (the word *knesset* is applied also to the Israeli parliament).

Roman Catholicism.—In the Roman Catholic Church the word is used in several senses: (1) The congregations or committees of the College of Cardinals which form administrative departments; *e.g.,* the congregations of Propaganda, Rites, etc. (*see* CURIA ROMANA). (2) The committees of bishops for the regulation of procedure at general councils. (3) Branches of a religious order, following its general rule but forming separate groups, each with its special constitution and observances; congregations of Benedictines, for example, include the Cassinese and the various national congregations. (4) Communities of religious under rule, composed of persons who have taken simple rather than solemn vows, such as the Passionists and Redemptorists (*see* ORDERS AND CONGREGATIONS, RELIGIOUS). (5) In France, religious associations of lay persons, male or female, for some pious, charitable or educational purpose.

Protestantism.—Protestant usage reflects the ambiguity of the King James version. A congregation usually means the assembly of worshipers gathered in a church at a particular service. But among English Nonconformists and American Protestants the term has been increasingly confined to the local church, often only to the lay people of the local church. In 1815–16 John Pickering, an early student of American linguistic usage, reported that "a church, as a body of persons . . . is distinguished in New England from a congregation, by the privileges which the former in general reserve to themselves of receiving exclusively in that church the sacrament and baptism. . . . Marriage, burial and public worship are open to the members of the congregation at large." The broadening of the standards for church membership in denominations of the Congregational tradition has tended to make even this distinction obsolete, and in America "congregation" has become virtually synonymous with "parish." (J. J. PN.)

CONGREGATIONALISM is the name given to that type of Christian churchmanship and church organization found in churches generally now called Congregational, but also called Independent (as in the 17th century in England, and in Wales today), and also in some churches not carrying either name or historically connected with the origins of the denomination in England.

As a method of church organization Congregationalism emphasizes the autonomy of the local church and the voluntary fellowship of such churches for counsel. It regards church authority as inherent in each local body of believers, as a miniature realization of the whole church, which can itself have only an ideal corporate being on earth. It holds this concept of polity to be based on the New Testament and conceives its own contribution to the church universal as consisting in witnessing to this concept. But it also affirms the necessity of voluntary fellowship with other churches. Congregationalism thus differs from pure Independency by reason of this emphasis on both local autonomy and the fellowship with all the other churches of its order. Besides, it acknowledges itself to be part of the church universal. Hence, Congregationalism stands for that kind of polity which regards as churches only the local congregations of the church universal. Christ is the sole head of the church universal; this church is composed of local congregations, each of which possesses independence, but is united with others by a voluntary tie of fellowship.

This method of church government is derived from the fundamental principles of Congregationalism: the immediacy of the relationship between the believer and God, the gathered church as a covenanted fellowship under the lordship of Christ and the priesthood of all believers. These principles, held throughout all differences, indicate the true character of Congregationalism, which cannot be wholly understood merely as a form of church organization.

Congregational churches in recognized unions or associations are to be found in Argentina, Australia, Brazil, British Guiana, England, Finland (as the Free Church), Ireland, Jamaica, the Netherlands (as the Remonstrant Brotherhood), New Zealand, Scotland, South Africa, Sweden (as the Mission Covenant Church), the United States and Wales (both as part of the Congregational Union of England and Wales, to which the English-speaking Welsh Congregational churches belong, and as the Welsh Independents, who are Welsh-speaking). All these churches are united in a free association known as the International Congregational council with headquarters in London. With these churches are associated also a number of United Churches which contain former Congregational elements—in Canada, north India, south India, Japan and the Philippines. Missionary service in many parts of Africa, in Ceylon, Hong Kong, India, Malaya, Micronesia, Papua, the South seas, Syria and Turkey extends the number of those within the Congregational fellowship. The total number of communicant members, excluding those in united churches and in mission churches, in the mid-20th century was about 2,100,000. The four largest groups were in the U.S. (1,432,000; United Church of Christ, 2,000,000), England and Wales (212,000; Welsh Independents, 118,000) and Sweden (98,000).

HISTORY

England

Origins.—Though the name "Congregational" was not in general use before the 1640s, the movement had its roots in the Reformation. It is no coincidence that the title of one of Congregationalism's foundation documents was Robert Browne's *A Treatise of Reformation Without Tarying for Anie* (1582).

The main effect of the Reformation in England was that ordinary people were able to read or hear the Bible in their own tongue without fear of persecution. It was not long before men of sensitive spirit began to feel themselves invited to share in biblical religion and enter into biblical experience. Such men tended to grow impatient with what seemed to them the more complacent, conventional religion of the dominant party in the Established Church. Some hoped to bring the church to fuller reform from within. Others felt driven to break away from the Church of England and its subservience to prelate, parliament and magistrate, and to form new groups in which they could be free to worship according to their consciences.

All these men, whether remaining within the Church of England or not, were nicknamed Puritans because they passionately desired purity in worship, church government and personal life. Those who left the Church of England were also called Separatists. Christians, they held, were called by God to separate not only from the world but also, if necessary, from the church, if the church had become worldly. They called the new groups which they formed "gathered churches"—that is, societies of men and women who knew and manifested the gifts and graces of God's Spirit, and were called out by God to be separate.

The separatist principle and the voluntary principle were at the same time revolutionary and determinative of Congregationalism. Its founders were united in a recognition of the true inwardness of religion. "He is a christian which is redeemed by Christ unto holiness and happiness for ever and professeth the same by submitting himself unto his lawes and government," as Robert Browne says in his *Treatise,* and the church is made up of such Christians. The church is thus defined in terms of the believers of whom it consists, and without whom and whose active and professing belief, and whose consequent and evident holiness, it cannot exist.

Congregationalism may thus be seen as one of the earliest attempts in England seriously to work out ecclesiologically the meaning of the Reformation doctrine of the priesthood of all believers, and to give due weight to the recovery at the Reformation of the sense of immediacy in the relation between the soul and God. That is not to say that the early Congregationalists were isolationists. On the contrary, they rediscovered much of the reality and glow of the New Testament *koinonia* ("communion" or "fellowship"). They were called Independents because they claimed independence of outer control—ecclesiastical control, whether by bishop or presbytery, no less than secular—but they sought such independence only in order to become more fully dependent on the Lord's will made known to them in fellowship. They came to be called Congregationalists because they claimed the right of all members of the congregation to a share in the direction of the church's affairs; but they claimed this as a right, because they saw it as a duty and privilege as they met together in the Spirit of Christ.

First Hundred Years.—Persecution by the dominant majority stimulated the elaboration of Congregational principles. This came in four waves of repression issuing from Lambeth during the primacies of John Whitgift, Richard Bancroft, William Laud and Gilbert Sheldon. The outstanding figure in the first was Robert Browne (*q.v.*), who, however, after much suffering, renounced his Separatist principles and conformed, though three of his contemporaries, Henry Barrowe, John Greenwood and John Penry (*qq.v.*), were martyred.

In the second period the most noteworthy was John Robinson (*q.v.*), who went into exile at Leiden, where he was pastor of the church some of whose members in 1620 sailed to New England in the "Mayflower." His writings include *A Justification of Separation* (1610), but he was anxious to distinguish those associated with him from the Brownists and Barrowists, and at the end of his life became less extreme in his separatism. John Cotton (*q.v.*), who in 1633 likewise went to New England, wrote in defense of Congregationalism *The Keyes of the Kingdom of Heaven and the Power Thereof* (1644). His path is described in the introduction to the *Keyes* by T. Goodwin and P. Nye as "that very Middle-way between what is called Brownisme, and the Presbyteriall-government."

In the turmoil of the English Civil War and still more under the protection of the Commonwealth legislation, Congregational churches sprang up in considerable numbers and with full conviction of their voluntary and separatist principles. The Independency of the Commonwealth was of a radical and self-assured type, conscious of its difference from the Presbyterianism which for a time had been established in England and still flourished in Scotland. In Sept. 1658 the elders and messengers of the Congregational churches met in the Savoy palace and issued a *Declaration of the Faith and Order owned and practised in the Congregational Churches in England* (*see* CONFESSIONS OF FAITH, PROTESTANT). It was a bold manifesto, but less radical than English practice, for its admission of occasional synods does not seem to have been followed.

Under the novel and experimental ecclesiastical establishment set up by Oliver Cromwell about 130 Congregational ministers accepted parochial livings. The number is a small proportion of those who were ejected at the Restoration, for these numbered more than 1,900, but it is remarkable that there were any at all.

The Congregationalists were now consolidated and were able to endure the repressive measures which followed the Act of Uniformity in 1662. There was no fresh large-scale emigration. The outstanding name in this period, as indeed already during the Commonwealth, was that of John Owen (*q.v.*), who had been converted to Independency by Cotton's *Keyes* and was thus in sympathy with the less extreme kind of Congregationalism.

18th Century.—The passing of the Toleration act in 1689 and the death of Queen Anne in 1714 saw the end of persecution though not of severe restrictions. The exclusion of Nonconformists from the universities led, however, to the establishment of academies by means of which a liberal education was provided, better in many instances than that given at that time at Oxford and Cambridge. The leaders of the academies trained many learned men,

chiefly for the ministry. From them a number of the Congregational theological colleges take their origin. The academies made a considerable contribution to English culture.

The beginning of the century was marked by a growth in the building of meeting houses, but in other ways Congregationalism declined. Earlier convictions were lost. *An Enquiry Into the Causes of Decay of the Dissenting Interest* (1730) gives as the primary cause "ignorance of their own principles." Almost the only shining light in this period was the introduction of a new type of hymnody by Isaac Watts and Philip Doddridge.

Arid theological discussion, the spread of deism and a general love of pleasure and desire for riches were distinctive features of a long period of the 18th century. Congregationalism was rescued by the evangelical revival which affected Nonconformists perhaps more than any other religious body. The preaching of George Whitefield in particular led to a quickening of the spirit and a growth in the number of churches. The sense of Christ's presence within the local church was recaptured. Lay preaching became common. The hymns of Charles Wesley added a new warmth to worship. A new concern was born for evangelization at home and abroad. Sunday schools and a concern for social service were also part of its expression.

19th Century.—The new passion for evangelization overseas led to the formation of the London Missionary society in 1795. Undenominational in its beginnings and designed to leave converts "to assume for themselves such form of Church Government as to them shall appear most agreeable to the Word of God," the society became increasingly the vehicle for Congregational service and witness. Missionary enterprise was not started without some criticism, but the society gradually grew and won confidence, and its work extended until it was responsible for large areas in Africa, China, India and Madagascar, as well as for Papua and the South seas. It remains independent, but receives practically all its support from Congregationalists. Its roll of honour includes Robert Moffat and David Livingstone in Africa, Robert Morrison in China and John Williams and James Chalmers in the South seas.

In 1836 a definitely Congregational society was formed to meet the needs of the thousands leaving Britain to settle in the colonies. The Colonial (later Commonwealth) Missionary society established Congregationalism in Australia, New Zealand, Canada and South Africa. It continues to care for emigrants, though its principal concern is for the Congregational churches of Jamaica, British Guiana and South Africa, originally fields of the London Missionary society.

Before the 18th century closed, itinerant societies had been formed among the churches for local evangelization. In many districts ministers, and in some cases churches, had begun to form associations "to promote mutual edification by Christian and ministerial intercourse, and to diffuse plans for the spread of the Gospel." Numerous attempts were made to form the churches and county associations into a national union, but there was fear of central organization, and some held that Independency's glory lay in not being a denomination at all. But the movement for union was too strong to be resisted. The churches were growing in numbers; by 1830 there were probably about 1,600 of them. The *Congregational Magazine*, a monthly founded as the *London Christian Instructor* in 1818, was helping to instill a denominational consciousness, while co-operation in missionary work overseas encouraged similar co-operation at home. The need for some method whereby the stronger churches could help the weak was becoming urgent.

The success of the county associations commended a larger union. Finally the Congregational Union of England and Wales was formed in May 1831. All suspicions were overcome and the union became firmly established. At first it attempted too much in its eagerness to show what could be accomplished through co-operation. It sponsored missions in the colonies, in Ireland and at home, and established a board of education, a Chapel Building society and an Insurance Aid society. It assumed responsibility for two periodicals. The strength of the organization was not sufficient for all these activities, and in 1857 the union severed itself from the affiliated societies and the magazines. Later, when its position was more assured, it began to gather the threads into its hands again. In particular it assumed responsibility for church aid and home missionary work. For this and for the growing responsibilities it accepted for the churches and for their ministers it raised considerable funds—notably the Central fund of £250,000 (1909) and the Forward Movement fund of £500,000 (1921), ministerial support and pensions being their primary purposes.

The increased activity of the union and the raising of these funds provided a supreme test for Congregationalism. It was not easy to reconcile the full independence of the local church with organized and official support and the necessary controls. An element of tension continued to be felt in the 20th century, but in particular situations it was repeatedly resolved. The union has neither sought nor been given final or absolute authority over the churches. At the same time the churches have given increasing powers to the union and have looked to it more and more for leadership and aid.

Because they were concerned for civic and religious liberty, Congregationalists, like other Nonconformists, became associated with all public movements to achieve them. Outstanding in the struggle for the rights of Nonconformists was the Congregationalist Edward Miall. The Test and Corporation acts were repealed in 1828, church rates abolished in 1868 and Oxford and Cambridge universities compelled to open their doors to Nonconformists. Congregationalists also began to wake up to social evils, and were active in securing measures for the extension of franchise, the abolition of slavery and the repeal of the corn laws.

From 1832 to the home rule split in 1886 Congregationalists were generally to be found supporting the Liberal party, which almost exactly expressed their political views. But the split divided the denomination, which did not again find a political party which fully represented its ideals and policy. The question of national education greatly concerned Congregationalists from the 1830s to the controversies of the beginning of the 20th century. In this period a well-remembered name is that of Charles Silvester Horne, a minister in London, member of parliament and passionate lover of freedom.

The closing years of the 19th century found Congregationalism rich in outstanding preachers, such as R. W. Dale, Joseph Parker, J. A. Macfadyen, Alexander Mackennal; theologians such as Andrew Fairbairn and P. T. Forsyth; administrators and ecclesiastical statesmen; and a host of distinguished laymen who made a rich contribution to business, professional, public and church life, such as Sir Albert Spicer, Sir Murray Hyslop, Sir Arthur A. Haworth and Sir John McClure.

20th Century.—Among developments in the first half of the 20th century was a decline in church membership, which began in 1908 and continued with but little check in the mid-1920s up to the mid-1950s. This could be attributed mainly to conditions which brought like results to all denominations—the effect of two world wars, failure to adapt quickly enough to modern concepts of thought and conditions of life, and a serious loss of touch with all but the middle classes. The second was a tendency toward theological liberalism, marked by the publication of R. J. Campbell's *New Theology* (1907), a superficial but temporarily popular work. There was later a revived interest in the Christ-centred teachings of P. T. Forsyth, and valuable contributions were made to theology and biblical scholarship by A. E. Garvie, W. B. Selbie, J. Vernon Bartlet, George Buchanan Gray, Sydney Cave, John S. Whale, C. H. Dodd, Nathaniel Micklem and others.

The 20th century saw growth in the work and responsibility of the union for and on behalf of the churches. In 1904 a new constitution was framed and with modifications was in use until a new formulation was made in 1958. It put the union's business in the hands of a council of about 300 members in the main elected by the county unions. To it the Administration committee was responsible. These committees were steadily increased, notably by the addition of a young people's department in 1908, a committee for women's work in 1915 and a board of moderators in 1920. Nine moderators were appointed to be responsible for the churches and ministers in a number of county unions grouped into provinces.

In 1924 the Publications committee was converted into a private limited liability company called the Independent press. In 1922 the *Congregational Quarterly* was started with the historian Albert Peel as editor; it ceased publication in 1958. In 1950 the union took over the privately owned *Congregational Monthly*. Youth work was begun at denominational level in 1883 and reorganized in 1908. Pioneer work was done in the encouragement of graded Sunday schools, Christian education and later in the concept of the family church.

Perhaps the most important 20th-century development was the acceptance after World War II of responsibility for a guaranteed minimum stipend for ministers and the raising of the necessary means through the Home Churches fund. This led to the adoption of an over-all budget scheme for all the work of the union by the voluntary decision of the churches to provide funds.

In mid-century consideration was given to finding the means whereby the union and the London Missionary society might be integrated and thus organically express the unity of church and mission. The fact that the society served more than one Congregational union made the working out of such an arrangement difficult.

In 1945 the Presbyterian Church of England made proposals for union with the Congregational Union of England and Wales. A plan submitted to the churches was rejected by the Congregational assembly of 1949. Nevertheless in 1951 the assemblies of the two bodies met together and pledged themselves to close cooperation in terms of a covenant. As a result there was co-operation both at home and overseas and agreement was reached as to the recognition of each other's ministries and as to standards of faith. Though a small denomination, English Congregationalists have contributed largely to ecumenical work in the World Council of Churches and the International Missionary council, providing leaders out of proportion to their numbers.

Scotland and Wales

Scotland.—Scottish Congregationalism owes its beginnings to two laymen, the brothers Robert and James Haldane. In the period of political and social unrest at the close of the 18th century they sought to arouse the Church of Scotland to the need for missionary effort at home and abroad by making preaching journeys up and down the country and by establishing Sunday schools. Their failure forced the Haldanes and their associates to found a new denomination.

The real architect of Scottish Congregationalism, however, was Greville Ewing, minister of the Church of Scotland who left that church to assist the Haldanes and who became convinced of the scriptural authority for the Congregational polity. As minister of the mother church of the denomination in Glasgow (now Hillhead church) he was an unwearied itinerant in the cause of Congregationalism, a founder of its Ministerial Training college and of the Congregational Union of Scotland (1812). Alongside and succeeding him as leaders were such gifted men as Ralph Wardlaw of Glasgow and William Lindsay Alexander of Edinburgh.

In the first century of the union's history outstanding names are George Macdonald, David Livingstone, Robert Moffat, James Chalmers and P. T. Forsyth. But also the little denomination made a valuable witness in terms of its evangelical spirit, liberal outlook and encouragement of Christian democracy.

In 1896 the Congregationalists were united with the Evangelical union, formed in 1843 by three ministers of the United Secession Church (James Morison, A. C. Rutherford and John Guthrie), who had been expelled for preaching a gospel which conflicted with the prevailing Calvinism of the day. The Evangelical union expressed its faith in terms of the "three universalities": that God loves all men, that Christ died for all men and that the Holy Spirit strives with all men. In the 50 years of its separate existence it produced among others the theologian Andrew Martin Fairbairn and the Labour leader James Keir Hardie. The teachings and outlook of the Evangelical union were close enough to those of the Congregationalists to suggest amalgamation as early as 1867.

Congregationalism has never grown to any considerable size in Scotland, having by 1960 a total of 150 churches and 34,500 members. It remains separate from, though in close fellowship with, the Congregational Union of England and Wales, and shares in support of the London Missionary society.

Wales.—While the English-speaking Congregationalists in Wales are included in the Congregational Union of England and Wales, those who originally spoke (and in many cases still speak) their native tongue are united as the Welsh Independents. Historically they trace themselves back to a revival which formed a church in 1639 in the village of Llanvaches in Monmouthshire. The flame of revival spread over the country and each centre became the home of an Independent church.

In time the churches tended to group together for conference and preaching festivals. The first *gymanfa*, or festival, was held in 1778. Regular associations were also built up and attempts were made to form a union of all the churches. At last in 1871, when the Congregational Union of England and Wales was holding an autumnal assembly in Swansea, the Welsh delegates met separately, and with the approval of the English union formed the Union of Welsh Independents. There were then in Wales 897 churches, and gradually, according to their choice, they found their place in the new union or the English one. The two unions have maintained close contact and by constitution send official representatives to each other's assemblies and co-operate in certain matters. The independence of the local churches in Wales has always been jealously preserved, and the union has been given little authority and has not developed any considerable organization. There is only one full-time officer, much of the work of the committees and of the council (the executive body) being done on a voluntary basis.

A bookroom and publishing department was begun in 1907, and a weekly organ, *Y Tyst* ("The Witness"), is published. In 1911 a sustentation fund was started to help to maintain a minimum stipend for ministers.

The Welsh churches maintain two theological colleges, but during the first half of the 20th century one-third of all the students settled down in or moved into English churches, leaving a shortage of ministers in Wales itself. In 1960, 975 churches with 118,000 members were served by only 350 ministers. Many of the churches rely, therefore, on lay preachers. (R. F. G. C.)

United States

Beginnings.—Congregational churches in the United States derive from two sources: the Separatists of Plymouth and the Puritans of the Massachusetts Bay colony. The former had taken refuge from persecution at Leiden in the Netherlands in 1608, but in 1620 a vanguard consisting of the younger members was sent to found a colony in the new world. They arrived on the "Mayflower" and settled at Plymouth. The greater portion of the Leiden congregation, including their pastor, John Robinson, remained in the Netherlands.

The Puritans, who did not separate themselves from the Church of England but wished only to reform it, decided to leave England because of the persecutions under Archbishop Laud. They secured a charter for their colony from Charles I, and beginning in 1629 established settlements in considerable numbers in and around Boston. In organizing their churches they ordained their ministers congregationally, even when the latter had already been ordained episcopally. The introduction of the congregational polity into their churches becomes understandable when one realizes that these Puritans belonged to the nonseparatist Congregational party in the English Church. Accordingly, both Plymouth and Massachusetts were congregational in polity. (*See* also Puritanism.)

When presbyterianism became dominant in England, the religious leaders of New England were summoned to a synod at Cambridge, Mass., in 1648 to consider the implicit dangers of this event to their ecclesiastical structure. They decided to accept the Westminster Confession of Faith as their doctrinal statement, but they adopted the thoroughly congregational *Platforme of Church Discipline* (the so-called *Cambridge Platform*) for their polity.

The Halfway covenant adopted in 1662 greatly affected the requirements for church membership, which originally depended

upon a profession of religious experience. Members had the right to present their children to be baptized and thus secured for them church membership. This system gave rise to an unforeseen difficulty: some of these children, upon growing up, did not profess religious conversion. It was decided that those who had acquired membership by virtue of baptism alone could not be regarded as in full communion. They retained all the privileges of church members except that they could not partake of the Lord's Supper and could not vote in church elections. But they could bring their children to baptism and pass to them the degree of membership the parents possessed.

Since a considerable group among the bay settlers consisted of university-trained men, interest in education was keen. This was evidenced in 1636 when the general court of Massachusetts voted funds for a college, to which the name of a minister, John Harvard, was given in 1639 (*see* HARVARD UNIVERSITY). Thus began the continuous program of organizing and sustaining colleges by the Congregational churches, an educated ministry being insisted upon from the earliest days.

Great Awakening and After.—The loss in religious fervour that occurred during the colonial period was a source of profound distress to the ministers of the Congregational churches. The general tendency of the time was to lay stress upon good works as the effective means of producing a religious experience, and preaching therefore was concerned largely with ethical idealism. It was not until about 1734 that a widespread and profound movement of religious revival began, which came to be known as the Great Awakening. Its origin was in the preaching of Jonathan Edwards (*q.v.*) of Northampton, Mass., a theologian and a preacher of unique power who ranks as perhaps the greatest intellectual leader produced in the Congregational churches. In 1740 George Whitefield came to America from England to help in the Awakening, news concerning which had produced a profound impression in the mother country. The movement then swept rapidly on. Many physical expressions of excitement accompanied the revival and created sharp divisions among the leaders. The good results of the Great Awakening are unquestioned, however. The moral standards of communities were lifted and religion became a vital factor in human experience such as it had not been before. A conservative estimate of the number added to the churches as a result of the revival is 25,000 out of a population of perhaps 300,000 in New England at that time.

The differences in opinion brought out by the Great Awakening, however, quickly deepened and soon the churches were torn by controversy. The old, stable Calvinism, which had been generally dominant, was sharply assailed by those who were not satisfied with its affirmations of the absolute sovereignty of God, the total depravity of man, the inability of the human will in the process of salvation and the doctrines of foreordination and election. Out of the discussions came at last the only distinctive system of divinity contributed by the United States to the history of doctrine. It was a form of modified Calvinism which is known as the New England theology, of which Jonathan Edwards and his followers were the principal exponents. Its basic tenet was emphasis upon the love of God in relation to men and the power of man in responding to the divine influence in the experiences of religion. But as was inevitable, the theological developments issuing from the Great Awakening swung to the left, and a strong Unitarian movement was incipient even when the Awakening was at its height. This did not come to full strength, however, until about 1800. Then the anti-Trinitarians became aggressive. In 1805 they secured the election of one of their number to the Hollis professorship of divinity at Harvard, thus entrenching themselves in the oldest college of Congregational heritage. Within ten years the Unitarian movement assumed such strength that it was able to carry a majority in many of the oldest and strongest of the New England Congregational churches, and, as a result of a favourable court decision, to maintain possession of the records and property of the organizations. In Boston, for example, out of 14 Congregational churches all but 2 became Unitarian, involving immense loss in members and money to the orthodox group, as they were currently known. In Massachusetts alone, 96 churches thus separated from the Congregational organization. (*See* UNITARIANISM.)

The period from 1800 to 1850 was marked by close union in missionary work with the Presbyterians, who had little strength in New England but possessed larger resources in New York and Pennsylvania. In doctrine the two bodies were in practical agreement, both being Calvinists in their earlier history. In church government they were not sharply separated. When the westward emigration demanded organized agencies to follow the settlers with religious ministration, it was natural that the Congregationalists and Presbyterians should seek to work together. In 1801 they adopted the Plan of Union, and in 1808 the Accommodation Plan for Western New York, for the purpose of missionary expansion. When the Presbyterians split in 1837 over the theological consequences of the Plan of Union, the Old School Presbyterian Church repudiated the plan. The New School continued the co-operation with the Congregationalists until the latter repealed the agreement at the Albany convention of 1852.

Theological Development.—Despite the Unitarian defection from Congregationalism, the theological trends within the latter were toward liberalism. This showed itself, first of all, in the system of Nathaniel W. Taylor of the Yale divinity school, who taught a doctrine of free will that modified the older Calvinistic view. He asserted that even though God made the choice of evil possible, it was left to man's free will whether or not he would choose it. But even more important for this liberalizing tendency was the influence of Horace Bushnell (*q.v.*), the inspirer of the "New Theology." In his *Christian Nurture* (1847) he argued in opposition to the commonly accepted assumption that every child must pass through a religious crisis of conversion, that a child is to grow up as a Christian and never know himself as being otherwise. In his most radical book, *God in Christ* (1849), he sharply rejected the traditional "substitutionary" theory of atonement for one essentially consonant with the liberal interpretation of that doctrine.

These liberal views became widely disseminated among the Congregational churches and resulted in a theological cleavage between the Congregationalists and the more conservative-minded Presbyterians. When the Congregationalists met at the national council in Boston (1865), they adopted after much discussion the so-called Burial Hill confession (at Plymouth) in which they practically broke with their theological past and would no longer use the term "Calvinist" for themselves. The most popular of the exponents of this evangelical liberal point of view were Henry Ward Beecher and Washington Gladden (*qq.v.*). The so-called "Kansas City creed" of 1913 bore testimony to this liberal tendency.

Organizational Developments.—In 1810 the American Board of Commissioners for Foreign Missions was organized. While entirely Congregational in origin, it included in its membership, at first, representatives of the Presbyterian and Dutch Reformed churches; later both these bodies withdrew. After 1840 the board extended its work widely, and it came to play a part in missionary work in foreign lands, especially Turkey, quite out of proportion to the numbers and wealth of its supporting churches. During the same time the boards established for home missions and education set vigorously to work. The contribution of the American Missionary association to the education of Negroes was conspicuous, particularly after the close of the Civil War in 1865.

In 1871 was organized the national council, the functions and powers of which were carefully defined and delimited. It was not to possess autonomous powers but to serve the interests of the churches in national, international and other delegated tasks. Another step was taken at Kansas City in 1913. The national council was given larger functions in the work of the church, still safeguarding the autonomy of the individual congregation. A general secretary was chosen to represent the churches of the nation in their relations with small congregational groups, other denominations and internationally.

United Church of Christ.—The inherent ecumenicity of the Congregational churches was manifested in 1931, when the merger with the small body known as the Christian Church was consummated; the name of the fellowship was changed to the Congregational Christian Churches.

In 1938 union of the Congregational Christian Churches with the Evangelical and Reformed Church (for the history of which *see* REFORMED CHURCHES: *United States*) into a new denomination, to be known as the United Church of Christ, was proposed. The first draft of the Basis of Union was issued in March 1943 and the final version in Jan. 1947. Since the Evangelical and Reformed Church was a Presbyterian body, the principal difference concerned the polity of the new denomination. The two polities were combined into a new pattern, neither presbyterian nor congregational. The merger of the two bodies was to be effected first and the constitution worked out afterward. When the Basis of Union was submitted to the churches, associations and state conferences for voting, the norm of 75% set by the executive committee was not reached. Nevertheless, the general council of the Congregational Christian Churches held at Oberlin, O. (1948), declared the Basis of Union approved for itself (not for the churches).

This decision was repeated next year at Cleveland, O., after the period of voting was extended, although the 75% goal had not been reached. Negotiations were terminated by the Omaha council (1956), which, by a vote of 1,310 to 179 (with 11 abstentions), authorized "the holding of the General Synod of the United Church of Christ." This body, composed of delegates from the two denominations, met in June 1957 at Cleveland, O., and elected a constitutional committee. In July 1961 at Philadelphia a constitution was adopted, the union was consummated and the United Church of Christ established. (O. S. D.; M. SPL.)

INTERNATIONAL

Congregationalism as it is found in the United States, Australia, New Zealand, South Africa, British Guiana and Jamaica can be traced back directly to England—in many cases (including Canada and Newfoundland before the union of 1925) through the work of the Colonial (later the Commonwealth) Missionary society. Irish Congregationalism grew largely out of the work of the Irish Evangelical society. Congregationalism in Argentina and some of the Congregational churches in Brazil was sponsored by German Congregationalists in the United States.

Congregationalism, however, exists in other lands where it has grown spontaneously, though not always using the name. The Remonstrant Brotherhood in the Netherlands was formed in 1619, as a result of the teaching of Jacobus Arminius. The union of Evangelical Congregational and Christian churches of Brazil formed in 1942 traces its origin to an Englishman who began work there in 1855. The Free Church of Finland for political reasons could not be officially registered until 1922, but churches had then existed for more than 30 years. The Swedish Mission Covenant Church was formed in 1878 as an evangelical movement within the state Lutheran Church.

Representatives of Congregational churches from all parts of the world first met in an International Congregational council in London in 1891. They continued to meet alternately in England and the United States at approximately ten-year intervals for fellowship and the exchange of views and experiences. At the meeting held in the United States in 1949 the council was provided with a constitution, a permanent secretariat and an office in London. Later meetings were held every five years. The council has no delegated or other authority and its purpose is still generally conceived in terms of fellowship and service between its constituent members.

POLITY, WORSHIP AND DOCTRINE

Polity.—From the 16th century there have been differences of understanding as to the extent of the local autonomy and independence implied in the Congregationalist conception of the local church as the basic unit of Christian fellowship, worship and experience. It was necessary for the early churches to assert these rights against the authority claimed by the Episcopal Church in its orders, its creeds, its relation to the state, and against the authority of Presbyterian courts. The independence of the local congregations was also most suitable at a time when communications were difficult for a small scattered body. But time has brought changes. Protestation is no longer a primary necessity. Co-operation among churches has become vital to their administration and survival. As a result, while the rights of the local congregation are still maintained, insistence on independence has largely disappeared. Councils and assemblies have been given considerable powers, if not considerable authority.

The local congregation, however, is still deemed the vital unit, as a covenanted fellowship of committed Christians. Confession of faith and membership of the local church are undertaken together. In the church all members are deemed to be equal and to have equal responsibility exercised through the church meeting. These meetings are normally held once a month, less frequently in the United States. The ideal of participation by all, or even by most, church members, however, is rarely achieved.

The general care of the church is in the hands of the deacons—men and women elected by members to represent them in sharing with the minister in the spiritual care of the congregation, in the distribution of the elements at the Lord's Supper and in the general administration of the church and its organizations. Deacons are usually elected for an agreed number of years only.

Ordination to the Congregational ministry is by the call of God and the call of the local church. Whereas in earlier days that might be sufficient, now the denomination is involved in the standards of training (though the theological colleges are independent), in recognition of status and by representative participation in ordination itself. John Owen, in his *Discourses Concerning the Holy Spirit* (1693), maintained that while the ministry is necessary to render a church "completely organical," yet men may "become a church essentially before they have any pastor or teacher." This view was confirmed in 1929 by the assembly of the Congregational Union of England and Wales.

Nearly all Congregational churches are now involved together in associations or unions which cover district, county or state areas. In England and Wales these county unions are themselves represented in a council of 300. To this body all the committees or organizations of the union are appointed and to it they are responsible. The council in turn reports to an assembly, which, however, is constituted by direct representation of the ministers and laity of every church. The assembly has no binding authority over local congregations. It does represent the collective mind of them all or of the majority, however, and its judgments or decisions generally, though not of necessity, are accepted. Increasingly the churches have accepted the value as well as the necessity of co-operation through an approved and controlled organization, and have recognized that the Spirit of God may move in large as well as small associations.

Worship.—The central feature of Puritan worship was the sermon, the declaration and exposition of God's Word and the application of it to the hearts of the congregation. This has remained characteristic of Congregationalism. Its ministers are "of the Word and Sacraments"—in that order. The church service is in large measure designed to promote the sermon as its climax.

The central and focal point of a Congregational church is traditionally the pulpit. A 20th-century tendency to place the pulpit to one side of centre has been mainly for aesthetic reasons, though it does indicate some appreciation of the importance of features of the service other than the sermon.

The Puritans accepted only two sacraments, baptism and the Lord's Supper, as of dominical institution, and these are still the only two sacraments recognized. Baptism is normally infant baptism, though there are differences in the interpretation of the significance of the act. Believer's baptism is not uncommon. Baptism is not considered a prerequisite to acceptance into church membership but is normally deemed desirable. The Lord's Supper or Communion is observed in most Congregational churches once a month, or sometimes twice (in the morning on one Sunday and in the evening on another). It normally follows a preaching service, sometimes after a brief interval so that those who do not wish to partake may retire. The service usually is conducted by a minister assisted by deacons, but the church may approve administration by a layman. Both the bread and wine are partaken

by all and are taken round to the congregation by the deacons. Nowadays the bread is almost always cut beforehand and the wine served in small glasses and not from a chalice. The wine, however, is drunk by all the congregation simultaneously. New church members are received at a Communion service and participation in the service is esteemed a mark and obligation of membership. An invitation is usually given, however, to "all who love the Lord Jesus Christ" to share in the service, which is thus open to all believers, whether members or not, and of any church. It once was customary to judge sincerity of faith by attendance at Communion and to remove from the membership roll those who without adequate explanation did not attend over a period of time; this is a dying custom.

The Puritans objected to set forms of prayer, or liturgies, as they did to set forms of preaching, or homilies. It was not until the end of the 19th century that experiments were made in the realm of ordered worship. Service books are now widely used, and various forms of liturgy, the use of set forms of prayer and unison reading of the Scriptures are often practised. The first official service book was *A Book of Congregational Worship* (1921); a later one is *A Book of Service and Prayers* (1959). Their use, however, is not compulsory and each church is free to devise its own forms. By the early 1960s there had been three Congregational hymnbooks, the one in general use being *Congregational Praise* (1951).

From no office of the church and from the performance of no service or sacrament are women excluded. The first ordination of a woman to a Congregational ministry in Great Britain occurred in 1917, and there are women ministers and deacons in all countries except Finland and those of South America.

Doctrine.—Congregationalists have always held that faith must be personal and direct. It is to be tested against the Holy Scriptures and no other formulation. There is, therefore, no creed or other statement of faith to which all do give, or any individual must give, assent. Church membership is entered into on a simple affirmation of personal acceptance of Jesus Christ as Lord and Saviour with such understanding of the implications of this as may be made known in the Scriptures, through the church and by experience. Nor does ordination to the ministry require assent to any creed.

This is not to say that the classic formulations of the faith are denied. They are extensively used as a help to belief and are sometimes repeated in church. Nor does this mean that Congregationalists have not formulated the faith which is generally believed among them. The Savoy *Declaration of the Faith and Order* . . . of 1658, in very large measure a duplicate of the Westminster Confession, set out the faith of Congregationalists of the period, not as prescribed form but as a statement of terms of communion. In America this formulation was preceded by the *Cambridge Platform* of 1648. Both were expressive of the Calvinistic views of the time.

Soon after the Congregational union was formed a formulation of 20 Principles of Religion was devised, and accepted in May 1833 as "the Declaration of the Congregational Body, with the distinct understanding, that it is not intended as a test or creed for subscription." In like manner U.S. Congregationalists expressed themselves in 1865, 1871 and 1883. In 1959 the Congregational Christian Churches of the United States as part of the United Church of Christ formulated a *Statement of Faith* which was adopted by the second general synod of that church as "a testimony and not a test." In the same year the Congregational Union of England and Wales set up a commission to devise a statement.

There cannot be said to be a Congregational theology. The teachings of John Calvin were strongly influential in earlier times. A reactionary movement toward Unitarianism in the United States at the beginning of the 19th century is described above. In Great Britain evangelical influences prevailed. Adventures in so-called liberalism in the early 20th century did not last. A middle-of-the-way evangelical orthodoxy would describe the present-day theological position of Congregationalism almost everywhere.

See also references under "Congregationalism" in the Index volume. (R. F. G. C.)

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(O. S. D.; M. SPI.)

CONGRESS, INTERNATIONAL: *see* CONFERENCE, INTERNATIONAL.

CONGRESS, UNITED STATES. The historical roots of the United States congress are found in the parliamentary assemblies of the middle ages. Since that period there has developed in western society the concept of representation based on elections, with broad suffrage, and an expanded legislative function that includes the general control of the national government. The formal structure of congress, the legal powers embodied in a written constitution and the relationship between congress and the president, however, are reflections of the political ideas current in the 18th century. (*See* CONSTITUTION AND CONSTITUTIONAL LAW; LEGISLATURE; REPRESENTATION; SEPARATION OF POWERS.)

The basic theory under which congress operates is that all official governmental action must have a legal base. This means that congress must have continuing relations with the rest of the government and with society as a whole, to see to it that the existing law is adequate and to create new law. Congress has become a great political regulator for adjusting conflict in U.S. society and an agency for controlling the government departments (*q.v.*) through law, personnel standards, appropriations and criticism.

The United States constitution of 1789 created a congress with two houses, having specific but restricted legal authority and separated structurally from the executive department (under the president) and the judicial system (coming to a head in the supreme court). (*See* UNITED STATES [OF AMERICA]: *Administration and Social Conditions;* PRESIDENT; SUPREME COURT OF THE UNITED STATES, THE.) The two chambers have similar functions to perform, and they have adopted similar procedures for performing them. There are, however, certain differences, which will be developed below. The business of congress has increased manyfold since the 18th century, but congress has proved remarkably resilient in adapting itself to the changing demands of a changing society. The policy adopted by congress during its history is, of course, reflected in public law, and to this extent the political controversies in congress and the legal solutions proffered are an intrinsic part of United States history.

Structure.—*House of Representatives.*—The house of representatives has grown considerably since the first congress of 1789, which had 65 members. In the mid-1950s congress had 435 members, and that figure had remained constant since 1912. In addition to the members, there was one delegate each from Alaska and Hawaii and a resident commissioner from Puerto Rico. These territorial representatives had the privilege of speaking but not of voting. On admission of Alaska and Hawaii as states in 1959, two additional representatives were automatically provided for under the constitution, but at the next apportionment the membership returned to 435, the total authorized by statute law.

Membership of the house is reapportioned among the states every ten years, following the decennial census (U.S. constitution, art. i, sec. 2), under a plan known as the method of equal proportions. The procedure for allocation is prescribed in the Apportionment act of 1929, which, with amendments, is the governing statute. After receiving their quota of seats, the states determine the size and boundaries of the congressional districts. The national law does not require a state to create single-member districts, nor does it specify standards of compactness, uniformity or contiguity that must be followed. However, in 1964 the U.S. supreme court ruled that congressional districts within each state must be substantially equal in population. (*See* Apportionment, Legislative.)

The biennial elections for the house of representatives are held in the various states on the Tuesday next after the first Monday in November, the elections being customarily organized and contested by the Democratic and Republican political parties (*qq.v.*). National laws regulating elections are found in the corrupt practice legislation (*see* Corrupt Practices), but for the most part the elections are regulated by the states.

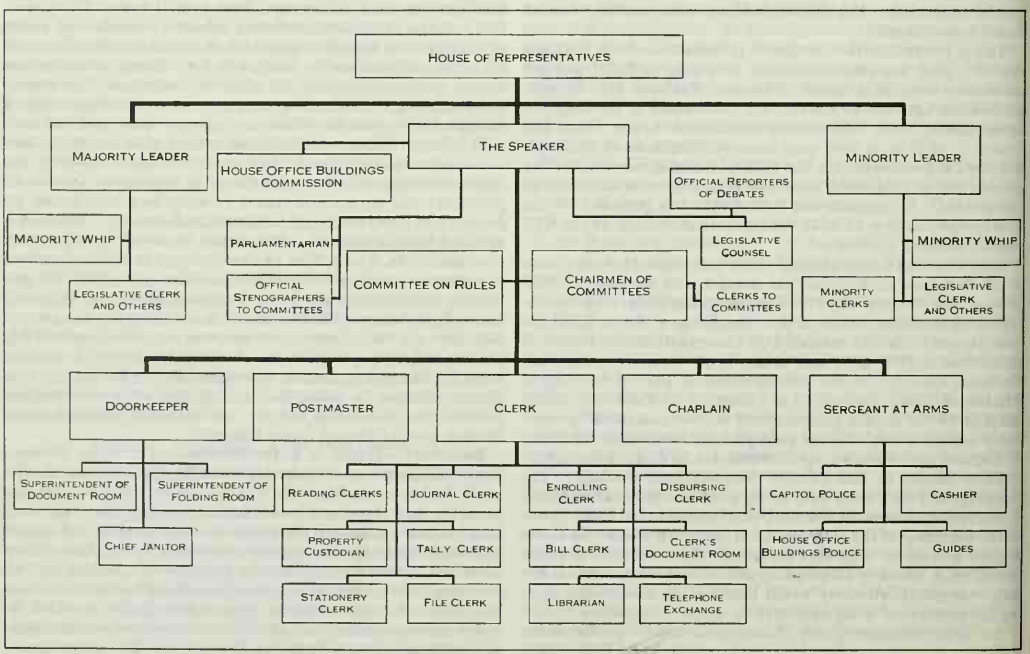
Inasmuch as the political strength of candidates for the house of representatives may differ from that of the president, a situation may result where the president's party, although victorious in the presidential election, does not control congress, or loses control of congress in a midterm election. The disparity in relative electoral strength may have subsequent repercussions in the relationship between the president and congress.

Disputed election contests are referred to a court or to a house committee; but the final decision on eligibility rests with the house of representatives, the constitution stating (i, 5) that "each House shall be the judge of the elections, returns and qualifications of its own members." The constitutional provisions for eligibility (i, 2) specify a minimum age of 25, United States citizenship for seven years and habitation in the state. Residence in a congressional district is not a constitutional requirement for eligibility, but candidates by custom reside in the district from which they are elected. The constitutional proviso (i, 6) that "no person holding any office under the United States shall be a member of either house" has the effect of preventing members of congress from heading the great governmental departments. This is one of the chief differences between parliamentary and congressional forms of government. If a member of congress accepts the offer, say, of the secretaryship of a department, he must perforce resign his seat.

Once elected, a member has certain constitutional privileges (i, 6) to protect him against interference in carrying out his duties. He is privileged from arrest (in all cases except treason, felony and breach of the peace) during attendance at the sessions of congress or in going to and returning from the same. He cannot be questioned in a court of law "for any speech or debate" in either house, and he has certain prerogatives in the form of travel allowance, administrative and secretarial assistance, the use of the mailing frank, office space and, in the early 1960s, an annual salary of $22,500.

In its internal organization, the house of representatives retains certain ancient parliamentary offices, including the speaker of the house (*see* Speaker), the clerk of the house, the sergeant at arms and the doorkeeper. The historically ambivalent position of the speaker of the house is revealed in the several functions the speaker is required to perform, for he is at once the servant of the house in presiding over its deliberations, in the performance of which he should be impartial, and the leader of his own party. In presiding over the house of representatives, the speaker has the assistance of a skilled parliamentarian, who is a permanent employee of the house. The clerk of the house has general charge of the records, but his jurisdiction does not extend to the staff of the committees or of members' offices. There is no central recruiting agency for the employees of congress. Although some appointments are made on political grounds, there was an increase in the professional competence of the congressional staff after the enactment of the Legislative Reorganization act of 1946.

Political parties (*see* Party, Political) have developed within legislatures as a method for controlling the proceedings and mobilizing the necessary majorities. In establishing the authority and the structure of a partisan organization, the general problem may be stated to be that of providing sufficient control over the



general legislative process so that the house of representatives will be able to act affirmatively and at the same time to permit the members a measure of freedom in debate and in voting, consistent with the heterogeneous nature of United States parties and the legal equality of elected representatives. The party structure is now quite diffuse, earlier attempts to centralize control in the speaker of the house or in the rules committee or in a caucus having been found to be unsatisfactory. The recognized party leaders are (in addition to the speaker) the majority and minority floor leaders and the party whips; the chairmen of committees also have considerable partisan influence. For the purpose of showing the true lines of influence and authority, however, the organizational charts of congressional parties may be more impressive than accurate. It may not be too much of an exaggeration to say that, in addition to the recognized party leaders, a specific pattern of power develops for the consideration of every major policy issue.

The central unit of the party is the conference or caucus, the main function of which is to develop a skeleton party organization that will be responsible for carrying on the day-to-day functions of the house. The party leaders are selected; the committees are organized. In general, the parties attempt to secure party representation at all the points in the political process where significant decisions are made. They provide the initiative in selecting the agenda, in developing the debate and in mobilizing support for particular decisions, although they do not exercise exclusive authority in these areas. Party control over its own membership is not strong, and considerable latitude of action is permitted party members.

The committee system is an important adjunct to the work of the house of representatives. The committees play a significant part in selecting and preparing bills for the further consideration of the parent chamber, and their choice of bills may be influenced by the advice of the bureau of the budget, the interested governmental departments or the attitude of the president. It is customary, but not mandatory, for the committees to hold hearings on legislation at which interested parties are invited to give testimony. The committees also play a significant role in the control exercised by congress over the governmental agencies; departmental heads and other responsible officials frequently are called before committees to explain or justify policy.

The committees have considerable autonomy and are not required to report back to the house all bills referred to them. However, a committee may be discharged from considering a bill further; this process requires a petition carrying the signatures of a simple majority of the members. Legislation reported by a committee is placed on a calendar to await its turn, but if it is of sufficient importance it will be taken from the calendar and brought to the floor by means of a special rule reported by the rules committee. The function of this latter committee is to control the flow of legislation considered by the house and the amount of time consumed in debate. On the floor of the house, the committee members take the leadership in developing the debate on legislation previously considered in the committee.

There were in the 87th congress 20 committees in the house, which for the most part were organized around major policy areas. With the exception of some of the political leaders, all members are assigned to committees and are expected to participate fully. Each committee has a limited membership, and members belong to only one major committee. In view of the fact that membership is more desirable on some committees than on others, members do not necessarily get the assignment of their choice when they first enter the house of representatives. Members advance on the committee through the seniority system, the chairmanship normally going to the member of the majority party who has served longest on the committee. The Legislative Reorganization act of 1946 made provisions for each of the standing committees to acquire a professional staff that assists the committee in acquiring and processing information. The members may receive additional research assistance from the legislative reference service of the Library of Congress.

Senate.—The organization of the senate is in many ways similar to that of the house of representatives, although its procedures are somewhat simpler. There is a less elaborate structure of political control, and, with its smaller membership, the senate is able to take action on many items by unanimous consent agreements.

With the admission of Alaska and Hawaii as states in 1959, there were 100 members of the senate, two from each of the states. The 17th amendment to the constitution (adopted in 1913) provides for the popular election of senators, whereas the constitution (i, 3) initially specified that senators were to be elected by state legislatures. In most states, vacancies may be filled by temporary appointments made by the governor.

The basic constitutional qualifications (i, 3) require a senator to have been a citizen of the United States for nine years, to be an inhabitant of the state for which chosen and to have attained to the age of 30 years. The full term of office is six years, the terms of one-third of the senate membership ending every two years. The popular election of senators on a state-wide basis may require a considerable fiscal outlay (and this possibly in addition to the cost of conducting a primary campaign). Normally, the senate appoints a special committee to investigate and supervise the conduct of elections, and complaints of unfair tactics or violation of law may be referred to this committee. The compensation of senators is the same as that of representatives, but appropriations for clerical assistance are somewhat larger.

The senate is served by a staff that carries on functions similar to those of the staff of the house of representatives. In particular, the secretary of the senate has custody of the records and exercises general supervision of other employees, and the sergeant at arms has responsibility for security measures. The presiding officer is the vice-president of the United States, who is assisted by the president pro tempore of the senate, an honorific, elected office (i, 3). Each committee has its own staff, and so too do the individual senators. As in the house, the administration of senate personnel is highly decentralized.

Although partisanship and party organization are significant factors in senatorial behaviour, the party structure of the senate cannot readily be described by reference to an organizational chart. There are several political units, including for each party a conference, a policy committee, a steering committee and a committee on committees. However, the position taken by influential senators may be more significant than the action (if any) taken by a formal party structure. Each party elects a leader, generally a senator of considerable influence in his own right, who is in general charge of co-ordinating senate activities, making arrangements with his opposite number for the consideration of legislation and defending party interests on the floor. This somewhat loose party organization is responsible for organizing the senate, including the important function of naming senators to committees. Each party also selects a committee to give assistance in senatorial campaigns, such as fund raising. The congressional parties co-operate with the national political organization while retaining a degree of independence and freedom of action.

The senate in the early 1960s had 16 standing committees. These play a significant role in preparing legislation for consideration by the senate, and they also exercise control over governmental departments. The seniority rule is normally followed in the selection of a chairman, senators advancing in rank according to the length of their service on the committee. Because of the strategic nature of their position, the chairmen of the important senate committees often exert considerable influence over public policy.

House and Senate.—There are several aspects of the business of congress that the senate and house share in common and that require common action. One item of common concern is the date for convening and for adjourning congress. Congress begins its annual session in January (20th amendment), although the president may also convene either house on extraordinary occasions (ii, 3). The two houses customarily agree on a date for adjournment (i, 5), although the president has authority (ii, 3), which he has never used, to adjourn congress in the event the senate and house cannot agree on a date.

Another item of common concern is the joint session, which may occur when the president or other dignitary addresses both houses

or when the electoral votes for the president and vice-president are to be counted (ii, 1). A third item relates to certain subjects of concern to both houses. To meet this common need, committees having membership drawn from both houses may be created, examples being the joint conference committees (for adjusting disputes between different versions of legislation), the joint atomic energy committee and the joint committee on printing.

The common interests of the houses of congress also are served by several agencies that in a very particular sense are responsible to congress or to joint committees of congress. These agencies include the government printing office, the general accounting office, the Botanic garden and the Library of Congress. The independent commissions have an indeterminate status in the governmental structure; they are charged with carrying out the law of congress, but they are not directly responsible to the president.

Process: House and Senate.—The house and senate have similar functions to perform, and they have developed similar techniques and procedures for performing them. In considering legislation, the committees take up the proposed bills, selecting for special attention those for which there is some political support and perhaps holding hearings on them. The public hearing, with testimony given by government officials and representatives of special groups, has become an accepted adjunct of the congressional process. Many of the hearings before congressional committees are published by the government printing office and contain a considerable amount of information on public policy.

The house and senate follow slightly different procedures in reaching agreement on the legislation to be considered, but the process normally includes negotiation between the committees concerned and the leaders of the parties. Debate is controlled more strictly in the house than in the senate; a specific amount of time (several hours) is allotted in the house for considering the more important legislation, the time being controlled by committee leaders and reallocated to members who wish to participate in the debate. In considering legislation, the house may normally propose amendments, and on the demand of one-fifth of those present the yeas and nays are taken. A detailed account of the debate in congress is recorded in the *Congressional Record*, which has a daily edition as well as a permanent edition. Congress also publishes the *Congressional Daily Digest* and the *Congressional Directory*, and each house publishes its own *Journal* (i, 5), which contains a technical record of the proceedings.

Senate debate is considerably freer than house debate and less subject to rules and restrictions. In general, the practice is for the senate to debate a measure until everyone has expressed his view, although occasionally the senate will require all debate to terminate at a specified time. The unanimous consent agreement is one of the factors that enables the senate to complete action on minor business in a limited amount of time, leaving more time available for subjects of greater importance. The freedom of debate in the senate may be abused by a filibuster (*q.v.*), a device by which a member or members will talk on interminably in the hope that the item will not be voted on. However, the rules provide for a method of terminating debate by the application of cloture, which in the early 1960s required the support of two-thirds of the members who were present and voting.

For an act of congress to be valid, both the house and senate must approve an identical document. Differences may be adjusted if one or the other of the two chambers gives way, but in some cases a joint conference committee is appointed to negotiate an adjustment of difference.

In its annual sessions, congress has developed a routine for considering the various items of business that regularly arise. At the beginning of a session, the president delivers his state of the union address (ii, 3), which describes in broad terms the legislative program the president would like congress to consider. Later in January the president submits his annual budget message and the report on the economy prepared by the president's council of economic advisers. During the subsequent months, the president submits nominations and treaties for which the advice and consent of the senate are requested (ii, 2). Inasmuch as the committees require a period of time for preparing legislation before it is considered on the floor, the legislative output of congress may be rather small in the early weeks of a session; the legislative calendars tend to be crowded in the closing weeks of a session. Legislation not enacted at the end of a session retains its status in the following session of the same two-year congress.

Meetings of the house and the senate are customarily open to the public (a card from a member's office is ordinarily required); secret sessions (i, 5) are rare. The press gallery provides accommodations for representatives of various communications media. The sessions of congress, however, are not broadcast either over radio or television but exceptions are made for addresses to joint sessions.

Position of the President and External Groups.—For some purposes, the president may be considered to be a functioning part of the congressional process; congress also has constant and continuous relations with the various governmental agencies, either in making new policy or in determining the effectiveness of existing policy. If the electoral college fails to produce a majority of electoral votes for any one person, the house may select a president (each state delegation having one vote) and the senate may select a vice-president (12th amendment). Congress also (ii, 1) "may by Law provide for the Case of Removal, Death, Resignation or Inability, both of the President and Vice President . . ."

The president is expected to keep congress constantly informed of the need for new legislation (ii, 3), and the various departments and agencies are required to send congress periodic reports of their activities. The president submits certain types of treaties and nominations for the approval of the senate (ii, 2). One of the most important of the legislative functions of the president, however, is that of signing or vetoing proposed legislation (i, 7). The president's power to veto legislation is not absolute and may be overridden by two-thirds vote of each chamber. Nevertheless, the influence of the president's potential power may extend to the procedures of congress; the possibility that a bill may be vetoed gives the president some influence in determining what legislation congress will consider initially and what amendments will be acceptable. In addition to these legal and constitutional powers, the president has influence as leader of his party; he is in a position to mold party policy and to mobilize support for the policy both in congress and among the electorate.

The supreme court (iii, 1) has no direct relations with congress and does not give advisory opinions on the constitutionality of legislation. However, decisions on the constitutionality of legislation by the supreme court, and by other federal courts prescribe the constitutional orbit within which congress can act.

The representatives of interest groups are not part of the formal structure of congress, but they may play a significant role in testifying before congressional hearings and in mobilizing opinion on select issues. The Congressional Reorganization act of 1946 required the registration of lobbyists who attempt to influence the passage of legislation.

Functions.—*Legislation.*—The basic assumption underlying official governmental action is that all acts of authority must have a legal base. In actual fact, many of the activities of congress are not directly concerned with enacting law, but the ability of congress to enact law is often the sanction that makes its other action effective. The general legal theory under which congress operates is that legal authority is "delegated" to the president or departments or agencies, and that the latter, in turn, are legally responsible for their actions. In some areas of delegated legislation, such as in proposals for governmental reorganization, congress must indicate approval of specific plans before they go into effect. Congress may also retain the right to terminate legislation by joint action of both houses. The annual output of congressional legislation is found in the *United States Statutes at Large*, which are in turn codified in the *United States Code*. Rules and regulations (the terminology varies widely) based on legislation are found in the *Federal Register*, and this in turn is codified in the *Code of Federal Regulations*.

Personnel.—Congress exercises general legal control over the employment of government personnel, the basic policy being contained in the Classification act of 1923, as amended. Political

control may also be exercised, the chief vehicle being the senate's power to advise and consent to nominations. This control, in the broadest sense, enables the senate to set standards of policy and competence for appointments to high public office. The control may also act as a check on the personnel policy of the service departments.

The senate's authority over personnel may enable individual senators to exercise considerable influence in the selection of federal officers whose jurisdiction lies wholly within a state. Neither the senate nor the house, however, has any direct constitutional power to nominate or otherwise select executive or judicial personnel (although in the unusual event that the electoral college fails to select a president and a vice-president, the two houses, respectively, are expected to do so). Nor does congress customarily remove officials, although sustained criticism of personnel may lead to their resignation or removal by the president. Congress may have recourse, however, to the seldom-used power of impeachment. In such proceedings, the impeachment is made by the house of representatives (i, 2) and the case tried before the senate, a vote of two-thirds of the senators present being required for conviction (i, 3). The last impeachment trial was held in the senate in 1936; in all, there have been 12 impeachment trials and four convictions.

Fiscal.—The power to levy and collect taxes and to appropriate funds (i, 8) gives congress considerable authority in fiscal matters. The basic law outlining the broad procedures to be followed by the government in spending money and raising revenue is found in the Budget and Accounting act of 1921, and to this may be added certain congressional rules and procedures. The president has the initial responsibility for determining the proposed level of appropriations (a function performed with the assistance of the bureau of the budget), the estimates for the next fiscal year being submitted to congress in January. At the same time, the president submits his budget message. Congress does not enact a single budget bill but, rather, considers various departmental and other appropriation bills during the first six or seven months of each session. The house and senate appropriation committees hold hearings on the appropriation bills, taking advantage of the opportunity to review past policy of the departments and agencies. Additional fiscal control is exercised by the general accounting office, a congressional agency which audits governmental spending and settles accounts, reports of its action being submitted to appropriate congressional committees.

The president's budget message includes references to anticipated revenue and, possibly, recommendations for changing the tax laws. However, congress considers revenue measures independently; they are not an integral part of the process for appropriating monies. In either case, however, the house of representatives assumes the initiative. Bills for raising revenue must originate in the house of representatives, according to the constitution (i, 7), and by custom appropriation bills originate there also. Proposals for changes in the tax structure are made by the treasury department and are considered by the ways and means committee in the house and by the finance committee in the senate. The revenue committees are assisted in their work, such as estimating tax yield or the effect of tax change, by the professional staff of the joint committee on internal revenue taxation, in addition to their own staffs.

Criticism and Investigations.—The critical function of congress has developed from its concern with the effectiveness of existing legislation and the necessity for new legislation. The expression of criticism takes several forms, ranging from debate to special inquiry. The custom has developed of inviting department heads and subordinates to testify before committees on matters of controversial public policy. The interrogation of department heads never takes place on the floor of the house or senate, although very occasionally the president or a departmental secretary will formally address one or both houses.

The most formal type of interrogation occurs when a committee or subcommittee conducts a special investigation, the object of the inquiry being set forth in a resolution passed by the parent body. In preparation for such an investigation, the general procedure is to grant a committee special authority to investigate a particular subject, special power being authorized to compel the attendance of witnesses and the production of papers. The exercise of this authority, in turn, has led to considerable adjudication in which the courts have been asked to determine the extent of congress's power to investigate. The broad powers of congress in this field have been upheld by the courts, although some cases have emphasized the importance of meticulous procedures. In the case of *McGrain* v. *Daugherty* (273 U.S. 135 [1926]), the supreme court said that "the power of inquiry—with process to enforce it—is an essential and appropriate auxiliary to the legislative function." This general principle was not changed in subsequent judicial rulings.

One of the most contentious phases of investigations is, and has been, the refusal of witnesses to testify. In its early history, congress itself punished contumacious witnesses, but subsequently it empowered the federal courts to try cases of contempt. The most effective claim for refusing to testify has been the protection offered by the 5th amendment to the U.S. constitution, which provides, among other things, that "no person . . . shall be compelled in any criminal case to be a witness against himself." However, special legislation also provides that, under certain judicial conditions, committees may compel testimony by guaranteeing that the witness will be immune from prosecution arising from his testimony. In the important case of *Watkins* v. *United States* (354 U.S. 178 [1957]), the court held that the 1st amendment protects a witness from identifying former Communist associates. Congress, the court said, has no "general power to expose where the predominant result can only be an invasion of the private rights of individuals."

See also references under "Congress, United States" in the Index volume.

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CONGRESS OF INDUSTRIAL ORGANIZATIONS: *see* AMERICAN FEDERATION OF LABOR–CONGRESS OF INDUSTRIAL ORGANIZATIONS.

CONGREVE, RICHARD (1818–1899), English philosopher, a Comtian positivist, was born at Leamington on Sept. 4, 1818, and educated at Rugby and at Wadham college, Oxford, where he obtained a fellowship. Inspired by a meeting with Auguste Comte (*q.v.; see* also POSITIVISM) he became a convinced positivist, resigned his Wadham fellowship (1855) and founded the positivist Church of Humanity in Chapel street, Holborn. In 1878, however, he caused a schism among positivists by repudiating the authority of Comte's successor, Pierre Laffitte. Afterward Congreve concerned himself especially with the ceremonial elaboration of the positivist religion. He died in Hampstead on July 5, 1899.

Congreve's positivist writings include *The New Religion in Its Attitude Towards the Old* (1859), *Essays, Political, Social and Religious*, 3 vol. (1874–1900), *Human Catholicism* (1876–77) and translations from Comte. He also published some historical works (collected ed., *Historical Lectures*, 1900), a translation of Aristotle's *Politics* (1855) and occasional notes on current affairs, such as pamphlets urging the British to evacuate Gibraltar and India.

CONGREVE, WILLIAM (1670–1729), English dramatist, the most brilliant of the writers of Restoration comedy, was born at Bardsey, near Leeds, on Jan. 24, 1670. In 1674 his father was granted a commission in the army to join the garrison at Youghal, in Ireland, being moved later to Carrickfergus, whence, in 1681, Congreve was sent to school at Kilkenny, the Eton of Ireland. In April 1686 he entered Trinity college, Dublin (of which he became M.A. in 1696), under the famous St. George Ashe, who also tutored his elder schoolfellow, Jonathan Swift. It was prob-

ably at the revolution of 1688 that the family moved to the Congreve home at Stretton in Staffordshire, Congreve's father being made estate agent to the earl of Cork in 1690. In 1691 he was entered as a law student at the Middle Temple. Never a serious reader in law, in 1692 he published a light but delightfully skilful near-parody of fashionable romance, possibly drafted when he was 17, *Incognita, or Love and Duty Reconcil'd*, which he issued over the name of Cleophil. He quickly became known among men of letters, had some verses printed in Charles Gildon's 1692 *Miscellany*, and was favoured by Dryden, who in that year published his translation of the satires of Juvenal and Persius (dated 1693), in which Congreve collaborated, contributing also the complimentary lines "To Mr. Dryden."

It was in March 1693 that he leaped into fame with the production at Drury Lane of *The Old Bachelor*, written, he said, in 1690, to amuse himself during convalescence. Warmly heralded by the ever-generous Dryden, who declared that he had never read so brilliant a first play, though it needed to be given "the fashionable Cutt of the Town," it was an enormous success, running for the then unprecedented length of a fortnight. But his next play, *The Double Dealer*, played in November or December at the Theatre Royal, Drury Lane, though far better, and introduced when printed by some over-panegyrical lines from Dryden, did not meet with the same applause. *Love for Love*, however, his best acting play, almost repeated the success of his first. Acted in April 1695, it was the first performance staged for the new theatre in Lincoln's Inn Fields, which was opened after protracted crises in the old Theatre Royal, complicated by quarrels among the actors, which had induced the lord chamberlain to issue a new licence to run concurrently with that of the old patentees at Drury Lane. Congreve became one of the managers of the new theatre, promising to provide a new play every year.

In 1695 he began to write his more public occasional verse, such as his pastoral on the death of Queen Mary, and his ode "To the King, on the taking of Namur"; and John Dennis, then a young, unsoured critic, collecting his *Letters upon Several Occasions* (published 1696), extracted from Congreve his *Letter Concerning Humour in Comedy*. By this time Congreve's position among men of letters was so well established that he was considered worthy of one of those posts by which in those happy days men of power in government rewarded literary merit: he was made one of the five commissioners for licensing hackney coaches, though at a reduced salary of £100 per annum.

Though Congreve signally failed to carry out his promise of writing a play a year for Lincoln's Inn, he showed his good intentions by giving into their hands *The Mourning Bride*. Improbable as it may seem to modern readers, this tragedy, produced early in 1697, enormously swelled his reputation and was his most popular play. No further dramatic work appeared for three years. In April 1698 appeared Jeremy Collier's famous attack, *A Short View of the Immorality and Profaneness of the English Stage . . .*, a vigorous document composed partly of fantastic argument and absurd statement, and on the other hand of shrewd, common-sense observations which had a great deal of validity. Congreve was not the sort of man to enter into this kind of literary fisticuffs, but, under pressure and on his behalf alone, he replied with his *Amendments of Mr. Collier's False and Imperfect Citations* (July) which, though not so poor as is usually taken for granted, was as little effective as most of the other answers. Then in March 1700, Lincoln's Inn Fields produced Congreve's masterpiece, *The Way of the World*, with a brilliant cast, which, though it is now his only frequently revived piece, was a failure with the audience. This was Congreve's last attempt to write a play, though he did not entirely desert the theatre. He wrote libretti for *The Judgment of Paris*, performed in 1701, and for *Semele*, printed in 1710. In 1704 he collaborated with William Walsh and Sir John Vanbrugh in translating Molière's *Monsieur de Pourceaugnac* for Lincoln's Inn Fields as *Squire Trelooby* (not the version now printed, which is by Ozell), and in 1705 associated himself for a short time with Vanbrugh in the Queen's theatre, or Italian Opera house, writing an epilogue to its first production.

The rest of his life he passed quietly enough, being in easy circumstances, thanks to his private income, the royalties on his plays and his not very exacting posts in the civil service, though they were by no means sinecures. In 1705 he was made a commissioner for wines, a post that he retained by virtue of Swift's good offices at the change of government in 1710 but which he relinquished in 1714 when he became an undersearcher in the customs; this latter post was bettered at the end of 1714 with the addition of the secretaryship of the island of Jamaica. He wrote a considerable number of poems, some of the light social variety, some soundly scholarly translations from Homer, Juvenal, Ovid and Horace, and some Pindaric odes. In these odes he indited his timely *Discourse on the Pindarique Ode* (1706), which brought some order into the wildly unrestrained form which poets since Abraham Cowley, forgetting Ben Jonson's example and ignoring the remarks of Edward Phillips (Milton's nephew), had indiscriminately proliferated. His friendships were numerous, warm and constant, as much with insignificant people, such as his early companions in Ireland, as with the literary figures of his time. No quarrels are attributed to him, except for a very brief one with Jacob Tonson the publisher. Swift, whose friendship with him had begun in early days in Ireland, was unvarying in his affection; for Gay he was the "unreproachful man"; Pope dedicated his *Iliad* to him; and Steele his edition of Addison's *The Drummer*. As to his relations with the other sex, his *tendre* for Mrs. Bracegirdle—who acted most of his female leads—is well known; they were always close friends, but whether the intimacy was of a deeper nature is undetermined. In his later years he was devotedly attached to the second duchess of Marlborough, and it is almost certain that he was the father of her second daughter Lady Mary Godolphin, later duchess of Leeds. This would account for the large legacy, of almost all his fortune, to the duchess of Marlborough. He died in London on Jan. 19, 1729.

Character and Literary Achievement.—Congreve's character was praised in Giles Jacob's *Poetical Register* (1719), where he is described as being "so far from being puff'd up with Vanity . . . that he abounds with Humility and good Nature. He does not shew so much the Poet as the Gentleman." The last phrase will serve as a gloss on the notorious meeting with Voltaire, who in 1726 had come tufthunting in England, and wished to extract what he could from the great English writer of comedy. Congreve, failing, fatigued, attacked by gout and half-blind, "retired without regret, . . . In easy contemplation soothing time" ("Letter to Lord Cobham"), did not feel equal to discussing the minutiae of comic writing, or a play he had written some 30 years earlier. He told Voltaire that he would be delighted to talk on general subjects, "on the footing of a gentleman" as he phrased it, but not on subjects of which he would be expected to display expert critical knowledge and affect the pundit.

Congreve is the outstanding writer of the English comedy of manners, markedly different in many respects from others of this sparkling period of the drama. This comedy was a development, shaped by the political and social conditions of the time, from late Stuart comedy, and really owed little to the French. Taking as its main theme the manners and behaviour of the class to which it was addressed, that is, the antipuritanical theatre audience drawn largely from the court, it dealt with fops, fanatics, fools, excited amateur scientists, imitators of French customs, conceited wits, fantastics of all kinds; but its main theme was above all the sexual life led by a large number of courtiers, not to mention Charles II, with their philosophy of freedom and experimentation. The dramatists dealt with it variously: Sir George Etherege a little flippantly, finding the whole scene in the main vastly enjoyable; William Wycherley with a deep, savagely satirical revulsion against the whole scene; Colley Cibber with a clumsy sentimentality, which expressed rather the indignant rebellion of the rising middle-class citizenry than any thought-out attitude. Yet it was all, without exception, critical comedy, aiming to "cure excess," bringing "the sword of common sense" to bear upon the extravagant assumptions of the age. Where Congreve rises almost immeasurably above them is in both the delicacy of his feeling and the perfection of his phrasing.

The latter is strikingly exhibited in the opening speeches of *The*

Old Bachelor, a play which no doubt appealed to the audiences because it handled with a new brilliance themes they were familiar with. If some of the repartee seems cheap and schoolboyish, that was the manner of the time. As Congreve progressed his speeches became more modulated, more musical, but always sure in their cadence. "Every sentence is replete with sense and satire," Hazlitt wrote, "conveyed in the most polished and pointed terms." As Meredith stated, "He is at once precise and voluble . . . in this he is a classic, and is worthy of treading a measure with Molière." He did not, however, achieve perfection until his last play, for he was not quite certain of himself, confusing a realistic presentation with an atmosphere of fantasy. It was perhaps this confusion which puzzled the audiences at his second play, *The Double Dealer,* which is in part clearly satirical and in part more purely comic. But he was not naturally satirical, being loath to portray "fools so gross, that . . . they should rather disturb than divert the well-natured and reflecting part of an audience"; and Pope was to ask, "Tell me if Congreve's fools are fools indeed." His real contribution begins to be felt in *Love for Love,* where the lovers express that fear of disillusion that comes with too easy fruition. What he had to say comes out clearly in *The Way of the World,* a play marred by the artificial contrivances of the plot. Here he is doing more than hold up to ridicule the assumptions that governed the society of his time. He could not regard love merely as the gratification of lust or as a battle of the sexes, a matter of wit rather than of feeling. He was averse from "rationalizing" love. The famous "bargaining scene" between Mirabel and Millamant is a plea for maintaining the valuable elements in sexual affection, a defense against the cynicism that pervaded, if not society, at least the stage. There is something tragic, too, about Lady Wishfort in her desperate attempt to preserve her youth. Congreve goes deeper than any of his contemporaries, has more feeling for the individual, and is far subtler. The equal of Molière? No. But the nearest English approach to him.

The Mourning Bride deserves better than the contempt which has been bestowed upon it for so long. Though the plot is outrageously fantastic, the poetic force behind it is not to be despised, and it has contributed two famous quotations to the common stock. Nor is Congreve's poetry negligible, though very minor. His love-pieces reveal that delicacy and respect for personality that characterize his two last comedies. His final poem, posthumously published, the "Letter to Lord Cobham" (his old friend Sir Richard Temple), is a fine example of the "retirement" poetry sporadic at that period, and his libretti are beautifully phrased for setting to music. Congreve was not a great poet, but he was a sensitive craftsman and nothing came from his hand that was not thoughtfully conceived and expertly contrived.

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Biography: Early lives are valueless. Edmund Gosse's *Life of William Congreve* (1888; rev. ed. 1924) was the first full biography, succeeded by D. Protopopesco, *Un Classique Moderne, William Congreve* (1924). By far the fullest and most accurate is that by John C. Hodges, *William Congreve, the Man* (1941). A brief account is given by Kathleen M. Lynch in *A Congreve Gallery* (1951), which contains an admirable bibliography. Contemporary references are to be found in the letters of Swift, Pope and Gay, and in Swift's *Journal to Stella.*

Criticism: Besides that included in the introductions mentioned above, detailed criticism is to be found in John Palmer, *The Comedy of Manners* (1913); B. Dobrée, *Restoration Comedy* (1924); Henry Ten Eyck Perry, *The Comic Spirit in Restoration Drama* (1925); Norman N. Holland, *The First Modern Comedies* (1959). (B. Do.)

CONGRUENCE, in mathematics, is a term employed in several senses, each connoting harmonious relation, agreement or correspondence.

Two geometric figures are said to be congruent, or to be in the relation of congruence, if it is possible to superpose one of them on the other so that they shall coincide throughout. Thus two triangles are congruent if two sides and their included angle in the one are equal to two sides and their included angle in the other. This idea of congruence seems to be founded on that of a "rigid body," which may be moved from place to place without change in the internal relations of its parts. But it must rest on a previous concept of metrical relations among the parts of the body, since otherwise there would be no basis on which to determine whether the body had changed in shape and size.

The position of a (straight) line (of infinite extent) in space may be specified by assigning four suitably chosen co-ordinates. A congruence of lines in space is the set of lines obtained when the four co-ordinates of each line satisfy two given conditions. For example, all the lines cutting each of two given curves form a congruence. The co-ordinates of a line in a congruence may be expressed as functions of two independent parameters; from this it follows that the theory of congruences is analogous to that of surfaces in space of three dimensions. An important problem for a given congruence is that of determining the simplest surface into which it may be transformed.

Two integers a and b are said to be congruent modulo m if their difference a-b is divisible by the integer m. It is then said that a is congruent to b modulo m, and this statement is written in the symbolic form $a \equiv b \bmod. m$. Such a relation is called a congruence. Congruences, particularly those involving a variable x, such as $xp \equiv x \bmod. p$, p being a prime number, have many properties analogous to those of algebraic equations. They are of great importance in the theory of numbers.

See DIFFERENTIAL GEOMETRY; DIOPHANTINE EQUATIONS; NUMBERS, THEORY OF: *Congruences in One Unknown;* TRIANGLE: *Congruence Theorems.*

CONIBO, a warlike tribe of Panoan (*q.v.*) linguistic stock living in Peru on the Ucayali river in the vicinity of the Pachitea. They live in palm houses sheltering about ten persons each, grouped in small communities of three or four houses. They welcomed Jesuit and Franciscan missions in the late 17th century in order to obtain iron, but soon revolted.

War raids were conducted in order to obtain slaves from weaker neighbours. Formerly, dugout canoes were made up to 60 ft. in length. They manufactured fine pottery decorated in red, black and cream designs, wove cotton textiles, and practised tropical agriculture. For hunting, spear throwers, long palmwood bows and arrows and, later, the blowgun were used. Shamans were influential; they diagnosed and cured sickness and foretold the future. Elaborate puberty ceremonies for girls were practised. Formerly, urn burial was practised at death; later, cremation. When parents became old, they were killed and eaten. In the early 1960s the estimated population of the Conibo was 3,000.

(M. W. St.)

CONIC SECTION. If a right circular cone is cut by a plane, the boundary curve of the intersection is said to be a conic section or, more briefly, a conic. According to the angle of intersection the conic is a parabola, ellipse, circle or hyperbola. The ellipse, like the circle, is a closed curve (*see* fig. 1). In the case of the parabola the cutting plane is parallel to an element (*see* CONE); the parabola is therefore an open curve (*see* fig. 2). The hyperbola consists of two open branches lying on the two symmetrical sheets (nappes) of the cone (*see* fig. 3).

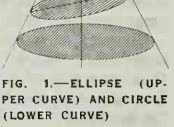

FIG. 1.—ELLIPSE (UPPER CURVE) AND CIRCLE (LOWER CURVE)

Greek Mathematicians; the Geometrical Viewpoint.—The description of conics given above is due to Menaechmus of Greece (*c.* 350 B.C.), the first man known to have considered the conic from a geometrical point of view. Menaechmus was a pupil of both Plato and Eudoxus of Cnidus. None of his writings are extant, but information about him is contained in works of other authors.

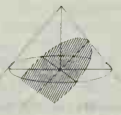

FIG. 2.—PARABOLA

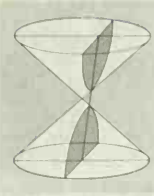

FIG 3.—HYPERBOLA

Menaechmus was led to the study of conics by his efforts to solve the problem of constructing a cube twice as large, by volume, as a given cube (the so-called Delian problem).

Euclid wrote four books on conic sections, but his work is completely lost. Archimedes succeeded in finding the area of the ellipse and of a sector of the parabola by a method closely akin to that of integral calculus, although calculus was not developed until the 17th century.

The pinnacle of Greek geometry, and perhaps of Greek mathematics in general, was reached in the eight books on conic sections by Apollonius of Perga (*q.v.*). Only the first seven have survived. Apollonius was the first to show that all conics are sections of any circular cone, right or oblique. But in studying these curves Apollonius treats them as plane curves, without regard to their spatial origin. The terms ellipse, hyperbola and parabola were introduced by Apollonius. His books contain the elementary theory of conics in a complete form.

Succeeding generations of Greek mathematicians added but little to the admirable treatise of the "Great Geometer," as Apollonius was called. However, an important contribution by Pappus of Alexandria should be mentioned. Pappus, who flourished about A.D. 320, showed that the ratio of the distances of any point on any conic from a fixed point (the focus) and a fixed line (the directrix) is constant. (This statement gives the analytical definition of a conic section.) The constant ratio is called the eccentricity and is denoted by e. The conic is an ellipse if $e < 1$, a parabola if $e = 1$ and a hyperbola if $e > 1$; for a circle, $e = 0$.

With the close of the Greek period interest in conic sections waned, and these curves were largely neglected until the first half of the 17th century.

Desargues; Conics as Projections of a Circle.—Like the "ancients," with whose works he was thoroughly familiar, Gérard Desargues approached the study of the conic by considering it as a section of a circular cone cut by a plane. But Desargues soon parted company with his predecessors and mentors by adopting a different point of view. He observed that the conic may be considered as an image, in the plane of section, of the basic circle of the cone or, in other words, that the conic is the projection of that circle from the vertex of the cone upon a second plane. Furthermore, if that conic in turn is projected the same way from another point upon a third plane, the image obtained is a conic. This concept of projection led Desargues to attribute to two parallel lines a common point "at infinity," and, further, to conclude that the points at infinity of all the lines in the plane lie on a straight line, "the line at infinity," thus adjoining the infinite domain to geometry.

Any figure in the plane of the initial circle gives rise, by the same operation of projection, to a corresponding figure in the new plane. Desargues noticed that some of the properties of the circle, and of the other figures in its plane, are reproduced in the new plane in a distorted way, while other properties are preserved and are identifiable in the new figure. He was thus the first geometer to draw a sharp distinction between the two kinds of geometrical properties, the "metrical" and the "projective."

Given a line m and a point O on it, the points of m may be paired off in such a way that the product of the distances, from O, of any pair of points is equal to a given constant, say K. Desargues said that the points of m paired off in this fashion are "in involution," and that the point O is the centre of the involution (*q.v.*). He showed that if a quadrilateral PQRS (*see* fig. 4) is inscribed in a conic (C); and if m does not pass through any of the points P, Q, R, S the line m meets the two pairs of sides (PQ, RS), (PS, QR) and the conic (C) in three pairs of points which are in involution. Moreover, any other conic passing through the points P, Q, R, S will meet the line m in a pair of points belonging to the involution (Desargues's theorem on pencils of conics).

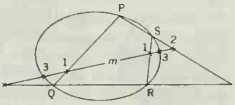

FIG. 4.—QUADRILATERAL INSCRIBED IN CONIC SECTION

If a triangle ABC lying in a plane (P) is projected from a point S′, not in (P), upon a plane (P′) into the triangle A′B′C′ (*see* fig. 5), the sides of the latter triangle meet the line of intersection m of the planes (P), (P′) in the same three points as do the corresponding sides of ABC. The proposition remains valid for two coplanar triangles: If the three lines joining the corresponding vertices of the two triangles are concurrent, the three points of intersection of the corresponding sides are collinear.

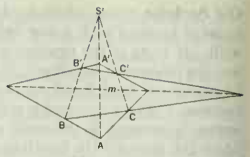

FIG. 5.—PROJECTION OF TRIANGLE ABC

Desargues was the first mathematician of modern times who showed marked originality in the treatment of conic sections, and was easily the greatest geometer of the 17th century.

Descartes; the Analytical Viewpoint.—The Greeks never referred to their geometry as being "pure" or "synthetic," for they knew of no other kind. Desargues in this respect adhered to the ways of the Greeks, although he was familiar with the work of his friend René Descartes. The latter was the first to point out, in his *Geometry* (1637), that the resources of algebra (*q.v.*) may be brought to bear upon the study of geometrical figures in general, and conic sections in particular. He is thus the father of Cartesian or analytic geometry (*q.v.*).

From the analytical point of view a conic section is the graph of an equation of the second degree in two variables, x and y, namely,

$$ax^2 + by^2 + 2cxy + dx + ey + f = 0,$$

where the coefficients are constants for a given conic and vary from one conic to another. This algebraic definition of a conic reveals at once the interesting fact that a conic is, in general, determined if five points of that conic are given. Indeed, if the co-ordinates of the five points are substituted, in turn, into this equation, five linear homogeneous equations in the coefficients are obtained. When solved simultaneously they yield, in general, the values of the coefficients in the above equation of a conic, and the conic may be graphed.

By a proper choice of co-ordinate axes the general equation of a conic may be reduced to one of the three standard forms

$$x^2/a^2 + y^2/b^2 = 1 \quad (1)$$
$$x^2/a^2 - y^2/b^2 = 1 \quad (2)$$
$$y^2 = 2px \quad (3)$$

which represent an ellipse, hyperbola and parabola, respectively.

Equation (1) shows immediately that if a point of the ellipse has for its co-ordinates (x_0, y_0), then the co-ordinates $(-x_0, -y_0)$ also satisfy equation (1); this shows that the origin is a centre of symmetry of the curve. If one of the two points (x_0, y_0), $(x_0, -y_0)$ lies on the ellipse, the other does also, and the x-axis is thus an axis of symmetry of the curve (that is, the lower part of the curve is the reflection of the upper part, the x-axis acting as a mirror). Similar reasoning holds true for the y-axis. The segments which (1) determines on these two axes are respectively equal to $2a$ and $2b$. These segments are said to be the major and minor axes of the ellipse. The ends of the major axis of (1) are the vertices of the ellipse.

Analogous results for the hyperbola are readily obtained from equation (2). The parabola (3) has no centre of symmetry. The x-axis is an axis of symmetry. The origin is the vertex of the curve and the y-axis is tangent to the curve at the vertex. Equation (3) is the focus of a point whose distances from a fixed point (focus) and a fixed line (directrix) are equal.

The above discussion illustrates the new point of view which Descartes revealed to his contemporaries through his analytical methods in geometry.

Projective Description of Conics.—The third phase in the study of conic sections came with the development of projective geometry. If A, A′ are two fixed points of a circle and M a variable point of that circle, the lines AM, A′M describe two pencils of lines

(A), (A′) such that to every line of (A) there corresponds a definite line of (A′), and vice versa (*see* fig. 6). Moreover, if *a, b, c, d* are any four lines of (A) and *a′, b′, c′, d′* the corresponding lines of (A′), the angles *a′c′, c′b′, a′d′, d′b′* are equal to the angles *ac, cb, ad, db*, respectively, and thus their sines are equal. Therefore, the anharmonic ratios (*see* PROJECTIVE GEOMETRY) of those two tetrads of lines are equal, and thus the two pencils of lines (A), (A′) are projective. Now if this circle is projected from a point S not in its plane and the projecting figure (which is a circular cone) is cut by another plane not passing through S, the circle will be projected into a conic and the two pencils of lines into two other pencils of lines projective to each other. Corresponding lines of those pencils will intersect on the conic. Thus the following important proposition is obtained: If two pencils of rays in the same plane are projective, their corresponding rays intersect in points lying on a conic which passes through the centres of the two pencils.

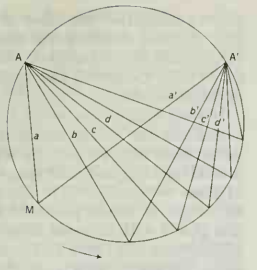

FIG. 6.—PROJECTIVE PENCILS OF LINES

There is thus a projective mode of generation of a conic section.

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(N. A. CT.)

CONIFERS (CONIFERALES). This is a large group of usually evergreen, cone-bearing trees, of which the pine, Douglas fir, hemlock, spruce, redwood and cedar are familiar examples. Coniferous forests are the major plant resource of North America, because of their value in furnishing building materials, pulpwood and many other lesser-known products. In addition to their economic importance, they are of great interest to the evolutionary biologist because they combine a nearly unbroken record of the past with a fascinating variety of types in existence today.

The order Coniferales is the largest order of the gymnosperms and includes about 48 genera with approximately 520 species which are found in all parts of the world. Usually they are trees of good size with profusely branched stems, in contrast to many other gymnosperms. There is a lateral growth zone or cambium which gives rise to a large amount of wood surrounded by a thin cortex and enclosing only a small amount of pith. Conifers also lack the ciliated swimming male gametes found in the cycads and ginkgo, having instead essentially naked male nuclei. The leaves of conifers also differ from those of other gymnosperms for they are never compound, but usually small and simple, needlelike leaves that persist for about three to ten years. In the larch (*Larix*) and the golden larch (*Pseudolarix*), however, the leaves are shed individually every fall; and the bald cypress (*Taxodium*) and the dawn redwood (*Metasequoia*) cast off small leaf-bearing twigs every season to remain leafless during the winter. Conifers have cones but these are never terminal on the main stem of the plant. The seed cones may be large and made up of dozens of cone scales. In a few genera, the seed-bearing scales are reduced to single ovules and they appear as if terminal on the secondary branches that bear them. However, with respect to pollen-bearing cones conifers are less diverse. All conifers have pollen borne in cones which are usually quite small.

Uses.—Conifers include some of the most useful plants aside from food plants. More than three-fourths of commercial lumber is obtained from species of pine (*Pinus*), Douglas fir (*Pseudotsuga*), spruce (*Picea*), bald cypress (*Taxodium*), redwood (*Sequoia*) and arborvitae (*Thuja*). In the south temperate zone, *Araucaria, Agathis, Podocarpus* and *Dacrydium* are very important timber species. The wood of all conifers is classed as softwood, in contrast to the hardwood lumber obtained from broad-leaved angiosperms such as oak, walnut, birch, poplar, gum, elm, ash, maple, hickory, mahogany, etc.

The pines also yield resin, pitch, turpentine and various oils. Important resins are obtained from *Araucaria* and *Agathis* in the southern hemisphere. A large amount of coniferous wood from both hemispheres enters into the manufacture of paper as pulp.

Many of the species not sufficiently abundant for lumbering, as well as the economically important species, are planted for ornament in landscaping. The pines of the Mediterranean region and the cryptomerias of Japan are justly famous examples. The seeds of some species of pine furnish food for man and the seeds of all conifers are eaten by animals. Seeds of the Italian stone pine have long been esteemed as a delicacy and are exported to other countries. In the southwestern United States, the Indians regularly harvest seeds of the piñon pine for food and for sale.

Distribution.—Conifers are most often found in more or less moist habitats in hilly or mountainous areas. They frequently occur at high altitudes extending up to timberline where they form the characteristic *krummholz* (*i.e.*, a belt of stunted tree growth). Four genera (*Taxodium, Glyptostrobus, Metasequoia* and *Pherosphaera*) occur in very wet places: lowlands, swamps, borders of lakes and rivers, etc. Another group includes those, such as *Juniperus, Cupressus, Abies, Pinus* and *Podocarpus*, which are large, wide-ranging genera. Their species occur in wet situations, mesic habitats and even extend into semidesert areas. The general restriction of the conifers to moist places may be brought about by their relatively poor (in comparison with the angiosperms) water-conducting systems.

If the distribution of the various genera is plotted on a map of the world it can be seen that they are strikingly concentrated in the mountainous areas around the Pacific basin and in the islands of the Pacific. They are rare as a group on the Atlantic and Indian ocean coasts.

About 30 genera are confined to the northern hemisphere and about 20 rarely get out of the southern hemisphere. Only three or four genera cross the equator with some of their species inhabiting both hemispheres. There is thus a distinct differentiation into a southern group and a northern group of genera. Paleobotanical evidence indicates that this distinction has existed since the late Paleozoic era. It also appears that the association of the conifers with mountainous areas and the Pacific basin is an old one as well.

Families.—Six families of Coniferales are usually recognized, although some botanists feel that there should be more or fewer. Some of the subfamilies are sometimes given family rank. Similarly some of the genera have been or may be subdivided as more evidence concerning their anatomy, embryology and chemistry becomes available. With this in mind, the numbers given for genera and species must be considered as tentative and dependent upon the authority consulted. The families considered here are: Pinaceae with 9 genera in two subfamilies, Araucariaceae with 2 genera, Taxodiaceae with 9 genera in two subfamilies, Cupressaceae with 18 genera in three subfamilies, Podocarpaceae with 7 genera in three subfamilies and Cephalotaxaceae with 1 genus (or 2 genera, if one problematical genus, *Amentotaxus*, is included in the family). In older works only two families were recognized: Pinaceae and Taxaceae. The proper disposition of the yews, Taxaceae, is a particular problem. Investigations have indicated that the Taxaceae probably never had ovule-bearing appendages aggregated into cones. In this way they differ from the conifers. Those Coniferales, which produce one or a few seeds (*e.g.*, Podocarpaceae) often have the cones so reduced as to be unrecognizable as such. Anatomical studies show that these are cones and logically these plants are grouped with those from which they were probably derived rather than with those they superficially resemble.

Stem Anatomy and Physiology.—The stem of conifers follows the same structural plan as the dicotyledonous angiosperms. The embryo produces a small amount of primary tissue and continues to grow from the shoot tip upward and from the root tip

downward. There is a central pith surrounded by a circle of vascular bundles with xylem toward the inside and phloem toward the outside. Superimposed on this primary growth is growth in diameter—the result of the activity of a lateral meristem or cambium which arises between the xylem and phloem. This cambium produces secondary xylem toward the inside and secondary phloem toward the outside, with the result that the primary tissues are separated, the phloem crushed, the xylem buried within the ever increasing mass of secondary wood. A second cambium, the cork cambium, produces the bark, a secondary tissue which replaces the epidermis of the root and stem. This cambium is frequently renewed and, arising each time farther into the secondary phloem, it eventually abuts upon the active phloem. The living part of the tree then consists of a hollow shell composed of the two cambia, the active phloem transporting food and the active xylem conducting water with its dissolved minerals.

Annual growth rings are produced in the secondary wood deposited by the cambium. Coniferous wood differs from the wood of angiosperms in the absence of vessels. Vessels are cells of the xylem which have lost their end walls. Arranged end to end they form what are functionally long pipes. Only in the Gnetales among the gymnosperms are vessels developed. In the conifers water is conducted through long tracheids which communicate through bordered pits, each closed by a delicate membrane through which the water must pass. In addition to the tracheids there are wood rays composed of living cells, usually only one or a few cell layers thick, and these are bordered by ray tracheids in many Pinaceae. The wood rays also communicate with the tracheids by means of pits. The size, shape and arrangement of the bordered pits, whether they are in one or several rows, whether or not they are accompanied by thickenings of the wall called crassulae, and especially the character of the pitting in the cross fields where ray cells border on tracheids, are criteria that enter into the study of wood anatomy.

The wood of some genera of Pinaceae has resin canals which are ducts lined with resin-producing cells. In other families there are only resin cells, or cells containing other oils, and many types have resin passages in the cortex. *Pseudotsuga* has spiral thickenings in its tracheids in addition to the thick secondary cell wall. These and other anatomical features of coniferous woods have been studied extensively and have been organized into keys for the identification of species by wood alone. The chemical nature of the resins also can be used to identify some conifers as well. Studies of the chemistry of the various products secreted by these plants have added materially to our understanding of their interrelationships.

Leaves.—The simple leaves of conifers are characterized by their small size; *e.g.*, the needle form represented by *Pinus, Cedrus, Tsuga, Picea*. The needlelike leaves are fitted by nature to prevent escape of water from the plant. Thus, these trees can retain their leaves in the winter, hence their common name of evergreens. The flat or angular linear leaves of *Thuja, Cupressus* and *Libocedrus* are appressed to the branches and have a single midvein. Leaves of the latter genera often have a prominent resin gland. The flat and comparatively broad leaves of some species of *Araucaria*, the leaves of *Agathis* and the leaves of the section *Nageia* of *Podocarpus* have several parallel veins. The largest leaves found in the conifers are those of *Podocarpus blumei*, which may be seven inches in length and nearly two inches broad; but with this exception, and the long needles of several of the pines, the leaves of conifers are relatively small. The leaves of most conifers show adaptations which reduce water loss, such as thick cuticle and few and modified stomata. The latter may be restricted to one or several lengthwise bands which are often visible as gray or white lines.

Many conifers have leaves that are polymorphic. The leaves of seedlings usually differ from the leaves of the mature tree. In some junipers, cypresses, etc., in which small leaves appressed to the stem are normal in adult plants, examples occur in which these leaves are replaced by longer, slender, needlelike leaves standing out almost at right angles to the branch. This condition is usually typical of the seedling stage. Such examples are often seen in cultivation and often are termed retinospora, though this term does not denote a true genus, but merely the persistence of the juvenile form of a species belonging to any of several genera; *e.g., Thuja, Juniperus, Cupressus, Chamaecyparis* and other trees of the same type.

In trees with resting winter buds the difference between the bud scales and the foliage leaves is always pronounced. When the winter buds have broken, the scars or the dried bud scales remain around the twigs and mark the growth of successive seasons. Some of those with naked buds also may show seasonal differences in the length of leaves produced along the shoots; *e.g., Araucaria*. The genera with flattened twigs usually have longer leaves on the edges of the twigs than on the sides. In the southern hemisphere there are many conifers of the genera *Dacrydium, Podocarpus* (section *Dacrycarpus*), *Acmopyle*, etc., in which the green foliage leaves are dimorphic and even trimorphic so that when judged by the shape of the leaves alone, they are not always recognized as belonging to the same species.

The occurrence of long and short shoots is a characteristic feature of *Pinus, Cedrus, Larix* and *Pseudolarix*. In *Pinus* the needles occur in pairs, or in clusters of three to five (rarely only one, or up to eight) at the apex of small and inconspicuous short shoots of limited growth (spurs). The spur is enclosed at its base by several scale leaves and is borne, upon a branch of unlimited growth, in the axil of a scale leaf. The short shoots of the other three genera are stout spurs bearing an indefinite number of needles and they are not shed with the leaves as are the spurs in pines.

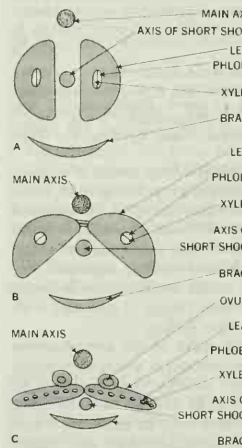


FIG. 1.—CROSS SECTIONS OF SHOOTS OF CERTAIN CONIFERS: (A) "NORMAL" SHORT SHOOT OF PINUS; (B) "DOUBLE NEEDLE" OF SCIADOPITYS; (C) OVULIFEROUS SCALE OF LARIX AND PINUS

A remarkable and unique leaf is found in the umbrella pine (*Sciadopitys verticillata*). These leaves are actually borne spirally in the axils of the scale leaves, but are restricted to apparent whorls alternating with regions of the twigs bearing only scale leaves. They are grooved and have two separate veins, suggesting an origin from a pair of needle leaves. A peculiarity of the leaves is the inverse orientation of the vascular tissue: each of the two veins has its phloem next to the upper, and its xylem next to the lower, surface of the leaf. This unusual position of the xylem and phloem is explained by regarding the needle of *Sciadopitys* as composed of a pair of leaves on a short shoot, fused by their upper margins (fig. 1).

In the genus *Phyllocladus* of New Zealand there are no green foliage leaves. In their place, and resembling leaves, are flattened branches (phylloclades) which are borne in the axil of small-scale leaves.

The leaves of most conifers are arranged spirally, but in one entire family, the Cupressaceae, they are always opposite, in pairs, or in threes. This applies also to the monotypic genus *Microcachrys* and to a few species of *Podocarpus*, but not to other conifers.

While the vegetative structures alone are not considered dependable as a basis for the classification of conifers, they may be very useful diagnostically. A special example is provided by the stomatal structures, including the number and arrangement of subsidiary cells and other cuticular features. It is possible to place all or nearly all living conifers into their families and genera on the basis of cuticular structures. In many fossils, the outward size and form and the details of cuticular structures are all that remain. The true classification of these fossils without reproductive parts may thus be determined and they may be compared with the living genera.

Reproductive System.—The basis for classifying the conifers as a group, however, is the reproductive system. Thus in order to fully understand the relationship of one plant to another, the botanist must know the structure of the cones as well as details of the development of the male and female reproductive organs and of the embryo.

The conifers, like other gymnosperms, have an alternation of generations, and the dominant generation that is seen, say, in a pine or a spruce, is the sporophyte. Sporophytes of conifers have unisporangiate cones; that is, one kind of cone will produce spores that develop into the male gametophyte (male gamete-producing plant), while another will produce spores that give rise to the female gametophyte. These are the staminate or pollen-bearing cones, and the ovulate, or seed-producing cones, respectively. The male gametophyte is the pollen grain, while the female gametophyte is produced inside the ovule and never escapes from the sporophyte. Monoecious conifers have both kinds of cones on the same plant; dioecious conifers have the two kinds of cones on different plants.

A typical staminate cone consists of a central axis, bearing from six to many scalelike appendages. These are arranged as the leaves; *i.e.*, they are spirally arranged except in the Cupressaceae where they are opposite or whorled. The scale is composed of a slender stalk terminating in an upturned blade and bearing from 2 to 15 pollen sacs or sporangia on its lower surface. The larger number of sporangia (6 to 15) is characteristic of *Araucaria* and *Agathis* in which the sporangia are also peculiar in their large size and in being long, slender and freely pendent. In the pine and podocarp families, there are always only two sporangia attached lengthwise along the stalk and usually a small pointed or rounded blade at the tip. Taxodiaceae and Cupressaceae have various numbers of pollen sacs, usually in excess of two. The sporangia are opened by longitudinal, occasionally by oblique or transverse, slits. An assortment of pollen-bearing scales of various types from different genera is shown in fig. 2.

In the origin of sporogenous or spore-producing tissue which gives rise to the tapetum (nutritive cell layers for the spores) and the pollen mother cells, the conifers agree with the cycads and ginkgo. Pollen mother cells undergo meiosis, a special type of cell division which results in four cells, each with half the number of chromosomes in the mother cell. Such a reduction division must always occur prior to the formation of gametes, since the fusion of gametes doubles the chromosome number. The sporophytic and gametophytic number of chromosomes are symbolized by $2n$ and n, respectively. After the spores in a quartet have become separated from one another, they develop a double spore coat consisting of the exine and intine. The outer layer or exine includes, in all Podocarpaceae (except *Saxegothaea*) and in most of the Pinaceae, a pair of bladderlike appendages which dry out as wings. The shape and structure of the exine often are sufficient to permit identification of the plant on this basis alone.

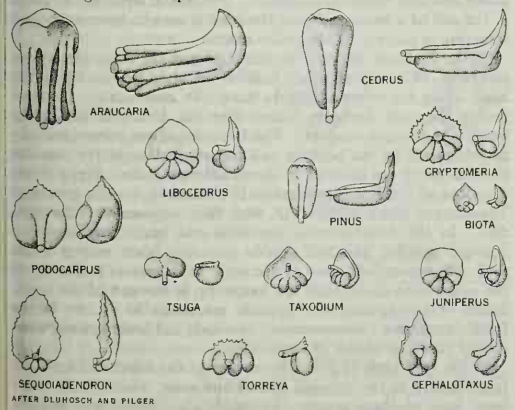
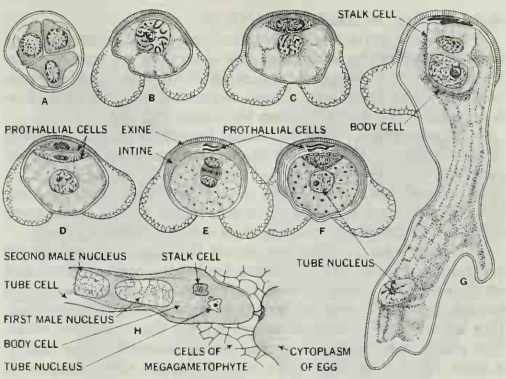


FIG. 2.—SCALES FROM THE POLLEN CONES OF VARIOUS CONIFERS



(A), (B), (C), (D), (E), (F), (G) FROM C. J. CHAMBERLAIN, "GYMNOSPERMS, STRUCTURE AND EVOLUTION," UNIVERSITY OF CHICAGO PRESS. (H) FROM G. M. SMITH ET AL., "A TEXT-BOOK OF GENERAL BOTANY"; REPRODUCED BY PERMISSION OF MACMILLAN COMPANY

FIG. 3.—DEVELOPMENT OF MALE GAMETOPHYTE (MICROGAMETOPHYTE) OF PINUS NIGRA FROM (A) AFTER MEIOSIS THROUGH (G) GERMINATION TO (H) JUST BEFORE FERTILIZATION (*see* TEXT)

Division of the spore nucleus begins the formation of the male gametophyte or pollen grain and its mode of development is an indication of evolutionary advancement. It is believed that those with a large number of sterile cells, or prothallial cells, are more primitive in this respect (that is, more like the ferns and club-mosses).

Stages in the development of pollen grains in pines are shown in fig. 3. Here the spore divides twice to form two abortive prothallial cells which become flattened against the wall while the intine is still forming. Pollen that has not matured to this stage within the pollen sac will not germinate normally. The cell that remains (D) is an antheridial intial, which forms, when it divides again, a tube nucleus and a generative cell. The pollen of pine is shed in this condition and is carried to the ovulate cones by wind. In several genera of Pinaceae, the generative cell divides to form a stalk cell and body cell before pollination, but otherwise all subsequent development takes place after the pollen grain becomes lodged on the nucellus of an ovule.

In Araucariaceae there are many more prothallial cells and these usually persist. In *Araucaria* there are about 15 prothallial cells, the nuclei of which persist after the walls between them disappear; subsequent divisions of these result in 20 to 44 free nuclei which are present in later stages in the pollen tube.

The Podocarpaceae include several genera in which more than two or three prothallial cells are formed and these cells or their nuclei may persist. *Pherosphaera* appears exceptional for no traces of prothallial cells have been found. In several other genera, where only two prothallial cells are formed, at least one of these persists.

No prothallial cells are produced in Taxodiaceae and Cupressaceae. Most of these shed their pollen with only two nuclei formed: the tube nucleus and the generative nucleus or generative cell. Only a single nucleus is found at the time of pollination in nine species representing five genera of Cupressaceae. In 11 species belonging to other genera in this family, as well as in all Taxodiaceae, the pollen grain contains two nuclei at the time of pollination.

The pollen grain is to be regarded as a separate, individual, though very small, plant which will produce the male gametes. After it has arrived at the nucellus of the ovule, it produces a pollen tube through which the various nuclei and cells are carried toward the female gametophyte. In the events that take place in the nucellus, those that follow the formation of the tube nucleus are uniform in all conifers. The generative cell usually gives rise to the stalk and body cells (fig. 3[G]). The body cell divides to form two male gametes or only the nuclei of the two male gametes;

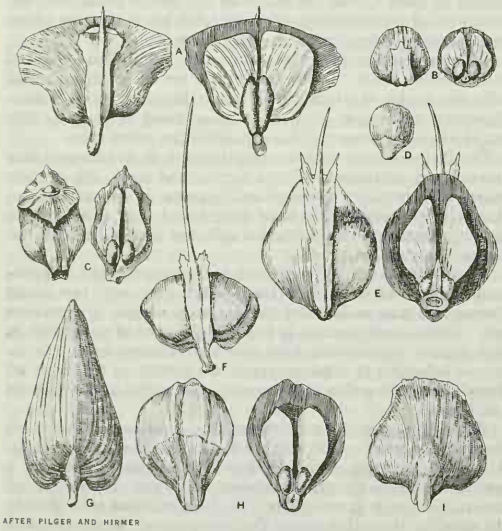
shortly before fertilization (fig. 3[H]).

Where both male nuclei may function in the fertilization of eggs of neighbouring archegonia, the male cells are equal in size. In the remaining genera of conifers, in which only one of the pair of male cells or nuclei is functional, the second male cell or nucleus is frequently much smaller than the functional one.

A large number of cells and nuclei formed in the pollen grains is considered a primitive condition, characteristic of the more primitive families, while few cells or nuclei in the pollen grains is considered advanced. Since all conifers form the stalk cell, they have at least four nuclei formed in the pollen grain, while angiosperms commonly omit the stalk cell and have only three.

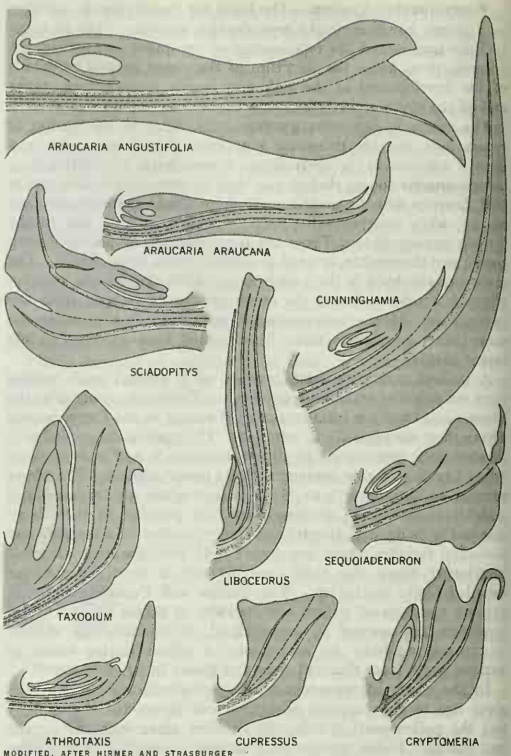
The seed cones of pines are among the most familiar conifer cones. They have numerous scales firmly attached to an axis and on each a pair of seeds is formed. A mature cone appears simple enough, but when cones are examined at the time of pollination, they are found to be much more complicated than the pollen cones. The scales which bear the ovules appear inserted in the axil of a bract which is as long as the scale or longer when the cone is young. All members of the pine family including spruces, firs, larches, etc., have this peculiar structure. In many firs, and notably in *Pseudotsuga* (Douglas fir), the bracts are long and project between the scales at maturity. In all pines, and in most of the other genera, the bracts remain rudimentary or are short and sometimes difficult or impossible to find in a mature cone. Fig. 4 shows an assortment of ovuliferous scales with subtending bracts, representing different genera of Pinaceae.

The ovuliferous scale has its vascular bundles in an inverted position with the phloem above the xylem. There is also a question as to whether this structure, if in any way comparable to a leaf, represents a single unit or is composed of several fused parts. Is it like the leaf of a fern bearing several sporangia on its surface, or does it represent as many sporophylls as there are ovules found on its surface? The morphological nature of the ovuliferous scale has been discussed by botanists for more than a century, during which proponents of one hypothesis or another have called it a carpel, a placenta, a flattened axillary shoot, a ligule, an outgrowth from the chalazal end of the ovule, etc. There has long been general agreement that the bract is homologous with a leaf, but leaves do not bear other leaves in their axil without the formation of at least some axis.



AFTER PILGER AND HIRMER

FIG. 4.—OVULIFEROUS SCALES WITH BRACTS IN PINACEAE: (A) ABIES ALBA; (B) LARIX DECIDUA; (C) PINUS SYLVESTRIS; (D) TSUGA CANADENSIS, (E) PSEUDOTSUGA TAXIFOLIA, (F) ABIES VENUSTA; (G) PSEUDOLARIX AMABILIS; (H) PICEA EXCELSA; (I) KETELEERIA DAVIDIANA



MODIFIED, AFTER HIRMER AND STRASBURGER

FIG. 5.—LONGITUDINAL SECTIONS OF CONE SCALES OF VARIOUS GENERA AND SPECIES OF CONIFERS

The question appears to have been resolved satisfactorily as a result of research on the morphology and anatomy of recent and fossil members of the Coniferales and of the now extinct Cordaitales (*see* PALEOBOTANY). Evidence shows that the ovuliferous scale is an axillary shoot, highly modified and bearing sterile scale-like appendages and fertile ovule-bearing appendages. The latter were never in their evolutionary history leaflike. Each ovule represents such an appendage and the remainder of the scale is composed of fused sterile appendages. The whole structure is borne in the axil of a bract and thus the cone is seen to be a compound structure in contrast to the pollen cone.

In the Pinaceae the ovuliferous scale and the bract are always separate. In nearly all other families the scale is united with the bract along its entire length to form the cone scale. In some genera the scale becomes longer than the bract, in others the bract is the longer element. The two component structures may be recognized by the position and the orientation of the vascular bundles which are inverted in the ovuliferous scale. Fig. 5 shows diagrams of the fused cone scales in *Araucaria,* various genera of Taxodiaceae and Cupressaceae, with their opposed vascular bundles. In the Araucariaceae the scale and bract are fused into a single member and this double structure bears only a single seed. The so-called ligule of the scale in *Araucaria* is the tip of the ovuliferous scale while the longer tip is the end of the bract. Scales of two species of *Araucaria* are shown in fig. 5. In the fossil Araucarias (*Proaraucaria*), the scale and bract are not completely fused as shown in fig. 6(C).

In the seed cone of *Sciadopitys* (fig. 5) the bract and scale are fused nearly to the exposed end of the scale, where these members, both of them greatly thickened, are distinct and may be recognized externally. Here the bract has only a single vascular

bundle while the scale has a bundle system that is branched, with strands leading off to the five or nine or more ovules borne on this structure.

In other members of the Taxodiaceae with which *Sciadopitys* is usually included, there is a more complete fusion of the bract and scale. In *Cunninghamia* the ovuliferous scale is only half as long as the bract, its tip forming a small thin ligule above the attachment of the seeds. The opposed bundles appear fused at the base, but diverge distally, in Cupressaceae. In those genera with woody cones the compound nature of the cone scale may be recognized, as is shown by the selection represented in fig. 5.

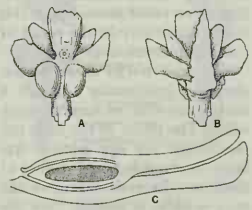
In the Podocarpaceae the ovuliferous scale usually becomes fleshy and is known as an epimatium. It may surround the ovule only at its base, or partially cover the seed. In most species the epimatium completely surrounds the seed, forming an outer integument as shown in fig. 7 (A) and (B). However, the vascular bundles of this outer member have the orientation that would be expected in the ovuliferous scale. Here the cone itself is reduced to an axis bearing several sterile bracts and ending in the ovule. The axis and its scales also become fleshy and swollen forming a receptacle on which the seed is borne.

The ovule, in the seed plants, is the structure in which the female gametophyte is produced by the germination of a spore which arises by meiosis of certain specialized cells in the nucellus, a tissue equivalent to a sporangium. The nucellus is open to the outside only through a narrow canal called the micropyle. The ovules of conifers are borne on the tip of their stalks, but since the appendages are inverted and frequently fused with the bract, the ovules and seeds appear on the upper surface of the cone scale. As stated before, this interpretation is supported by the inverse orientation of the vascular bundles in the ovuliferous scale as well as by the fossil evidence. The Pinaceae always have two ovules per scale. In some families there are as many as eight or nine, in others the ovules occur singly.

The micropyle is directed toward the main cone axis in Pinaceae, Araucariaceae, most Podocarpaceae and in some genera of the Taxodiaceae. In the remaining Taxodiaceae, in the genera *Dacrydium, Phyllocladus, Acmopyle* and *Pherosphaera* (all belong to the Podocarpaceae) and in the Cupressaceae and Cephalotaxaceae, the ovules and seeds are erect. In the earliest stages of evolution the ovules were erect, but there is abundant evidence to indicate that in many of the fossils, even in the Paleozoic, inversion of the ovules had occurred (*see* fig. 6[A] and [B]). Furthermore, the families of living conifers that have erect ovules and seeds are represented by fossil ancestors only in more recent geological rocks. It is reasonable to suppose, therefore, that the erect ovules in living forms developed from the inverted types.

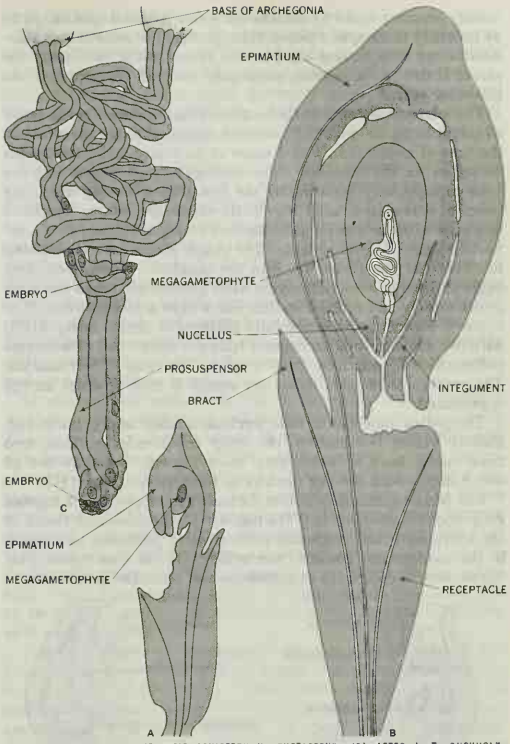
The erection of the ovule was accompanied by a great reduction in the seed cone. The cones having the largest number of scales always have inverted seeds; it is only among those with few scales per cone or with the cone reduced that erect seeds are found.

The young ovulate cones appear on the plant at the time that the pollen is ready to be shed from the pollen cones. They are small and loose and, with their scales spread apart so that the pollen may lodge on any part of the cone including the ovules, have a bristly appearance. The transfer of pollen is accomplished by wind. Ultimately some of the pollen grains find their way to the nucellus within the ovule. Thus we have the male gametophyte which will produce the male gametes brought to the vicinity of the female gametophyte within the nucellus. The pollen tube of the male gametophyte must then grow through the nucellar tissue to bring the gametes



(A), (B) AFTER J. WALTON, "VOLTZIA" IN "MEM. PROC. MANCHESTER LIT. AND PHIL. SOC."; (C) FROM WIELAND, "THE CERRO CUADRADO PETRIFIED FOREST"; CARNEGIE INST. OF WASH. PUBL. 449

FIG. 6.—CONE SCALES: VOLTZIA LIEBEANA: (A) SIDE FACING CONE AXIS, WITH CENTRAL SEED AT SCAR; (B) OPPOSITE SIDE, SHOWING BRACT; (C) LONGITUDINAL SECTION OF CONE SCALE OF PROARAUCARIA, A FOSSIL ARAUCARIA FROM PATAGONIA



(A) AFTER E. STRASBURGER, "DIE CONIFEREN U. GNETACEEN"; (B) AFTER J. T. BUCHHOLZ, "BOTANICAL GAZETTE"; THE UNIVERSITY OF CHICAGO PRESS AND E. W. SINNOTT, "ANNALS OF BOTANY"; REPRODUCED BY PERMISSION OF CLARENDON PRESS; (C) AFTER J. T. BUCHHOLZ, "BOTANICAL GAZETTE," THE UNIVERSITY OF CHICAGO PRESS

FIG. 7.—OVULES OF PODOCARPUS TOTARRA AFTER FERTILIZATION, SHOWING DEVELOPMENT OF EMBRYO (*see* TEXT)

together. Entrance to the ovule is gained through the micropyle and accomplished by a pollination drop mechanism essentially like that in cycads. However, the droplet method of gaining entrance is not universal. For example, in *Larix* and *Pseudotsuga*, the lips of the integument become stigmatic on the inner surface and catch the pollen of the exposed surface spread apart at this time. In a few days the stigmatic lips roll inward to close the micropyle and this transfers the pollen to the inside. In *Saxegothaea* the nucellus enlarges and protrudes from the micropyle and the pollen then falls directly on its surface.

The greatest departure from the usual pollination mechanism is shown by *Araucaria*, which varies in the direction of angiosperms, for here the pollen falls on the ligule formed by the tip of the ovuliferous scale (*see* fig. 5) and germinates there, growing for a considerable distance before reaching the ovule.

However the details differ in the various genera, the pollen tube always approaches the egg by digesting its way through the nucellus.

After pollination the micropyle usually closes; the ovuliferous scales thicken slightly so that the entire cone is closed and remains shut until the seeds are matured. The ovules that were pollinated, along with the cones, enlarge fully before fertilization (*i.e.*, the fusion of gametes), but in the pine and several other genera, this growth does not begin until a year or two after pollination.

Although the distance traveled by the pollen tube is usually very short, the process requires several months even in the annual genera such as *Abies, Picea, Larix, Pseudotsuga, Keteleeria* and *Tsuga*, the Cupressaceae and most Taxodiaceae. Pines are bi-

ennial, requiring 14 to 15 months (in a few triennial species, 26 to 27 months) to complete pollen tube growth. *Araucaria* and *Sciadopitys* are also among the biennial types, while in *Cedrus* the period is five to six months, extending from fall till spring of the following year.

The internal anatomy of the ovule in *Pinus* is shown in the series of stages in fig. 8. Fig. 8(A) shows a section through the ovule at the time of pollination, with a spore at its centre and a few grains of pollen on the nucellus. The micropyle soon closes and the cone enlarges very little during the first season, during which the cones also remain small. Fig. 8(B) shows the winter condition in a pine with the female gametophyte enlarged slightly in a free-nuclear stage of development. The pollen grains have germinated but have not penetrated far into the nucellus. These structures begin to enlarge only in the year after pollination, when the cone grows rapidly and reaches its full size within a few months. The ovule of a cone that has not fully enlarged is shown in fig. 8(C), with two of the several archegonia fully developed and with several pollen tubes approaching them at about the time of fertilization. The archegonia are the female sex organs in each of which an egg is produced.

The pollen tube has a tube nucleus, a stalk and a body cell. Shortly before fertilization, the body cell divides to form two male nuclei, both of which may enter the egg, but only one of which unites with the egg nucleus in fertilization (fig. 3[H]).

The female gametophyte, like the male gametophyte, is a haploid generation: it contains half the number of chromosomes found in the sporophyte and originates from a spore produced by meiosis in the sporogenous tissue of the ovule. Of the four spores produced, only one survives to germinate and form the gametophyte;

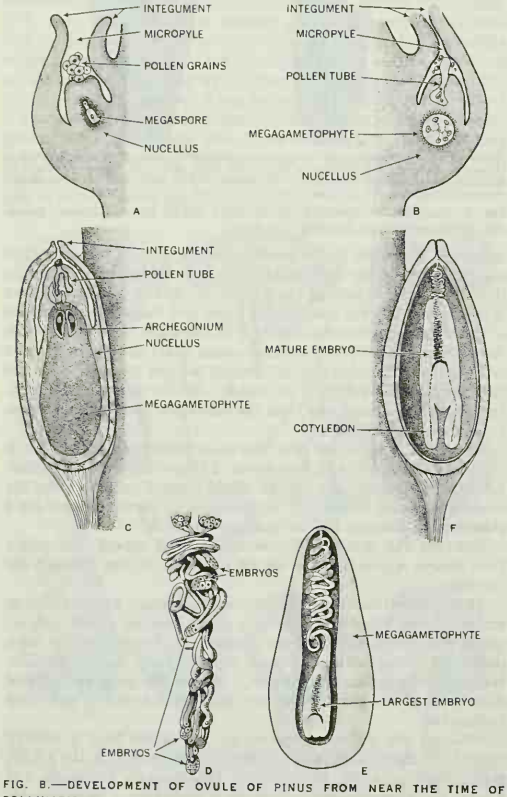
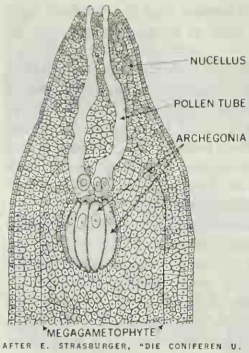


FIG. 8.—DEVELOPMENT OF OVULE OF PINUS FROM NEAR THE TIME OF POLLINATION TO MATURE EMBRYO (*see* TEXT)



AFTER E. STRASBURGER, "DIE CONIFEREN U. GNETACEEN"

FIG. 9.—UPPER PORTION OF OVULE OF BIOTA, SHOWING ARCHEGONIAL COMPLEX IN RELATION TO POLLEN TUBES JUST BEFORE FERTILIZATION

the other three abort and disappear. Germination of the spore is accomplished by nuclear division, but without cell wall formation. This free-nuclear stage, as it is called, is accompanied by great enlargement. It is surrounded by a spore membrane through which it is nourished. When cell walls finally begin to appear, they form between the nuclei, nearly all of which are situated peripherally. These cell walls extend from the periphery toward the centre and become closed when they meet from opposite sides. They are subdivided later into rows of cells.

The archegonia usually originate from certain cells of the gametophyte situated near the micropylar end of the ovule. In the Pinaceae the archegonia have necks composed of from four to eight cells, sometimes situated in several tiers, and a distinct jacket of nutritive cells surrounding the large egg. Between the egg and the neck of the archegonium a cell is produced which is called the ventral canal cell and which disappears by the time of fertilization. In the other families of Coniferales only ventral canal nuclei are formed, while some genera appear even to omit formation of the ventral canal nucleus. The Pinaceae are considered to be primitive in this respect, while the forms without the ventral canal nucleus are the most advanced; those with ventral canal nuclei are intermediate. In all cases the ventral canal cells or their nuclei are regarded as vestiges, relics of the fern type of archegonial formation, and they have no known function.

In Taxodiaceae, with the exception of *Sciadopitys*, and in all Cupressaceae, numerous archegonia are grouped into an archegonial complex (fig. 9). In this close grouping they are separated from one another by a single cell wall and the entire group may be surrounded by a common archegonial jacket. Thus it is possible for both male cells, from a single pollen tube to fertilize two adjacent eggs, two pollen tubes to fertilize four eggs, etc., a common occurrence in both Taxodiaceae and Cupressaceae.

In the *Sequoia* group of the Taxodiaceae and in the *Callitris* group of the Cupressaceae, the archegonia are situated laterally on the gametophyte (fig. 10). Here the pollen tubes fertilize eggs that are situated about halfway down the sides of the female gametophyte. While both of these groups, belonging to different families, have lateral archegonia, they are not necessarily closely related on other grounds and this resemblance may be the result of convergent evolution.

The male nuclei enter the archegonia by passing through a narrow opening between the neck cells. The union of the male nucleus with the egg nucleus has been observed in many species of conifers. In most instances the male nucleus is smaller than the egg nucleus, but the difference in size may be due only to the amount of nuclear sap present in the respective nuclei at the time of fertilization. Each contributes the same number of chromosomes to restore the diploid or sporophytic number of chromosomes in the zygote. The amount of chromatin is probably the same,

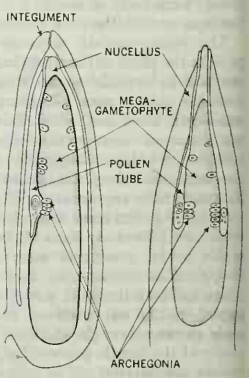


FIG. 10.—OVULES OF (LEFT) SEQUOIADENDRON AND (RIGHT) ACTINOSTROBUS AT TIME OF FERTILIZATION

for when a difference in size has been noted, the male nucleus usually stains more deeply. After the male nucleus contacts the female nucleus, they combine slowly and the nuclear membranes that separate them gradually disappear. The two components of the fusion nucleus may be recognized for some time; they have been observed to enter the prophase of the first mitotic division separately, as the resulting chromosome groups are sometimes recognizable in the metaphase of the first division.

Development (Embryogeny).—The type of embryogeny, or mode of formation of the embryo, is one of the most important features in serious study of the Coniferales. Unfortunately the processes which go on are complicated and unlike those in animals so that they are difficult to understand. It is necessary to describe them in some detail, however, in order to present a complete picture of the evolutionary relationships in this important group of plants. The embryogeny of conifers shows considerable diversity. Nevertheless, it appears to be almost constant within a particular genus. The only exception is the genus *Podocarpus*, but in this large taxon the same rule holds when applied to the subgenera or sections of the genus considered as units. The differences in embryogeny between the various genera occur principally in their early stages of development.

A common feature in seed development in gymnosperms is the production of more than one, or even many embryos at the beginning of seed development. This may come about in two ways: since there is more than one archegonium, and hence egg, several zygotes (fraternal twins) may begin development; or early in embryogeny, the zygote, called a proembryo at this stage, may split to form several embryos (identical twins). Usually both types of development occur at the same time, but of the many embryos formed only one survives to maturity in the mature seed.

Multiple embryo formation or polyembryony is universal among conifers. Simple polyembryony would be found possible in all genera with more than one archegonium to be fertilized. However, in addition to this, the zygotes of most conifers give rise to several embryos coming from each fertilized egg through cleavage polyembryony. The embryogenies of about 37 genera are known sufficiently to warrant the statement that cleavage polyembryony is found in a great majority of the conifers; it is found in some modified form in over half of the genera which have been examined.

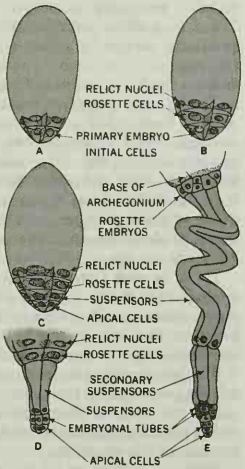


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FIG. 11.—DEVELOPMENT OF PROEMBRYO OF PINUS (*see* TEXT)

After fertilization the zygotic nucleus undergoes two successive divisions near the centre of the eggs in the Pinaceae which will be described as a typical form from which deviations may be mentioned later. These nuclei migrate to the lower part of the egg where they undergo another division before walls begin to form between them. The upper of the two tiers of cells which result and which have incomplete walls undergoes another division forming a new tier of cells. This tier is the rosette, and it has an open tier of incompletely walled cells above it, the relict nuclei of which soon disintegrate. The eight cells (fig. 11[A]) with complete walls arranged in two tiers are each the potential origin of a separate embryo in all genera of this family, with the exception of *Pseudotsuga* in which the four rosette-forming nuclei migrate and disintegrate in the upper end of the egg. Another division of cells in the lower tier forms a tier of suspensor cells between the lowest tier and the rosette tier. This is followed by the elongation of the suspensor tier, thus ending what has been called the prostage of the embryo.

Subsequent development is accomplished by a series of divisions of the cells giving rise to new cells in regular succession by division of the apical cells below. The new additions to the suspensor are called embryonal tubes which gradually build up a secondary suspensor as they in turn elongate. A prosuspensor, to be described for many of the conifers in other families, is not formed in the Pinaceae.

From these early stages onward, the different genera of Pinaceae vary somewhat. In *Pinus* and *Cedrus* a separate embryo is formed from each of the eight walled cells of fig. 11(B). In *Pinus* the four lower embryos become separated from one another much sooner than in *Cedrus* (fig. 11[E]). In *Tsuga* the lowest tier of cells forms four embryos as in *Pinus* and *Cedrus*, but the cells of the rosette tier, with the possible exception of *Tsuga mertensiana*, usually disintegrate without forming embryos. In *Keteleeria* the rosette tier forms rudimentary embryos of several cells. In *Pseudolarix* these cells usually remain undivided, but between the rosette and the apical tier, other embryo-forming units may originate in both of these genera.

In *Abies*, *Larix* and *Picea* the rosette cells usually collapse without further subdivision, while the rosette is not formed in *Pseudotsuga*. In all of these last four genera the lower embryonic cells appear to be combined into a single embryo, giving the appearance of simple polyembryony. However, J. M. Schopf has shown that in *Larix*, at least, and probably in some of the others where neither the suspensor cells nor the apical cells become separated from one another, the units represented by the four vertical rows of cells undergo an intense competitional growth during later stages of the embryogeny, until one of the apical cells finally overtops the others, with the result that only one of them gives rise to the tissue that enters into the meristem of the surviving embryo.

The last stages of development in the embryogeny of the Pinaceae are more uniform in all genera, but there are differences in the number of cotyledons. This number varies even within a species and is usually in excess of two. In *Pinus* and *Cedrus* there are usually 7 to 12 cotyledons, in *Picea*, *Abies*, *Larix* and *Pseudotsuga*, 5 to 7. Only in *Tsuga* and *Keteleeria* the number falls to four, three and two cotyledons.

In Araucariaceae a very different type of embryogeny is encountered. In the proembryo of *Agathis* and *Araucaria* at least 32 free nuclei are formed and these remain near the centre of the egg where they become organized into a small sphere of cells. A group of cells near the centre of this sphere gives rise to the embryonic meristem; those situated near the periphery on the side toward the neck of the archegonium elongate together to form a massive prosuspensor; and those situated on the side toward the lower end of the archegonium form a multicellular cap. The latter is protective and is cast off later when the suspensor structure has become greatly elongated and twisted. No cleavage polyembryony occurs, but several archegonia may be fertilized corresponding to the number of embryos present in the gametophyte. The surviving embryo of the seed has four cotyledons in some species of *Araucaria*, two in others and in *Agathis*.

In *Sciadopitys* the embryogeny follows a different pattern, resulting in an extreme example of cleavage polyembryony. The only thing in common with the Araucariaceae is the fact that there are 32 free nuclei formed in the proembryo before walls appear between them, but these are all situated in the lower end of the egg. They become organized into three or four tiers or regions, with the lowest group composed of 12 to 18 or more embryonic cells somewhat irregularly arranged. Above this is a tier of seven to nine cells which elongate forming a prosuspensor. Above the prosuspensor there may be a layer of rosette cells or this may be represented only by a few cells or entirely absent, with a layer of relict nuclei that disappear at the top. The terminal or lower group of embryonic cells is each a separate embryo initial that develops only after the prosuspensor has become long and twisted (*see* fig. 12). Each of these cells divides to form two cells, an apical embryonic cell and a primary suspensor cell, though the embryonic cell may divide again before the latter

elongates. Elongation of the primary suspensors pushes the individual units deep into the gametophyte, where, after a period of intense competition, one or a few of them survive the later stages. Usually only a single one remains to mature as the embryo of the seed in the final stage.

Rosette cells may give rise to embryos in the region above the prosuspensor so that the number of embryos coming from a single zygote may exceed two dozen; this potential number is doubled or trebled if the eggs in two or three separate archegonia are fertilized. The matured embryo only has two cotyledons.

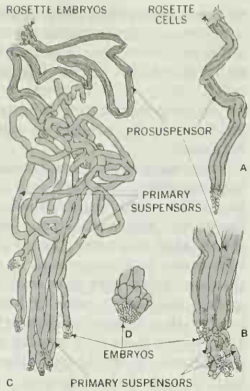

FIG. 12.—EMBRYOGENY OF SCIADOPITYS (*see* TEXT)

The other Taxodiaceae differ somewhat from *Sciadopitys*. In *Cunninghamia*, *Taiwania*, *Cryptomeria* and *Taxodium* there are eight free nuclei when walls are formed in the proembryo. Usually there is no group of rosette cells and there are fewer cells in the prosuspensor and fewer embryonic cells. The single-celled primary suspensor is omitted from the individual embryos, but in its stead a massive group of several embryonal tubes elongate as a massive secondary suspensor. The mature embryo has two cotyledons in *Cunninghamia* and *Taiwania*, three in *Cryptomeria* and four to six in *Taxodium*.

The *Sequoia* group within the Taxodiaceae have embryogenies that differ from each other markedly. Both of these genera have archegonia situated laterally on the gametophyte. They are small, numerous and grouped together (*see* fig. 10). The embryogeny of *Sequoiadendron* would correspond closely with that of *Sciadopitys* except that the proembryo forms only eight free nuclei before walls are formed between them, and the prosuspensor is a much weaker and more ephemeral member. Cleavage polyembryony results in a smaller number of embryos, even when the rosette embryos are included. The mature embryo usually has four cotyledons. In *Sequoia* on the other hand, the first division of the zygote is followed by the formation of a cell wall between the nuclei, another division results in a four-celled proembryo from which no prosuspensor is formed, but usually four individual embryos borne on primary suspensors emerge. The mature embryo of the seed has two cotyledons in the majority of cases. While there appear to be marked differences in the embryogenies found within Taxodiaceae, it is possible to relate them all to each other and back to a prototype that would not differ greatly from that of *Sciadopitys*.

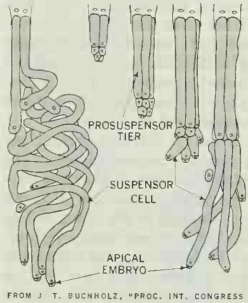

FIG. 13.—EMBRYOGENY OF A SINGLE ZYGOTE OF BIOTA (*see* TEXT)

Cupressaceae show four types of embryogeny. One of these, found in *Cupressus*, *Chamaecyparis*, *Biota* and *Libocedrus*, is illustrated in fig. 13 for a single zygote. Usually there are two or multiples of two zygotes, since all these forms have the archegonia grouped into a complex so that two neighbouring eggs may be fertilized by the two male cells in a single pollen tube (*see* fig. 9). There are no rosette cells; usually four cells make up the prosuspensor, with four or more cells arranged tetragonally below, each giving rise to an embryo borne on a primary suspensor. Several species of *Cupressus* have three to four cotyledons, other species two cotyledons, the number found in the other three genera.

Thuja has an embryogeny which follows a development very similar to that of the above genera up to the stage shown in fig. 13(A). However, there is no cleavage in the embryo, the parts hold together as a single unit so that only one embryo is produced from each zygote.

In the group of genera represented by *Actinostrobus*, *Callitris* and *Widdringtonia* the archegonial groups are situated laterally on the female gametophyte and are very small and numerous (*see* fig. 10). The proembryo forms walls after the second division of the zygote and there are about four embryo initial cells plus a few inactive cells in each archegonial unit. There is no prosuspensor. The four individual embryos coming from each zygote develop independently on the ends of the primary suspensors followed by secondary suspensors; in the matured seed the embryos are dicotyledonous.

A fourth type of embryogeny in this family is found in *Juniperus*. The early stages agree with the embryogeny of *Biota* up to the stage shown in fig. 13(A), with the tier of prosuspensor cells elongating much more, followed by an elongation of the lowest tier of embryonic cells. The cells of the lowest tier cut off small cells at their tips after elongation, and may repeat this process several times, with some of the cells dropping out at each step. Finally an embryonic initial cell is formed from which an embryo develops in the usual fashion.

In the Cupressaceae there is nearly always cleavage polyembryony, *Thuja* being the exceptional genus, with *Thujopsis* somewhat intermediate, for in it cleavage polyembryony is greatly restricted.

Podocarpaceae have a variety of types of embryogeny which correspond more or less to the different genera and to the major subdivisions of the genus *Podocarpus*. Some species have 32 free nuclei formed in the proembryo before walls are formed, the majority of species of *Podocarpus* and other genera in the family have 16 free nuclei, and several species are known in which only 8 free nuclei occur at this time. All of them have prosuspensors which have from 3 or 4 to 20 or more cells that elongate, none of them have primary suspensors (single-celled suspensors), but form a massive secondary suspensor which follows the prosuspensor. There are definite embryo initial cells organized in the proembryo and these are usually binucleate through a considerable period of this stage of the embryo. The forms with 32 free nuclei in the proembryo and with numerous binucleate embryonic cells (considered to be the most primitive types) have cleavage polyembryony in reduced form, while a number of species in different groups have attained simple polyembryony. The latter include *Phyllocladus* in spite of numerous binucleate cells, and *Podocarpus totara*, *P. nivalis*, *P. hallii* and others, in which only a single binucleate cell is borne at the end of the prosuspensor (*see* fig. 7[B] and [C]). Many of the embryogenies in this family are known only in a few stages of development. The embryos have two cotyledons when the seeds are ripe.

It can be seen from the above discussion of embryogeny in the conifers that there is indeed a wide variety of types of development, some complicated and bizarre. It should also be clear, however, that information of this sort can aid materially in the understanding of interrelationships in the conifers.

The less obvious features of development, together with the details of gametophyte formation, often are more important than the superficial external characteristics of the sporophyte in deciding which genera are primitive and which advanced or in building up systems of classification.

With the production of the embryo—the new individual of the sporophytic generation—the life history of the conifer has come full cycle and the process begins again when this individual undergoes meiosis to produce the spores giving rise to a new generation of gametophytes.

See GYMNOSPERMS and separate articles on specific conifers. *See* also references under "Conifers" in the Index volume.

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CONINGHAM, SIR ARTHUR (1895–1948), British air marshal, was born Jan. 19, 1895, in Brisbane, Austr. After studying at Wellington and Victoria colleges in New Zealand, he joined the New Zealand army in 1914, serving in the infantry and later in the cavalry in Samoa and Egypt (1914–16). Although dysentery and typhoid fever forced him out of the dominion army in 1916, he joined the royal flying corps later the same year and served throughout the remainder of the war.

Shot down twice in action and once wounded, he was awarded the distinguished flying cross and given a permanent commission in the Royal Air Force in 1919. After World War I Coningham remained with the R.A.F. as a flight lieutenant and saw duty in Iraq as a squadron leader. In 1925 he was awarded the air force cross for leading a 5,600-mi. contest flight from Cairo to Nigeria which opened a trans-African route used in World War II to supply aircraft to the middle east, the U.S.S.R. and India. Later he served as an instructor in England at the R.A.F. college and Central Flying school and as air commander of a bomber group in England until 1941.

Appointed air vice-marshal in 1941, he commanded the R.A.F. and gave support to the British 8th army during the Allied offensives in Libya (1940–1942). In 1943 he participated in the Allied drive in Tunisia.

He commanded the 1st tactical air force of the R.A.F. in the Mediterranean (1943–44), and on Jan. 25, 1944, was selected as commander of the 2nd tactical air force of British and U.S. units which took part in the Normandy invasion. In that campaign he successfully carried out his doctrine of concerted use of air power and land power.

After 1945 Coningham was commander in chief of the Flying Training command of the R.A.F. (he was made air marshal in 1946) until his retirement in 1947. In 1942 he was created a knight commander of the Order of the Bath and in 1946 a knight commander of the Order of the British Empire. He died at sea on Jan. 30, 1948, in an air crash on a flight from the Azores to Bermuda.

CONINXLOO, GILLIS VAN (1544–1607), Flemish landscape painter, whose work represents the gradual transition from the fantastic conception of landscape of the 16th century as seen in the early work of Paul Brill to the realistic representation of the 17th. He was born Jan. 24, 1544, probably at Antwerp, and studied under Lenaert Kroes and Gillis Mostaert. After a period of travel in France he returned to Antwerp in 1570 and was made a member of the guild of painters. He had to leave his home again in 1585 to escape from religious persecution, and stayed at Frankenthal in Germany until 1595 when he settled in Amsterdam. He was buried in Amsterdam Jan. 4, 1607.

The development of Coninxloo's style is often described in three periods which somewhat correspond with his residence in Antwerp (1570–88), Frankenthal (1588–95) and Amsterdam (1595–1606). The transition is characterized by the gradual replacement of the deliberately composed landscape fantasies of his early period with his later, more naturalistic works in which the colour is blended into a harmonious atmospheric tone.

CONJUNCTION, a general term signifying the act or state of being joined together. It is used technically in astronomy and grammar. In astronomy two bodies are said to be in conjunction in right ascension, or longitude, when they have the same right ascension or longitude. The conjunction of Mercury or Venus with the sun is "superior" when the planet lies beyond the sun and "inferior" when the planet is between the earth and the sun. For use of the term in grammar, *see* GRAMMAR.

CONJUNCTIVITIS is inflammation of the conjunctiva, the thin mucous membrane lining the eyelids and extending over the globe to the limbus of the cornea. Like the mucous membrane of the nose, the conjunctiva is subject to inflammations produced by chemical irritants (*e.g.*, smog), allergy (*e.g.*, hay fever), bacteria, viruses and, occasionally, fungi and rickettsiae. Most inflammations of the conjunctiva are exogenous, but a few are endogenous by way of the blood stream. Conjunctivitis varies in severity from mild irritation (*e.g.*, chronic catarrhal conjunctivitis) to severe, incapacitating forms (*e.g.*, trachoma, ocular pemphigus, gonorrheal ophthalmia), which are accompanied by corneal inflammation and lead to scarring and visual loss. *See* also EYE, HUMAN: *Diseases of the Eye*. (P. T.)

CONJURING, the art of entertaining by pretended performance of those things which cannot be done. The conjurer is an actor who, to perform his feats, combines psychology with manual dexterity, frequently with mechanical apparatus. The two most common terms for the art, conjuring and magic, had in their earlier meanings association with devils, spirits and unholy powers. (*See* WITCHCRAFT.)

In the 20th century a more enlightened public, while recognizing intellectually that these apparently supernatural effects are, in reality, achieved by natural means, is, nevertheless, still dominated emotionally to some extent by the superstitions and fears of the unknown common in the past. The audience is, in short, usually willing to indulge in the prime requisite for the enjoyment of any form of theatrical entertainment—a "suspension of disbelief." It is an important part of the skill of the conjurer to nurture, through an adroit use of audience psychology, this predisposition to be fooled and amazed. This could be called showmanship.

Conjuring does not depend upon the quickness of the hand deceiving the eye. The newer terms, legerdemain, prestidigitation, sleight of hand, used to identify the art are questionable, since they suggest rapidity of movement and absence of equipment. Only in a minority of feats does the magician attempt to deceive the eye. He designs his tricks primarily to fool the minds of his audience, and to achieve this deception he usually depends upon apparatus and the use of natural physical and chemical phenomena. The magician so presents his work that the mind of the observer will take no notice of a great many things which his eyes can see. This focusing of attention of the audience on some actions so that others will be disregarded is called, by magicians, misdirection, a term of doubtful accuracy, since the conjurer directs attention toward one action rather than away from another.

A magician's manual operations, though not performed rapidly, require great deftness of touch and complete certainty of action. Independent use of the fingers and other unusual hand and arm movements are used in many tricks with the added handicap of each having to appear to be entirely normal. The magician's dexterity, unlike the musician's, is similar to the surgeon's in the type of deftness. Unlike the surgeon, the magician also must keep in mind the appearance of his movements. The magician is like the musician only in that he must have precision of time and exactness of rhythm.

Apparatus is of three types: (1) equipment which is exactly as it appears to the audience; (2) equipment which, secretly, has been prepared to aid the performance of the trick without altering its appearance; (3) equipment which is hidden from sight and used without the knowledge of the audience. Among those feats dependent upon apparatus some require but one type, while others need a combination of two, or even all three forms.

While tricks vary greatly, about 80% of the success of a conjurer's performance depends upon the use of psychology, 10% upon skilled manipulation and 10% upon the use of equipment. What makes an exhibition of mysteries effective is the agreeable personality of the conjurer and the timing, naturalness and smoothness of his performance.

A performance of the impossible is not only an intriguing show, but one which can be understood and enjoyed by all types of people of every country. Magic is an art of the theatre which is completely international. Most of the old and basic feats in magic are performed by the magicians of all nations, and, while slight variations exist in performance or equipment, the underlying principles are identical. It is unlikely that these basic tricks were taken from one land to another, but, rather, that they were developed locally, and the methods were alike because each nationality adopted the most simple means of performance. As magicians advanced through the ages, different

and more elaborate feats of magic were devised in various countries. In the 19th century, magicians of the world began interchanging their mysteries so that more and more oriental feats came into the programs of occidental performers, and eastern conjurers augmented their shows with the tricks of their western colleagues.

Early History.—Many scholars have written of the methods for the tricks shown in ancient times by the pagan priests of Egypt, Greece and Rome. It is known that optical illusions were used, apparently to bring forth divinities; that tubing was used to carry the voices of hidden humans, thus giving the effect of speaking idols; and that a variety of mechanical contrivances were used to produce weird occurrences before the altars. However, it is most unlikely that conjurers of the period, in any country, had such close association with the priests as to be told the methods of the temple illusions. It is also doubtful whether the conjurers even knew of the existence of the priestly magic. At any rate, the feats of the ancient conjurers were quite different. The conjurers were able to perform their mysteries anywhere, while, because of the required equipment and preparation, the pagan priests could show their magic only in the temples. Some of the conjurers, however, did turn to their own advantage the superstitious awe in which many held their work.

By the time people were civilized enough to record history, they described the performances of conjurers. These ancient notes are sketchy, but enough is told to know that conjurers' feats were much like those of later periods about which there are more complete reports.

Throughout the entire world, the more skilful of the early conjurers were entertainers at the courts of the rulers, and those of lesser skill performed in the market places for the people or at the feasts of the wealthy. Their feats were very much alike and quite limited in number. The principal trick, which, known as the "Cups and Balls," still is popular, was one in which three inverted cups and a ball were used. The ball mysteriously would jump about invisibly from cup to cup, then multiply into three balls with each seemingly having the ability of undiscernible locomotion. The basis for this mystery is a secret additional ball which, by skilled manipulation, is put under one cup while the known ball is removed, as secretly, from another cup. The manipulative work in this trick, as in most, is aided by the distracting conversation of the conjurer. Because the trick was in the program of every early conjurer, and always a favourite with audiences, magicians received more recognition for the performance of the Cups and Balls than for all their other feats.

The ancient Greek term for conjurer was *Psephopaiktes*, and one of the old Roman words was *Calcularius*. Both meant "he who deals with pebbles." In different countries pebbles, or other small objects, were used for the trick instead of balls. The shape and type of cup used also varied. Another Roman word for conjurer, *Acetabularius*, meant, "he who deals with vinegar cups." Descendants of the Roman conjurers used the cylindrical boxwood measures, instead of vinegar cups, and a popular old Italian term for magic was *giuoco di bussolotti*, "the game with the measures." Similarly in France, a conjurer was called *joüeür de goubelets*. A usual adjunct of equipment for the Cups and Balls was a bag, with strings, tied around the waist of the conjurer, like an apron. It was not only a serviceable way to carry the properties of the trick, but was a handy place for the conjurer secretly to acquire or dispose of the balls. Throughout Europe the conjurer's pocket apron was the badge of the profession, and *Taschenspieler*, "pocket player," became the common term for magician in German.

The Cups and Balls is one of the basic tricks of magic, and Egyptian, East Indian, Chinese and other eastern magicians performed the feat exactly as did the Europeans, except, because of the differences in clothing, the pocket apron was never needed by oriental magicians. Other universal tricks of the early conjurers were the restoration of a piece of string which had been severed, and apparently thrusting knives into the body. The first was accomplished by failing to cut the string in the manner suggested, and the second by substituting special, harmless knives for the real ones offered for inspection. Other generally used magic was performed with borrowed rings and coins. Any trick done with a borrowed object always has been doubly interesting.

The medieval magicians traveled more than had their predecessors, and, as itinerant mountebank performers, even toured countries other than their own. Their equipment was limited to what could be carried on their backs, and, while the old tricks still were used, the performances were augmented with feats done with borrowed fruit, vegetables and small fowl, as well as with men's hats and women's kerchiefs. With the advent of the printed playing cards, a whole new field of magic was opened, as an infinite number of tricks could be done with cards, and a deck could be carried easily.

More and more, the magicians in their travels followed a regular itinerary and built a following for their annual appearances. Many cities had a "street of the conjurers" where performances could be seen daily. Some magicians were able to give more impressive shows by having extra equipment carried on a donkey or horse, while others joined with entertainers of various other types, ballad singers, storytellers, acrobats and musicians, to give more elaborate performances. These larger shows were given in rented barns or storehouses, and for more people than could see a street or market-place exhibition. The increased remuneration was the magician's greatest interest in the size of his audience.

At least the majority of the feats of the conjurers of olden times were recorded. The first book to describe the secrets of sleight of hand and magic equipment was the *Discoverie of Witchcraft* (1584), and it was written by Reginald Scot, who was not a magician, for the sole purpose of convincing the public that sorcery had no part in such performances. The first book devoted solely to the subject, *The Art of Jugling, or Legerdemain* (1614), by S.R. (probably Samuel Rid), and the anonymous later volume *Hocus Pocus Junior* (1634) both gave clearer descriptions of the methods employed in the art. It is likely both volumes were unsigned because their authors feared those who still believed that magicians had contact with devils. Scot's book was burned by the common executioner because of such beliefs. Juggler (from the Latin *joculator*) was an early term for conjurer as was Hocus Pocus, used, with other pretended magic words, by performers throughout Europe. These books showed that magicians were learning more about mechanics and knew how to construct boxes with false bottoms and how to make a keg out of which several liquors could be drawn from the one spigot. A number of books describing the same tricks, written by other magicians, appeared in Europe during the 17th century, though *Engaños a Ojos Vistas* (1733), by Pablo Minguet e Yrol, was the only volume to stress the use of the pocket apron. By the time the more advanced and literate conjurers began to write about their work, they not only had discovered better hiding places for the balls but realized that the success of a trick depended more upon the acting ability and manner of the performer than on any piece of equipment.

Beginning of Stage Performances.—In the 18th century, many more books on magic appeared, but the only advance recorded of the art was the use of magical automata and apparent transference of thought from a magician to his assistant. The latter was first shown (1781) by Philip Breslaw (1726–1803) and later (1783) by Guiseppe Pinetti de Wildalle (1750–1800). Occasionally, magicians exhibited true automata (*i.e.*, motivated entirely by mechanics), though usually their figures were pseudo-mechanical masks for the tricks performed. While such automata as a doll which would play on a flute any tune requested or a toy bird which would blow out the flame of one candle and light another by a further gust were tricks, not mechanics, they added interest and variety to the performances. Real automaton figures were publicly exhibited, usually by the mechanics who made them, and were interesting to the public because of their ingenuity of construction. Magical automata did what was impossible for the mechanical kind.

The great increase in equipment made necessary semipermanent quarters, with stages better suited to display the tricks, so conjurers rented stores and halls and made them into small theatres. The portability of equipment no longer being the first consideration, magicians started using large and completely draped tables with trap doors operated by hidden assistants. An object placed on such a table and momentarily covered from the sight of the audience could be caused to disappear or to become totally different by the mere command of the magician, plus the work of the hidden assistant. Because of the quantities of apparatus, magicians avowed supermechanical knowledge and based their wonders on a scientific claim rather than the magic words previously used.

The public did not object, for people were becoming conscious of the remarkable possibilities of mechanics and were losing interest in the pretense of magic spells. Professor as a title for magician, invariably self-bestowed, became generally accepted. Many traveling conjurers also were using more equipment which was transported in special wagons. The rear of such a wagon would open to form a stage; the front would make the living quarters. In short, the wagon was both a home and a stage on wheels.

Of course, some magicians continued to perform in market places, at fairs and in barns and taverns, but changes were occurring in magic. Notable conjurers of this period were: Isaac Fawkes (1675?–1731), Christopher Pinchbeck (1670–1732), Jacob Meyer (1735–90), who was known as Philadelphia, Kalterfelto (1730?–99), Flockton (1740?–94) and Lane, about whom there is little personal data.

Possibly greater public interest in magicians and their work than previously had been given was accorded performers of the 18th century because they advertised themselves in newspapers and further attracted personal attention by wearing striking costumes at all times. Though certain conjurers added ventriloquism, juggling, sword swallowing or even fire eating and other "heat-resistant" feats to their magic exhibitions, such demonstrations were no more a part of conjuring than was medicine because some conjurers sold curatives in connection with their shows.

Once magicians had theatres to play in, and could use quantities of equipment, their shows became extremely elaborate and, in the early 19th century, stages were filled with apparatus frequently claimed to be constructed of solid silver. Only a part of the equipment was employed in any one performance, and some of the most ornate pieces had no use other than to add to the number of articles displayed. The printed programs carried long lists of the names of tricks possessed by the magician from which a selection was supposedly made for each entertainment. While many of the tricks were performed by all the magicians, new program names for the tricks were devised by each one. The elaborate paraphernalia-decked stages and the costly and fanciful costumes assumed by the magicians lent a grandeur to the performances that earlier shows had lacked. The greatest conjurers of this type were: Bartolomeo Bosco (1790–1863), Ludwig Leopold Döbler (1801–64), Philippe (Jacques Noel Talon, 1802–78) and Alexander (Johann Frederick Alexander Heimburger, 1819–1909). All were great travelers who gave their shows in many countries.

One of the last of these great ornamental conjurers was Dunkell (Henri Robin, 1805–74), a native of the Netherlands, who pretended to be French. He claimed to be the inventor and was, at least, the first to show (1847) the illusion later known as "Pepper's Ghost." It was based on an optical principle Baptista Porta, the Italian philosopher, had described in effect 300 years earlier (*Magia Naturalis*, 1588), by which, on an inclined plate glass, a transparent reflection, or ghost, could be made of a person hidden to the audience. The ghostly effect was enhanced because the spectre, on the unseen glass, seemed to walk about among living people. These actors were behind the glass and had rehearsed their parts carefully so that their actions coincided with those of the actor, who, in a different part of the theatre, was the original of the ghost. The illusion depended largely upon the arrangement of the lights, which could be controlled to give any amount of substantiability to the ghost or cause it to disappear altogether.

For the few years until the public learned of the method employed, the ghost illusion had great popularity. Its importance to the history of conjuring is that it was the first of the tricks utilizing glass. Later conjurers made full use of sheet glass, both plain and silvered, in designing magical illusions. Spectres, having little or no action and lacking the ability to mingle with humans, had been produced earlier by means of magic lanterns. This method to produce ghosts had been mentioned, in a vague way, by writers long before the magic lantern's accredited invention by Athanasius Kircher in the 17th century. While such lanterns probably had long been used by charlatans to bring forth ghosts and demons, there is no evidence of their use for entertainment by conjurers until 1784 in a show produced by Robertson (Etienne Gaspard Robert, 1763–1837), a Belgian optician and magician, even though they had been described most inadequately since 1727 in books on magic.

Beginning of Modern Magic.—In contrast to the elaborately equipped, fantastically dressed school of conjurers, another group went to the opposite extreme. Actually Conus (sometimes called Comus, and whose real name was Cotte; d. 1836) was the forerunner of the advocates of simplicity of performance, though Wiljalba Frikell (1818–1903) was the real leader. Frikell was the first magician to appear in conventional evening clothes. His magic depended almost entirely upon his personal skill, and he eschewed most of the usual equipment. He wrote (*Lessons in Magic*, 1858) that "the use of complicated and cumbrous apparatus diminishes the amount of astonishment conjurers are enabled to produce which is a defect not compensated by the external splendor and imposing effect of such paraphernalia." Johann Nepomuk Hofzinser (1806–75), an Austrian, who appeared only in his own country, was among the other conjurers to eliminate displays of apparatus from their shows. These simplified exhibitions required new tricks, and Hofzinser devised many varied feats of magic and was the most prolific inventor of card tricks. Although comparatively few magicians went to the extreme of Frikell and Hofzinser, their work had an enormous effect on the shows of all later conjurers.

John Henry Anderson (1812–74), a Scot, who called himself the Great Wizard of the North, while considerably influenced by advocates of simplification in later life, was in another field a leader of magicians. Anderson was the first great advertiser and, by example, showed that tremendous public interest could be invoked in exhibitions of magic, particularly when the interest first was directed toward the performer himself. The people showed their countenance of Anderson and his magic by paid attendance at his shows.

Robert-Houdin (Jean Eugene Robert, 1805–71), a Frenchman, made so many improvements in magic equipment and so carefully and systematically classified all that was known about presentation that he is called the father of modern conjuring. While he claimed to have originated almost all the tricks he performed, as well as the innovations in performance, actually his work was based largely on the best ideas of his predecessors. Robert-Houdin followed Frikell in adopting gentlemen's attire, and though he did not do away with apparatus, he did, in the main, use what appeared to be common and familiar objects. He modernized the mechanical marvels originated by Pinchbeck and others and improved the table mechanisms which Pinetti had devised, to eliminate the necessity for draped tables with hidden assistants. Pinetti had used tables with tops which, while no thicker than normal tables, concealed levers with cords running to off-stage assistants by which to operate mechanical tricks placed on the tables.

Robert-Houdin ran electric wires to his tables which operated electromagnets instead of levers, as well as cords, motivating pistons. He was the first, and one of the very few magicians, ever to utilize electromagnetism, though Döbler previously had used electricity in his feat of causing 200 candles to light simultaneously upon the firing of a pistol, and Philip Breslaw had used a common magnet to control the activities, on the surface of water

in a bowl, of "The Learned Swan," a wooden figure with an iron core.

In 1849 Robert-Houdin made a sensation with his floating boy. It was a marked improvement on a mysterious suspension which, in 1826, Ling Lau Lauro had been the first to show in the occident, although there are records of its having been shown several years earlier in Madras, India, and possibly was of Indian invention. In the original effect, a person sat cross-legged, several feet in the air, upon nothing. The fingers of the floating man's one outstretched arm lightly touched a perpendicular bamboo rod set upon a stool or platform raised above the stage. The secret was that inside the bamboo pole, affixed to the platform, ran an iron bar bent at the top at right angles and to which was attached a metal support to uphold the body. The body support, and such of the iron outside the bamboo pole, was covered by the sleeve and clothing of the subject, and, necessarily, screens or curtains had to mask the preparation for suspension. Robert-Houdin made a metal body rest which could be worn inside the subject's clothing and had a mechanical method by which the support and the pole could be connected, in full sight of the audience, to allow the boy to lie horizontally in the air. He added to the presentation by giving an acceptable, though false, reason for the suspension. It was claimed to be the effects of ether, which had the property of making a body totally devoid of weight. Ether was then a new discovery, and its real qualities were known only to a few scientists. Robert-Houdin also materially improved the signaling method for apparent "thought transference," which had been a feature of Pinetti and others. Many of Robert-Houdin's "inventions" may be shown to be of earlier origin, but he brought each to a point of perfection undreamed of by the originators. Robert-Houdin influenced a number of magicians, including Anderson, and was copied slavishly by Robert Heller (William Henry Palmer, 1830–78) and others. Heller, an Englishman, even went to the length of dyeing his hair and assuming a French accent in his attempt to be like the other man. Heller's success waited upon resumption of his own personality, his brilliantly witty style of performance, and in following Robert-Houdin only in ideas. Georges Meliès (1861–1938), who had been a student of Robert-Houdin and was later the proprietor of the Théâtre Robert-Houdin in Paris, became interested at the end of the 19th century in the newly invented motion-picture camera and its possibilities as a vehicle for conjuring. The Meliès magic films, if viewed by an audience sophisticated in the modern techniques of motion-picture photography, would seem obviously deceptive, but they were sensations in 1900. In his attempts to mystify the viewers of his films, Meliès evolved such currently accepted camera practices as the fade-out, the lap dissolve and the double exposure.

Robert-Houdin led also in writing professional books on magic. Prior to his works there had been but one real manual on the subject, *La Sorcellerie Ancienne et Moderne Expliquée, ou Cours Complet de Prestidigitation* (1853), by Jean Nickolas Ponsin (1777–1853), a French amateur. All the earlier publications, including Henri Decremps (1746–1826?), *La Magie Blanche Dévoilée* (1784) and later works, while tremendously interesting as historical records, merely exposed, with little detail, the methods by which tricks were done and contained nothing on how to learn to do them. While Ponsin actually described how to do tricks, Robert-Houdin, possibly because of his greater knowledge of the subject, gave an understanding of the underlying art of magic, as well as superb lessons, in *Les Secrets de la Prestidigitation et de la Magie* (1868). Robert-Houdin's other books also are excellent, and all have been translated into several languages. Following Robert-Houdin, hundreds of other magicians have contributed, in many languages, to the literature of the subject. A large proportion of the books on the art are privately circulated professional publications.

Two of the best-known conjurers were Compars (Carl) Herrmann (1816–87) and his younger brother Alexander (1843–96), known as Herrmann the Great. They used comparatively little equipment and were most skilled manipulators, though, in later life, Alexander performed a number of large illusions which had come into vogue. Other prominent performers of the period were: Signor Antonio Blitz (1810–77), Joseph Michael Hartz (1836–1903), Louis Haselmayer (1839–85), Baron Hartwig Seeman (1833–86), Le Commander Bernard Marius Cazeneuve (1839–1913), The Fakir of Oolu (Alfred Sylvester, 1831–86), Dr. Lynn (Hugh Simmons, 1838?–96) and Colonel Stodare (John English, 1831–66). Through their constant travels they gathered the magic of the entire world and added it to their shows, and all invented some magic. The Fakir of Oolu devised an improvement on the suspension, which permitted the floating person to be shown in several changes of position and permitted also the final removal of the supporting rod. The rod was removed only in a dim light and was accomplished by having a shell stick which could be taken off the iron rod. The iron rod was covered with dull material matching the back curtain and became invisible in dim light.

Hartz and Stodare invented many small tricks which remain popular. Stodare, with an illusion the "Sphinx," invented by Thomas William Tobin of the Polytechnic institution, was the first magician to make use of mirrors to hide objects. The effect of the illusion was that a live (though bodiless) head of a man rested on a light three-legged table in the centre of the stage. The secret was that between the legs of the table were mirrors set at the proper angles to reflect the sides of the stage which had hangings identical with those behind the table. The spectators apparently would be able to see the back curtain through the legs of the table, though actually they saw the reflections of the side curtains. The mirrors were invisible because the edges were masked by the table legs. Behind the mirrors was ample space for the body of the man who, through a hole in the table top, exhibited his "detached" head.

Modern Magic.—John Nevil Maskelyne (1839–1917) played an enormous part in the advancement of magic. He invented a number of magical effects; he founded a theatre of magic in London, which he, his sons and grandsons ran for over 50 years; he encouraged, engaged in and advised with the inventions of scores of other magicians. He originated (1865) the feat of escape from a box which was locked and roped after he had entered. He caused a levitated person to rise and fall in the air (1875), and was the first to eliminate all visible means of support. His son Nevil Maskelyne (1863–1924) added the use of a large solid hoop to pass over the floating lady, a convincing way of showing an absence of support. Again, in "Cleopatra's Needle" (1875), Maskelyne was the first to use the counterweight principle to make a heavy object void of weight. In this illusion, an obelisk-shaped box was carried about the stage as if it were extremely light, though two persons, who later appeared, were hidden inside all the time. Maskelyne also constructed the two best magical automaton figures: "Psycho" (1875) was a card player and calculator built on an idea of John Algernon Clarke, and "Zoe" (1877) was a portrait artist who drew likenesses of various celebrities.

For many years, Maskelyne had George A. Cooke as a business associate, and the names of Maskelyne and Cooke became synonymous with conjuring. After Cooke's death (1904), Maskelyne took David Devant (David Wighton, 1868–1941) into a partnership, which lasted until 1915. Devant, the greatest of English conjurers, was prolific with new ideas in magic. Buatier De Kolta (Joseph Buatier, 1845–1903), who appeared in many of Maskelyne's shows, invented some of the most striking magic ever performed. His "Vanishing Lady" (1886) and the "Flying Bird Cage" (1873) were the best of his many inventions. Both depended more upon the manner of performance than on the secret equipment used. De Kolta also improved "Black Art," or "Modern Black Magic," a series of effects first shown by Max Auzinger (1839–1928), who usually performed under the name of Ben-Ali-Bey. Black art is based on the optical principle that, with proper lighting conditions, both shadow and form can be eliminated, and objects will seem to be invisible when covered with light-absorbing material (usually black, hence the name), identical with the background. Using this principle, anything can be caused to disappear upon being covered with cloth, or be made to appear by reversing the operation. Assistants, handling the covers, were themselves

"invisible" because of the material of their completely enveloping costumes.

Harry Kellar (1849–1922), the first great American-born magician, made many refinements in magic and performed superbly the large as well as the small tricks. Beginning with the final decade of the 19th century, American magicians were the first to specialize in their magic. Among these specialists were: Howard Thurston (1869–1936), who originally performed only with cards; Thomas Nelson Downs (1867–1938), who did magic only with coins; and Harry Houdini (*q.v.*), who exhibited feats of extrication from ropes, handcuffs and shackles. These conjurers had, of necessity, to originate a large proportion of their tricks and, particularly in modes of manipulation, added materially to methods in magic. Thurston later took over the Kellar show, and Houdini also added diverse magic to his performances. Other specialists were Horace Goldin (1873–1939), who featured large effects shown with extreme rapidity, and Nate Leipzig (1837–1939), who did only small tricks requiring great dexterity. Goldin invented many famous illusions, among which was "Sawing a Woman in Half" with a motor-driven circular saw.

Magicians strive constantly to add new material to their shows, but not all possess inventive abilities. Some of those who devise the best magic are not good showmen, and the public will remember the tricks of a great performer rather than the original magic of one less skilled in presentation. For example, the performances of the Great Lafayette (Siegmund Neuberger, 1872–1911) or those of Chung Ling Soo (William Ellsworth Campbell, 1861–1918), who styled his stage name after the great Chinese magician Ching Ling Foo (Chee Ling Qua, 1854–1918), advanced magic and the professional status of magicians more than did the inventions of Selbit (Percy Tibbles; d. 1938), one of the most original magicians. The successful magician's showmanship is based on his ability to play a role and whether he appears to be a "professor," a "sorcerer" or a "charming young man" his effective performance will play a larger part in winning his audience than will his magical invention.

Two major factors have caused magicians to simplify their equipment and to develop a more intimate manner of presentation in the years after 1930. The first of these is the extinction, due largely to economic factors, of the touring magic show which constituted a full evening's entertainment—a type of presentation associated with Kellar, Thurston and, in its last days, Harry Blackstone and Dante. The second factor lies in the tremendous advances in science together with the everyday use of its applications and developments. It is manifestly difficult to impress an audience which receives moving images in its homes via television with the magic of a mirror trick or a phantasm thrown by a hidden projector on a puff of smoke.

Magicians of today, therefore, attempt to appear less like sorcerers or "professors" and more like attractive and extremely skilful actors, and their equipment is made to look as ordinary and unmagical as possible. The main arena of performance for the magician is in the night club, where his act must be on and off stage quickly and short and compelling enough to compete with the attractions and distractions which abound. Occasional attempts to televise magic have proved largely unacceptable to audiences which distrust the possibility that the tricks are achieved by camera sorcery. Conjuring may be fully effective only in "live" performance.

For magic in primitive cultures, *see* MAGIC.

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(J. MU.; R. FD.)

CONKLIN, EDWIN GRANT (1863–1952), U.S. biologist noted for his studies of human evolution, was born at Waldo, O., on Nov. 24, 1863. He graduated at Ohio Wesleyan university, Delaware, O., in 1886 and received from Johns Hopkins university, Baltimore, Md., in 1891 the degree of Ph.D. He was professor of biology at Ohio Wesleyan in 1891–93, and professor of zoology at Northwestern university, Evanston, Ill., from 1894 to 1896 and at the University of Pennsylvania, Philadelphia, from 1896 to 1904 when he was appointed to a similar chair in Princeton university. He made valuable researches in embryology and cytology and in the mechanism of heredity and evolution, and by his skill as an investigator, teacher and writer rose to foremost rank among American zoologists. Besides numerous contributions to scientific journals, his writings include *Heredity and Environment in the Development of Men* (1915–21), *Direction of Human Evolution* (1921) and *Problems of Organic Adaptation* (1921). He retired from active teaching in 1933 and spent the years thereafter in research. He died Nov. 20, 1952.

CONKLING, ROSCOE (1829–1888), a prominent U.S. lawyer and influential Republican member of congress during the Reconstruction era. He was born at Albany, N.Y., Oct. 30, 1829, the son of Alfred Conkling (1789–1874), a distinguished jurist, legislator and diplomat. Obviously destined for politics, Roscoe Conkling made his first campaign speeches in 1848 in behalf of Zachary Taylor and Millard Fillmore. After studying law in Utica, he was admitted to the bar in 1850. Between 1850 and 1858, he won an enviable reputation as an orator, lawyer and political leader. Conkling was a keen debater and possessed a striking personality. As a Whig he took part in the campaign of 1852 in behalf of Gen. Winfield Scott. He was active in the formation of the Republican party and helped the party carry New York state for John C. Frémont in 1856. He was elected to the U.S. house of representatives in 1858 and again in 1860. He was defeated for re-election in 1862 by Francis Kernan, but in turn defeated Kernan in 1864.

Conkling upheld the Lincoln administration in its conduct of the Civil War but consistently attacked the generalship of Gen. George B. McClellan. Conkling was chairman of the committee on the District of Columbia; member of the special joint reconstruction committee of fifteen; and of the ways and means committee. He was an avid supporter of the 14th amendment to the constitution. He was re-elected in 1866 but did not take his seat because he was elected to the senate in Jan. 1867. Conkling was re-elected in 1873 and 1879. As a senator he early showed his aptitude for leadership. He was a member of the leading senatorial committees and chairman of the committees on commerce and the revision of the laws. It was his leadership that most influenced the Grant administration in its over-all policy toward the South. He received 93 votes for the nomination for president in the Republican convention of 1876. His support of Grant's nomination for a third term in the 1880 convention caused a split in the Republican party. He and his colleague Thomas C. Platt (*q.v.*) resigned from the senate on May 16, 1881, over a dispute with President Garfield concerning patronage. He sought re-election as a vindication but was defeated. President Arthur, who succeeded to the presidency after Garfield's assassination, offered Conkling a seat on the bench of the U.S. supreme court in 1882 but he refused the appointment. He then practised law in New York city where he died on April 18, 1888.

See D. B. Chidsey, *Gentleman from New York: a Life of Roscoe Conkling* (1935). (F. M.)

CONN (fl. 2nd century A.D.), Conn Cétchathach, "Conn of the Hundred Battles," is, in the heroic tales, one of the most famous of Irish kings. T. F. O'Rahilly in his *Early Irish History and Mythology* (1946) raises or reduces him to the status of a god of the other world, but this view is very difficult to accept. Variants of the name, such as Condos, Senocondos, Condollus, are found attached to very ordinary mortals among the Celts of Gaul and the epithet "of the Hundred Battles" suggests vigorous human activity. More important still as evidence of his existence and his prowess is the term Leth Cuinn ("Conn's Half") applied to the northern half of Ireland in which Conn held sway. The earliest recorded political division of the country is into five parts: Ulster, Tara (Meath), Leinster, Munster and Connaught. By the 5th century there had come into being the title "king of Ire-

land," thereafter long held alternately by members of two branches of the royal line descended from Conn, established respectively in the midlands and in the north. The term "Conn's Half" most probably came into use during an intermediate stage in the process of unification, when Conn was predominant in the northern half of Ireland but could not win even nominal allegiance from the southern half, then known as Leth Moga Nuadat or Leth Moga ("Mog's Half") after the Eoganachta king Eogan, or Mog Nuadat, who ruled there. All the stories of Conn in Irish literature are in the traditional style, full of romance with a kernel here and there of history. In the genealogies Conn is the ancestor of Niall of the Nine Hostages (379–405) and through him of the greatest dynasty known to Irish history, the Uí Néill.

(J. J. Ry.)

CONN (Con), **LOUGH,** a lake in County Mayo, western Ireland, is drained through the river Moy into Killala bay. At Pontoon, Lough Conn is joined to the smaller Lough Cullin (3 sq.mi.) to form a fine sheet of water 11 mi. long and 4 mi. wide. Lough Conn is floored by Carboniferous limestone and, standing at 42 ft. above sea level, is essentially a lake of the lowland. The limestones give place to older rocks, locally granites, which extend westward to the Atlantic shores. A short distance to the west, Nephin (2,646 ft.) and other mountains rise to more than 2,500 ft. The shores are varied and in places consist of peat bogs but in others of closely formed ridges of glacial drift. There are numerous islands in the lakes, none of them inhabited. There are no villages on the lake shores and many of the farms are remote and can be approached only by rough lanes. At Pontoon the bridge across the channel connecting the two loughs is a favourite angling spot, and in this area there are some fine woods, believed to be the native forest, of oak, or oak with birch, varied with rowan, holly, ash, hazel and a rich ground vegetation.

(T. W. Fr.)

CONNAUGHT, ARTHUR WILLIAM PATRICK ALBERT, Duke of (1850–1942), third and favourite son of Queen Victoria, was born at Buckingham palace on May 1, 1850. He was created duke of Connaught and Strathearn in 1874. He entered the Royal Military academy, Woolwich, in 1866 and did well in the army, becoming full general in 1893 and field marshal in 1902. He served in Egypt in 1882, commanding the guards brigade at Tel el Kebir. He then went to India and held the Bombay command from 1886 to 1890. Returning to England, the duke held various military appointments, notably commander in chief in Ireland (1900–04), inspector general to the forces (1904–07) and commander in chief in the Mediterranean (1907–09). As governor general of Canada (1911–16) he was very popular but his governorship was not without controversy, largely resulting from his attempt to intervene in Canadian military affairs. Connaught's state functions included the opening of the first parliament of the Union of South Africa in 1910 and the inauguration of the new chamber of princes, legislative assembly and council of state in India in 1921. He withdrew from public life in 1928 and died at Bagshot park, Surrey, on Jan. 16, 1942.

In 1879 the duke had married Princess Louise Marguerite of Prussia (d. 1917). Their elder daughter, Margaret (1882–1920), married the crown prince of Sweden (later King Gustavus VI) in 1905. The duke's only son, Prince Arthur of Connaught (1883–1938), married, in 1913, Princess Alexandra, duchess of Fife (1891–1959). Their son Alastair Arthur (1914–43) succeeded his grandfather in 1942, but on his death in 1943 the dukedoms became extinct.

CONNAUGHT (Connacht), one of the five ancient kingdoms or provinces of Ireland, lies in the western and northwestern areas of the island. Its eastern boundary is still, in large part, the middle course of the river Shannon. It comprises the counties of Mayo, Sligo, Leitrim, Galway and Roscommon (*qq.v.*). Area 6,611 sq.mi.; pop. (1961) 419,221.

In early times Connaught (Cóiced Connacht) was divided into three regions, from north to south, Gamanraige, Tuatha Taiden and Fir Craíbe. About A.D. 400 the kingdom lost to Munster that part of Fir Craíbe which is now the county of Clare. Meanwhile, in the 4th century, the great Irish rulers of the midlands, whose central fortress was Tara, had displaced the ancient line of Connacht kings and a close connection began between Tara and Crúachu (Rathcroghan, County Roscommon), the traditional capital of the Connacht state. To this Tara dynasty belonged Brión and Fiachra, who in the 5th century founded septs, Uí Briúin and Uí Fiachrach, that were to give the kingdom all its rulers until the Norman invasion.

Toirdelbach (Turloch) O'Connor (d. 1156) was strong enough to claim the kingship of Ireland, and his son Ruadri (Rory) was generally recognized as king of Ireland when the Norman knights and later Henry II himself came to deprive him of that position (1171). But Ruadri's brother Cathal Crobderg ("of the Red Hand") O'Connor was king of Connacht to his death in 1224. Henry III then made a grant of the kingdom in 1227 to Richard de Burgh and Richard's son Walter became earl of Ulster (1264) as well as lord of Connaught. When William de Burgh, earl of Ulster, was murdered in 1333, he left no male heir; his daughter married Lionel, afterward duke of Clarence, and the title was subsequently transmitted through their daughter Philippa to the Mortimer earls of March and ultimately to the crown (1461). Connaught was, however, occupied by junior branches of the De Burghs, who took respectively the appellations of MacWilliam Uachtar and Iochtar ("the Upper and Lower MacWilliam"), and became the Clanricarde and Mayo Burkes. In 1543 Ulick de Burgh was created earl of Clanricarde and in 1603 MacWilliam Iochtar, Viscount Mayo.

In 1576 Connaught was divided into shires by the lord deputy, Sir Henry Sidney, who had also placed it, like Munster, under a president (1569), a system which remained effective for about 70 years and was not finally abandoned until 1662. In 1585 Sir John Perrot made with the resident gentry and chiefs the "composition of Connaught," which confirmed to them possession of their lands by knight service of the crown. The result was that most of the province remained loyal to the crown during the Tyrone rising (1594–1603) and remained the most Gaelic and Norman part of Ireland. For its subsequent history *see* Ireland: *History.*

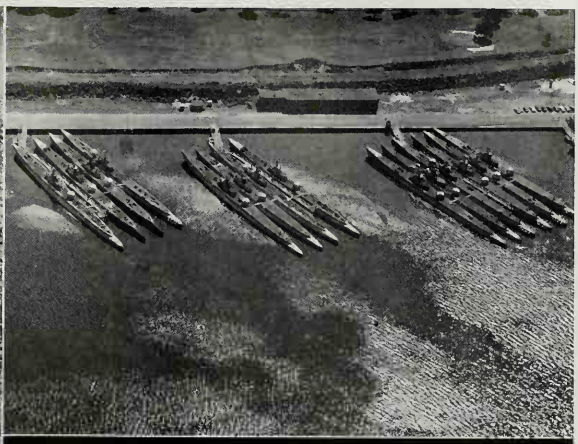
(J. J. Ry.)

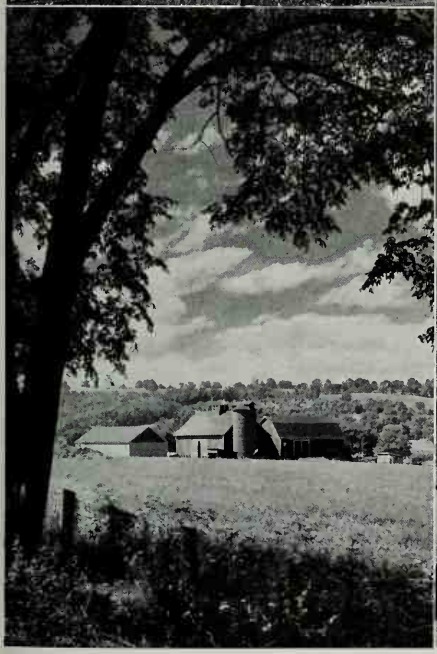
CONNECTICUT is called the "Nutmeg state," because, in the early days, its residents were considered so shrewd they could sell wooden nutmegs. It is one of the 13 original states of the union, and one of the New England group. It is bounded north by Massachusetts, east by Rhode Island, south by Long Island sound and west by New York; the southwest corner projects along the sound, indenting New York for about 13 mi. It is the 48th state in size, Rhode Island and Delaware being the only states smaller in area. The state capital is Hartford and the state ratified the constitution Jan. 9, 1788. The white oak has been designated the state's official tree, the mountain laurel its official flower and the robin the official bird. The state flag is composed of a white shield on a blue background. Beneath the shield is a white streamer bearing the state motto. "Connecticut" is supposed to mean "beside the long tidal river" and is of Indian origin.

The state has 169 towns (many of which are townshiplike in character) which are the principal units of local government.

PHYSICAL GEOGRAPHY

Physical Features.—Connecticut lies in the south portion of the peneplain region of New England. The state is situated between approximately 41° 00′ and 42° 03′ N. and 71° 47′ and 73° 40′ W., and its total area is 5,009 sq.mi., of which 110 are water surface. Its surface is in general that of a gently undulating upland divided near the middle by the lowland of the Connecticut valley, the most striking physiographic feature of the state. The upland rises from the low south shore of the state at an average rate of about 20 ft. in a mile until it has a mean elevation along the north border of 1,000 ft. or more, and a few points in the northwest rise to a height of about 2,000 ft. above the sea. The lowland dips under the waters of Long Island sound in the south and rises slowly to a height of only 100 ft. above them where it crosses the north border. In the north the lowland is about 20 mi. wide; in the south it narrows to only 5 mi.; its total area is about 1,400 sq.mi. Its formation was caused by the removal of a band of weak



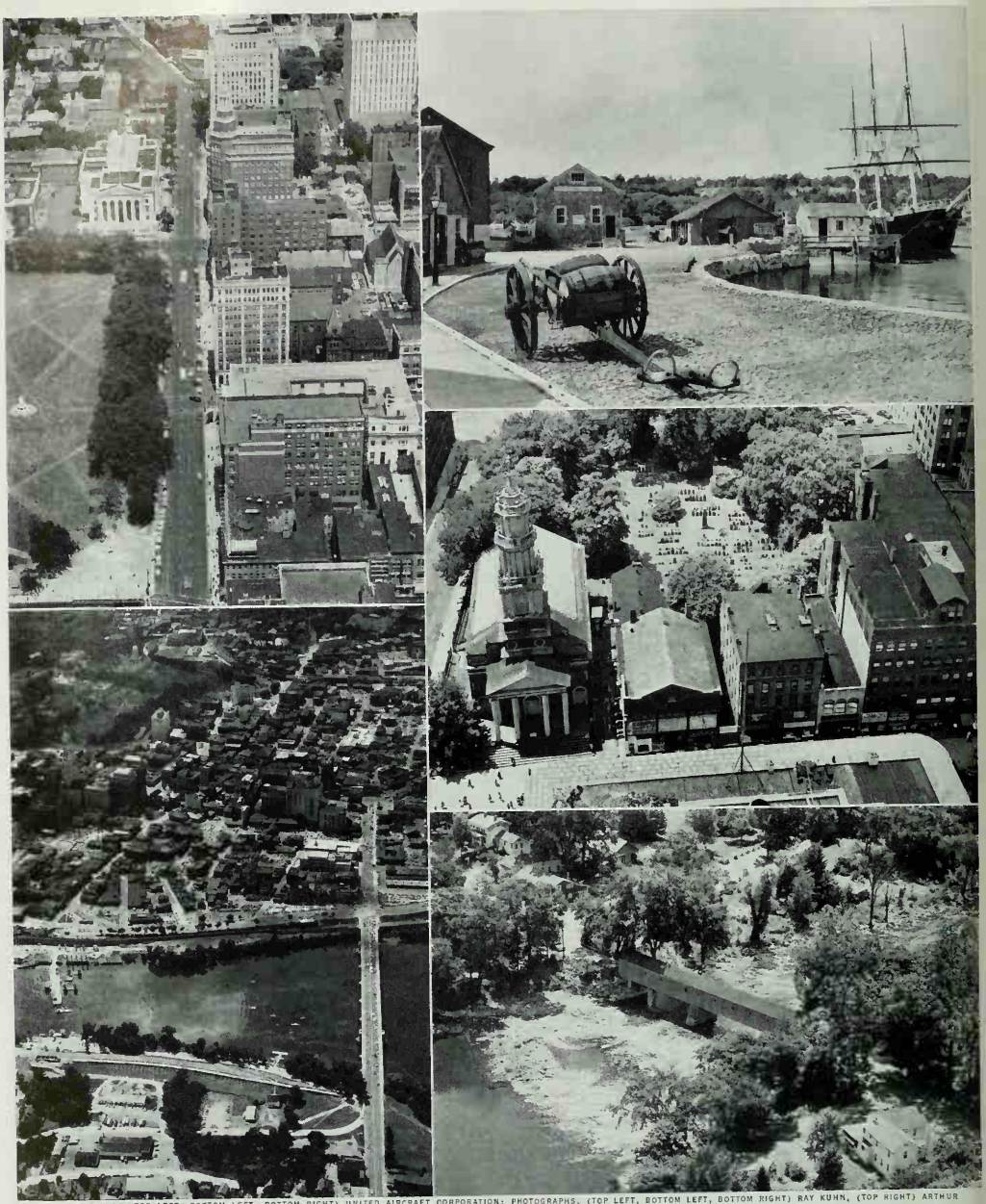


BY COURTESY OF (TOP LEFT, CENTRE RIGHT, BOTTOM RIGHT) CONNECTICUT DEVELOPMENT COMMISSION, (TOP RIGHT) UNITED AIRCRAFT CORPORATION; PHOTOGRAPHS, (TOP LEFT) JOSEPH SCAYLEA, (TOP RIGHT) RAY KUHN, (CENTRE RIGHT) ROBERT YARNALL RICHIE, (BOTTOM LEFT) AARON G. FRYER FROM BLACK STAR

VIEWS OF CONNECTICUT

Top left: Colonial home at Glastonbury
Top right: Submarine fleet at U.S. naval base, Groton
Centre right: Copper alloy casting shop, Waterbury
Bottom left: Farm scene near Salisbury
Bottom right: Sterling Divinity quadrangle, Yale university, New Haven

CONNECTICUT



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CITIES AND TOWNS OF CONNECTICUT

Top left: Aerial view of New Haven business district

Top right: Square-rigged sailing vessel, the "Joseph Conrad," tied up at pier, Mystic

Centre right: Colonial burial ground next to the Center church house, Hartford. Center church is the oldest ecclesiastical society in Connecticut

Bottom left: Aerial view of Hartford with the Connecticut river in the foreground

Bottom right: Covered bridge over the Housatonic river near West Cornwall

rocks by erosion after the general upland surface had been first formed near sea level and then elevated and tilted gently south or southeast; in this band of weak rocks were several sheets of hard igneous rock inclined from the horizontal several degrees and so resistant that they were not removed but remained to form ridges, such as West Rock ridge near New Haven and the Hanging hills of Meriden. The ridges are generally deeply notched, but their highest points rise to the upland heights directly to the east or west. The west section of the upland is more broken than the east section, for in the west are several isolated peaks lying in line with the south continuation of the Green and the Housatonic mountain ranges of Vermont and Massachusetts, highest among them being: Bear mountain 2,322 ft.; Gridley mountain, 2,211 ft.; Mt. Riga, 2,010 ft.; Mt. Ball (Bald), 1,770 ft.; Lions Head, 1,738 ft.; Canaan mountain, 1,762 ft.; and Ivy mountain (Goshen), 1,658 ft. The lowland is drained by the Connecticut river as far south as Middletown, but there the river turns to the southeast into one of the narrow valleys in the east section of the upland, the turn being caused by the fact that the river acquired its present course when the land was at a lower level and before the lowland on the soft rocks was excavated. The principal rivers in the west section of the upland are the Housatonic and its tributary, the Naugatuck; in the east section is the Thames, which is really an outlet for three other rivers (the Yantic, the Shetucket and the Quinebaug). The Connecticut river is navigable as far as Hartford, and the Thames as far as Norwich. The Housatonic river, which in its picturesque course traverses the whole breadth of the state, has a short stretch of tidewater navigation. The seacoast, about 100 mi. in length (not recognizing coastal indentations), has a number of bays, making several good harbours which have been created by a depression of small valleys.

In spite of the fact that Connecticut is a highly urbanized state, approximately 60% of its landscape is forested. There are 26 state forests, the largest of which are Tunxis (in Hartland), Pachaug (Voluntown), Natchaug (Eastford), Housatonic (Sharon), Cockoponsett (Chester) and Nipmuck (Union). In addition there are nearly 600 state and local parks. The acreage of cultivated farm land has been declining for more than a century.

Climate.—The climate of Connecticut, though temperate, is subject to sudden changes; yet the extremes of cold and heat are less than in the other New England states. The mean annual temperature is 49° F., the average temperature of winter being 27° and that of summer 72°. Since the general direction of the winter winds is from the northwest, the extreme of cold is felt in the northwestern part of the state. The prevailing summer winds, which are from the southwest, temper the heat of summer in the coast region, but extreme heat is found in the central part of the state. The annual rainfall varies from 45 to 50 in.

Vegetation and Animal Life.—Mountain laurel, the state's official flower, grows profusely on the rocky Connecticut hillsides. Some towns have laurel festivals in the spring. Almost as common as laurel are white dogwood and pink azalea, the latter known locally as honeysuckle. Among the wild flowers frequently seen in Connecticut's woods are trailing arbutus, violets, hepatica, bloodroot, jack-in-the-pulpit, cowslips, buttercups, wild geraniums and lupine. The trees are largely hardwood with oak, ash, birch, hickory, poplar, sycamore, beech, hard maple and butternut the most common. In the northern part of the state hemlock and white pine are abundant. Other typical Connecticut trees are sugar maple, red pine, black walnut, elm and willow.

Small animals common in the state include foxes, rabbits, squirrels, woodchucks and skunks. White-tailed deer are still sometimes seen, and mink, muskrat and otter are sometimes trapped. Of the kinds of birds most often seen, some of the commonest are clapper rails, fish crows, orchard orioles, hooded warblers, brown creepers, water thrushes, juncos, sapsuckers and robins. Game birds include fresh-water ducks, ruffed grouse, quails and pheasants.

State Parks and Historic Sites.—Connecticut has set aside an unusually large proportion of its total land area for public parks and forests. New Britain ranks second among all the cities in the United States in the amount of its area in public parks, per unit of population. There are more than 70 state parks which total about 21,000 ac.; there are 26 state forests covering approximately 122,000 ac. The latter are designed principally to preserve and develop the forest for the enjoyment of future generations, but they are also open for hiking, hunting and other outdoor activities.

There are eight state monuments: an old iron furnace at North Caanan; the Israel Putnam burial place at Brooklyn; the John Mason burial place at Groton; the place Indian Chief Miantonomo died at Norwich; the burial place of Nathan Hale at Coventry; the burial place of Nathaniel Lyon at Eastford; a site of a fort at Old Saybrook; and the site of an Indian battle at Fairfield.

Among the more outstanding buildings of historic interest are the Trumbull house (1740), the home of Revolutionary War Gov. Jonathan Trumbull at Lebanon; the Nathan Hale homestead (1776) at South Coventry; the first law school (Tapping Reeve) in the United States, established in 1784, at Litchfield; the old state house (1792–95) designed by Charles Bulfinch at Hartford; and what is probably the oldest stone house in the U.S., the Henry Whitfield house at Guilford, built in 1639 and now a museum. Other notable houses are the Samuel Huntington house at Norwich; Glebe house at Woodbury; the Oliver Ellsworth house at Windsor; Gay manse at Suffield; Lyons house at Greenwich; Grave house at Madison; Whitman house at Farmington; the Silas Deane house at Wethersfield. The Wadsworth athenaeum and the Mark Twain memorial (the writer's one-time home) are at Hartford. The Mystic Seaport and Marine museum at Mystic houses one of the finest collection of clipper ship models in the U.S. The Shakespeare festival held annually at Stratford is also of considerable interest.

Only a few of the historical sites found in the state are associated with American wars. Of these the principal one is Ft. Griswold in Groton, the site of a skirmish in the Revolutionary War.

A characteristic feature of the Connecticut landscape is the village green surrounded by white, frame, colonial houses. Many of the towns are well preserved, notably Guilford, Wethersfield, Farmington, Woodstock, Litchfield, Hampton, Chaplin, Old Lyme and Lebanon.

HISTORY

Colonial Period.—The first settlement by Europeans in Connecticut was made on the site of the present Hartford in 1633 by a party of Dutch from New Netherland. In the same year a trading post was established on the Connecticut river, near Windsor, by members of the Plymouth colony, and John Oldham (1600–36) of Massachusetts explored the valley and made a good report of its resources. Encouraged by Oldham's account of the country, the inhabitants of three Massachusetts towns, Dorchester, Watertown and New Towne (now Cambridge), left the colony for the Connecticut valley. The emigrants from Watertown founded Wethersfield, the first English settlement in Connecticut, in the winter of 1634–35; those from Dorchester settled at Windsor in the summer of 1635; and in the autumn of the same year people from New Towne settled at Hartford. This removal to Connecticut, in which they were led principally by Thomas Hooker (*q.v.*), Roger Ludlow (*c.* 1590–1665) and John Haynes (d. 1654), was caused by the colonists' discontent with the autocratic character of the government in Massachusetts. However, the instrument of government which they adopted in 1639, known as the Fundamental Orders of Connecticut, reveals no radical departure from the institutions of Massachusetts. Their most original feature was the omission of a religious test for citizenship. On the other hand, the union of church and state was presumed in the preamble, and in 1659 a property qualification (the possession of an estate of £30) for suffrage was imposed by the general court.

Another migration to the Connecticut country began in 1638, when a party of Puritans who had arrived in Massachusetts the preceding year sailed from Boston for the Connecticut coast, and there founded New Haven. Soon after their arrival these colonists drew up a "Plantation covenant" which made the Scriptures the supreme guide in civil as well as religious affairs; but no copy of this is now extant.

A third Puritan settlement, named Saybrook, was established in 1635 at the mouth of the Connecticut river, under the auspices of an English company. Immigration from England soon declined because of the Puritan revolution, and the colony was sold to Connecticut in 1644.

Unification.—The next step in the formation of modern Connecticut was the union of the New Haven colony with the older colony. This was accomplished by the royal charter of 1662, which defined the boundaries of Connecticut as extending from Massachusetts south to the seas and from Narragansett bay west to the South seas (Pacific ocean). This charter had been secured without the knowledge or consent of the New Haven colonists, and they naturally protested against the union with Connecticut. But because of the threatened absorption of a part of the Connecticut territory by the colony of New York, granted to the duke of York in 1664, and the news that a commission had been appointed in England to settle intercolonial disputes, they finally assented to the union in 1665. Hartford then became the capital of the united colonies, but shared that honour with New Haven from 1701 until 1875. The 1662 charter created a corporation under the name of the Governor and Company of the English Colony of Connecticut in New England in America, sanctioned the system of government already existing, provided that all acts of the general court should be valid upon being issued under the seal of the colony, and made no reservation of royal or parliamentary control over legislation or the administration of justice. Consequently there developed in Connecticut an independent, self-reliant colonial government which looked to its chartered privileges as the supreme source of authority.

The Charter Oak.—The period of most serious friction in the early life of Connecticut was that during the administration of the New England colonies by Sir Edmund Andros (*q.v.*), who in pursuance of the crown's policy both in England and in its American colonies visited Hartford on Oct. 31, 1687, to execute quo warranto proceedings against the charter of 1662. It is said that in the course of a discussion at night over the surrender of the charter the candles were extinguished, and the document itself (which had been brought to the meeting) was removed from the table where it had been placed. According to tradition it was hidden in a large oak tree, afterward known as the "Charter Oak." But though Andros thus failed to secure the charter, he dissolved the existing government. After the English Civil War of 1689, however, government under the charter was resumed, and the crown lawyers decided that the charter had not been invalidated by the quo warranto proceedings.

Religious affairs formed one of the most important problems in the life of the colony. The established ecclesiastical system was the Congregational. The code of 1650 (Connecticut) taxed all persons for its support, provided for the collection of church taxes by civil distraint if necessary and forbade the formation of new churches without the consent of the general court. The new Halfway covenant of 1657, which extended church membership so as to include all baptized persons, was sanctioned by the general court in 1664. Throughout most of the 18th century there was constant friction between the establishment and the nonconforming churches; but in 1791 the right of free incorporation was granted to all sects.

The Revolutionary Period.—Connecticut took a prominent part in the American Revolution. At the time of the controversy over the Stamp act the general court instructed the colony's agent in London to insist on "the exclusive right of the colonists to tax themselves, and on the privilege of trial by jury," as rights that could not be surrendered. The patriot sentiment was so strong that loyalists from other colonies were sent to Connecticut, where it was believed they would have no influence, but among the nonconforming sects, on the other hand, there was considerable sympathy for the British cause. Preparations for war were made in 1774; on April 28, 1775, the expedition against Ticonderoga and Crown Point was resolved upon by some of the leading members of the Connecticut assembly; and although they had acted in their private capacity, funds were obtained from the colonial treasury to raise the force which on May 8 was put under the command of Ethan Allen (*q.v.*). More than one-half of George Washington's army at New York in 1776 was composed of Connecticut soldiers. Yet with the exception of isolated British movements against Stonington in 1775, Danbury in 1777, New Haven in 1779 and New London in 1781, no battles were fought in Connecticut territory.

In 1776 Connecticut was reorganized as a state, the charter of 1662 being adopted by the general court as "the Civil Constitution of this State, under the sole authority of the people thereof, independent of any king or prince whatever." In the formation of the general government the policy of the state was national. It acquiesced in the loss of claimed land in Pennsylvania through a decision (1782) of a court appointed by the confederation; favoured the levy of taxes on imports by federal authority; and relinquished (1786) its claims to all remaining western lands, except the Western Reserve, a part of Ohio. In the constitutional convention of 1787 the present system of national representation in congress was proposed by the Connecticut delegates as a compromise between the plans presented by Virginia and those presented by New Jersey.

The 19th Century.—For many years following the Revolution, the Federalist party (*q.v.*) controlled the affairs of the state. The opposition to the growth of American nationality which characterized the later years of that party found expression in a resolution of the general assembly that a bill for incorporating state troops in the federal army would be "utterly subversive of the rights and liberties of the people of the State, and the freedom, sovereignty and independence of the same," and in the prominent part taken by Connecticut in the Hartford convention (a secret session, 1814–15, of delegates from five New England states to consider grievances against the national government and to consider revising the federal constitution) and in the advocacy of the extensive amendments proposed by it. However, the development of manufactures, the discontent of nonconforming religious sects with the establishment, and the confusion of the executive, legislative and judicial branches of government in the constitution opened the way for a political revolution. All the discontented elements united with the Democratic party in 1817 and defeated the Federalists in the state election; in 1818 the existing constitution was adopted. From 1830 until 1855 there was close rivalry between the Democratic and Whig parties for control of the state administration.

In the Civil War Connecticut was one of the most ardent supporters of the Union cause. When Pres. Abraham Lincoln issued his first call, for 75,000 volunteers, there was not a single militia company in the state ready for service. Gov. William A. Buckingham issued a call for volunteers in April 1861; and soon 54 companies, more than five times the state's quota, were organized.

After the war the Republicans were more frequently successful at the polls than the Democrats. Representation in the lower house of the general assembly, by the constitution of 1818, was based on the townships, each township having two representatives, except townships created after 1818, which had only one each. This method constituted a serious evil when, in the transition from agriculture to manufacturing as the leading industry, the population became concentrated to a considerable degree in a few large cities and the relative importance of the various townships was greatly changed. A constitutional amendment of 1828 provided that senators should be chosen by districts, and that in the apportionment regard should be paid to population, no county or township was to be divided and no part of one county was to be joined to the whole or part of another county, and each county was to have at least two senators; but by 1900 any relation that the districts might once have had to population had disappeared. This system of representation sometimes put in power a political party representing a minority of the voters. In 1878, 1884, 1886, 1888 and 1890 the Democratic candidates for state executive offices received a plurality vote; but, as a majority was not obtained, these elections were referred to the general assembly, and the Republican party, in control of the lower house, secured the election of its candidates. In 1901 constitutional amendments were adopted making a plurality vote sufficient for election, increasing the number of senatorial districts and stipulating that "in forming

them regard shall be had" to population.

The growth and movement of population has greatly complicated and confused the representative system. In 1774 the apportionment was not grossly inequitable, there being only six towns with less than 1,000 inhabitants and three with more than 6,000 population. However, in mid-20th century the 11 smallest towns with a total population of 6,105 had 15 representatives whereas the six largest towns with an aggregate population of 753,046 had 12 representatives. This condition was the single most significant feature of the government of the state because it conditioned the operation of the whole system. A constitutional amendment in 1901 provided for decennial reapportionment of the senate, if necessary, but the last reapportionment was made in 1903.

The 20th Century.—Between 1902 and 1960, 16 amendments to the constitution were adopted: some of the most important were granting the governor power to veto specific sections of appropriation bills in 1924; and, in 1948, increasing the term, from two years to four years, of the governor, lieutenant governor, secretary-treasurer, comptroller and also of the judges of probate beginning Jan. 1951.

World War I was a period of great industrial expansion and consequent prosperity. Enlistments in the armed services numbered 65,728. After the Armistice, despite a recession, the state continued prosperous until the depression of the 1930s which was especially severe in Connecticut. However, conditions were improved by federal agencies, as well as by an extensive public works program undertaken by the state. A number of towns thus acquired new schools, libraries, town halls and other public buildings at about half the cost of the work in normal times. Under the same conditions many miles of dirt roads were hard-surfaced.

With the outbreak of World War II in Europe, Connecticut firms began to receive large war contracts. Employment and production reached a new peak. The state adjutant general's office estimated enlistments of men and women at 210,891, with fatalities at 5,724.

Many important measures of social legislation were adopted after 1930, notably: systems of unemployment compensation; old-age assistance; a fair employment practices act; an act prohibiting discrimination because of racial, religious or national origin; and a minimum-wage bill. In 1937 the state administration was extensively reorganized by a series of legislative acts which increased the powers of the governor, established a department of finance and control and put the employees of the executive department under the merit system.

An interracial commission was established in 1943 and a housing authority the same year. The Connecticut turnpike, which skirts Long Island sound from New York to Rhode Island, was opened in 1958. Two laws of major importance were passed by the general assembly in 1959. The first abolished the county governments as of Oct. 1, 1960, the necessary county functions being transferred to the state government. The second law revised the local court systems. The municipal court judges and the justices of the peace were replaced on Jan. 1, 1961, by a new circuit court system. The circuit court was composed of 44 full-time judges, one of whom would be the chief judge.

In Connecticut politics, Dwight D. Eisenhower, heading a Republican sweep in 1956, received the largest plurality of any presidential candidate in Connecticut history. In 1958, however, Democratic Gov. Abraham Ribicoff was re-elected in the largest election landslide in the state's history. In addition to all of the elective state offices, the Democrats controlled the general assembly for the first time in 82 years and filled all vacancies in the U.S. congress, six representatives and a senator. In 1960 the state's electoral votes went to John F. Kennedy, Democrat.

GOVERNMENT

The constitution of Connecticut was framed and adopted in 1818 with subsequent amendments. Amendments are adopted after approval by a majority vote of the lower house of the general assembly, a two-thirds majority of both houses of the next general assembly and ratification by the electors. A special session of the general assembly in 1965 redistricted the state senate and reapportioned the house of representatives, in accordance with a U.S. supreme court ruling (1964) that electoral districts for both houses must be substantially equal in population. Senate membership remained at 36, with equalized districts. House membership was reduced from 294 to 177, also elected from districts; thus was abolished town-by-town (township) representation, a system dating from the adoption of the Fundamental Orders in 1639 and retained in the King's charter of 1662 and, for the house, in the constitution of 1818 (which established a district system for the senate). The 1965 reapportionment meant a shift in control of the assembly for the first time in the state's history from the rural Republican townships to the populous Democratic urban areas. The special session also provided for a constitutional convention to draft a permanent framework for the legislature.

Since 1950 the executive and legislative officials, including the attorney general, are elected for four-year terms. The judges of the supreme court of errors and the superior court, appointed by the general assembly on nomination by the governor, serve for eight years, and the judges of the courts of common pleas, chosen in like manner, serve for four years. In providing for the judicial system, the constitution said: "The powers and jurisdiction of which courts shall be defined by law." The general assembly interpreted this as a justification for interference in legal matters. It has at various times granted divorces, confirmed faulty titles, annulled decisions of the justices of the peace and validated contracts against which judgment by default has been secured.

Qualifications for suffrage are the age of 21 years, U.S. citizenship, residence in the state for one year and in the township for six months preceding the election, a good moral character and ability "to read in the English language any article of the constitution or any section of the statutes of this state." The right to decide upon a citizen's qualifications for suffrage is vested in the selectmen and clerk of each township. A property qualification, found in the original constitution, was removed in 1845.

The 15th amendment to the federal constitution was ratified (1869) by Connecticut, but Negroes were excluded from the suffrage by the state constitution until 1876.

Finance and Taxation.—At mid-20th century, the state's receipts from all sources amounted to more than $350,000,000 annually. Of this sum, a little over 5% was derived from the federal government and more than four-fifths from state tax sources. Specifically, the principal sources of state revenues were motor vehicle licences, gasoline taxes, sales and use taxes, a tax on insurance companies and an inheritance tax. There was no personal income tax. The state's expenditures totaled slightly less than $500,000,000 annually and the state's bonded indebtedness was approximately $575,000,000. During this period, state and local governments spent about 29% of their revenues on education, nearly 33% on highways, about 5.5% on public welfare and slightly more than 7% on health and hospitals. The state's income was more than four times as great as it had been prior to World War II, but expenditures had increased nearly five times. Prior to 1938, Connecticut had no bonded indebtedness. Per capita income has been well above the national average for many years.

POPULATION

The population of Connecticut in 1790, the year of the first federal census was 237,946. Its population ranked eighth among the 18 states and territories that then composed the union and was classified as 97% rural. Between 1830 and 1840 the state grew at the slowest rate in its history. In 1840 the population was only about 4% greater than it had been in 1830. By mid-19th century the population was 370,792 which made Connecticut the 21st most populous state out of 37. It remained largely rural in character as approximately 84% of its inhabitants were classified as nonurban. From 1850 to 1860 the population increased at the highest rate in the state's history until the 1950 to 1960 decade. The census of 1860 showed an advance of 24.1% over that of 1850. By 1900 the state had 908,420 inhabitants and was ranked 29th among the states and territories in the federal census of that year. The 50 years between 1850 and 1900 more than halved the rural population—in 1900 only 40% of the population was

classified as rural, reflecting the growing industrialization of the New England area to which Connecticut belongs. The entire urban population in 1960 which included also the thickly settled suburban areas, or "urban fringe," amounted to 1,985,567 persons or 78.3% of the state total. The nine standard metropolitan statistical areas (Bridgeport, Hartford, Meriden, New Britain, New Haven, New London-Groton-Norwich, Norwalk, Stamford and Waterbury) in 1950 contained nearly three-fourths of the total population. In 1960 these metropolitan areas housed 77.6% of the total population. In 1960 Connecticut had a population of 2,535,234, an increase of 527,954, or 26.3% over 1950. The population per square mile in 1960 was 506.1, as compared with 49.7 for the U.S. as a whole.

By the second half of the 20th century, Connecticut was one of the most highly urbanized states in the U.S. None of the Connecticut cities was very large, but the size of the cities was not a true index of the degree of urbanization of the state, because the state constitution makes annexation of new territory by the cities nearly impossible and most urban communities had outgrown the legal city limits. Suburban growth in the metropolitan areas was a more reliable measure of the extent of urbanization. Thus, more than 69% of the population of the Hartford metropolitan area was to be found outside the city of Hartford. One reason for the increasing urbanization is the fact that Connecticut lies in the path of the great coastal urbanized zone extending from Norfolk and Richmond, Va., to Portland, Me.

In spite of the architectural and monumental evidences of its colonial origins, Connecticut was no longer the land of the Puritan, or even the Yankee. Nearly half of the population was foreign born or of foreign or mixed native and foreign parentage. There had been an infusion of substantial numbers of Polish, Italian, Irish, French Canadian, English, Canadian, German, Swedish and Lithuanian immigrants. In addition about 50,000 Negroes lived in the state.

The population of the state was distributed by colour and nativity in 1960 as follows: 84.9% native white; 10.7% foreign-born; and 4.2% native nonwhite. There were 96.3 males per 100 females in the white population and 95.6 in the nonwhite population; 8.3% of the population was 65 years old or over; and 42.2% of the population 14 years old and over was the labour force.

Of the total number of employed, 1.8% was engaged in agriculture, 5.6% in construction and 40.3% in manufacturing.

*Connecticut: Places of 5,000 or More Population (1960 census)**

Place	Census of Population				
	1960	1950	1940	1920	1900
Total State	2,535,234	2,007,280	1,709,242	1,380,631	908,420
Ansonia	19,819	18,706	19,210	17,643	12,681
Bethel	5,624	4,115	—	—	—
Bridgeport	156,748	158,709	147,121	143,555	70,996
Bristol	45,499	35,961	30,167	20,620	6,268
Danbury	22,928	22,067	22,339	18,943	16,537
Derby	12,132	10,259	10,287	11,238	7,930
East Hartford	43,977†	29,933†	18,615†	11,648†	6,406†
East Haven	21,388†	12,212†	9,094†	3,520†	1,167†
Enfield	31,364†	15,464†	13,561†	11,719†	6,699†
Fairfield	46,183†	30,189†	21,135†	11,475†	4,489†
Greenwich	53,793†	35,509†	35,509†	22,123†	12,172†
Groton	10,111	7,036	4,719	4,236	5,962†
Hamden	41,056†	29,715†	23,373†	8,611†	4,626†
Hartford	162,178	177,397	166,267	138,036	79,850
Manchester	42,102†	34,116†	23,799†	18,370†	10,601†
Meriden	51,850	44,088	39,494	29,867	24,296
Middletown	33,250	29,711	26,495	13,638	9,589
Milford	41,662	26,870†	16,439†	10,193†	3,783
Naugatuck	19,511	17,455	15,388	15,051	10,541
New Britain	82,201	73,726	68,685	59,316	25,998
New Haven	152,048	164,443	160,605	162,537	108,027
New London	34,182	30,551	30,456	25,688	17,548
Norwalk	67,775	49,460	39,849	27,743	6,125
Norwich	38,506	23,329	23,652	22,304	17,251
Portland	5,587	3,975	4,321†	3,644†	3,856†
Putnam	6,952	8,181	7,775	7,711	6,667
Rockville	9,478	8,016	7,572	—	7,287
Seymour	10,100†	5,342	6,754†	6,781†	3,541†
Shelton	18,190	12,694	10,971	9,475	2,837
Southington	19,952	5,955	5,088	5,085	3,411
Stamford	92,713	74,293	47,938	35,096	15,997
Storrs	6,054	10,008†	4,559†	2,574†	1,827†
Stratford	45,012†	33,428†	22,580†	12,347†	3,657†
Terryville	5,231	—	—	—	—
Torrington	30,048	27,820	26,988	20,623	8,360
Wallingford	29,920†	16,976†	14,788†	12,010†	9,001†
Waterbury	107,850	104,477	99,314	91,715	28,646
West Hartford	62,382†	44,402†	33,776†	8,854†	3,186†
West Haven	43,002†	32,010†	30,021†	16,614†	6,995†
Wethersfield	20,561†	12,533†	9,644†	—	—
Willimantic	13,881	13,586	12,101	12,330‡	8,937
Winsted	8,136	8,781	7,674	8,248§	6,804

*Populations are reported as constituted at date of each census.
†Town (township) population.
‡Windham township which includes Willimantic city.
§Winchester township which includes Winsted city.
Note: Dash indicates place did not exist during the reported census, or data not available.

EDUCATION

Historical.—Soon after the foundation of the colonies of Connecticut and New Haven, schools similar to the English grammar schools were established. The Connecticut code of 1650 required all parents to educate their children, and every township of 50 householders (later 30) to have a teacher supported by the men of family, while the New Haven code of 1656 also encouraged education. In 1672 the general court granted 600 ac. of land to each county for educational purposes; in 1794 the general assembly appropriated the proceeds from the sale of western lands to education, and in 1837 made a similar disposition of funds received from the federal treasury. Beginning on July 15, 1909, the organization of public education was changed from the district type to town management type. Appropriations for the support of the schools are made at a town meeting.

In 1941 regional schools were authorized. Under this law two or more towns could join in establishing a school for the participating towns. In addition to local support for schools, the state aided its schools by making various grants from time to time. In 1947 a new school grant law was passed which aimed at a minimum expenditure of $140 per pupil. Ten years later, the state achieved an expenditure of $341 per pupil. This was considerably higher than the national average and 11th highest in the country. In 1938, the state appropriated about 6% of its income for educational purposes, but after World War II, two and one-half times as much was being spent.

Higher Education.—Originally, the New England settlers had intended to establish institutions of higher learning in all of the colonies. With this objective in mind, the general court of the New Haven colony met in 1648 to choose a site for a college. Massachusetts, where Harvard university had been founded in 1636, objected to the plan for a new college on the grounds that New England could not support more than one college. Thus it was not until 1701 that the Rev. James Pierpont and ten other clergymen formed the nucleus of what was to become Yale university. The general assembly supported the Pierpont plan and a site for the school was chosen at Saybrook. However, until 1707 classes met at Killingworth (Clinton). The college was moved from Saybrook to New Haven in 1716. In 1718 the school took the name of Yale after Elihu Yale who had financially assisted the college. It was the first institution of higher learning in the United States to grant the degree of doctor of philosophy (1861) and was the first to establish a school of fine arts (1869). In 1960 the institution had an endowment of approximately $195,000,000 and a library containing nearly 4,250,000 books.

Other private colleges in Connecticut included Albertus Magnus college, New Haven (Roman Catholic, 1925); Annhurst college, Putnam (Roman Catholic, 1941); University of Bridgeport, Bridgeport (nonsectarian, 1927); Fairfield university, Fairfield (Roman Catholic, 1942); Quinnipiac college, Hamden (nonsectarian, 1929); St. Joseph college, West Hartford (Roman Catholic, 1925); St. Thomas seminary, Bloomfield (Roman Catholic, 1897); Trinity college, Hartford (Episcopal, 1823); and Wesleyan university, Middletown (nonsectarian, 1831). The University of Connecticut, Storrs (1881), university and land-grant college, has undergraduate branches at Hartford, Stamford, Waterbury and Torrington; schools of law and of social work and a college of insurance are at Hartford. Other state-supported colleges are Danbury State college, Danbury (1903); Southern Connecticut State college, New Haven (1893); Central Connecticut State college, New Britain (1849); and Willimantic State Teachers college, Willimantic (1889). State-supported junior colleges are Mitchel college at New London (1938) and New Haven college at New Haven (1920). The federal government maintains the United States Coast Guard academy at New London (1876). In Feb.

1957 the state's general assembly chartered the University of Hartford to unite three separate degree-granting institutions: the Hartford Art school, Hartt College of Music and Hillyer college.

HEALTH, WELFARE AND CORRECTIONS

The welfare activities of the state are under the direction of the commissioner of welfare. The activities are mainly in the categories of old-age assistance, aid to the blind, aid to the disabled and aid to dependent children. In addition, the state maintains the following charitable institutions: the Veterans' home and hospital at Rocky Hill; the Mystic Oral School for the Deaf at Mystic; Cedarcrest sanatorium in Wethersfield and Newington, Laurel Heights sanatorium in Shelton, the Seaside in Waterford, the Norwich State Tuberculosis sanatorium in Norwich and the Undercliff sanatorium in Meriden. The mental hospitals are the Connecticut State hospital in Middletown, the Norwich State hospital in Norwich and the Fairfield State hospital in Fairfield.

Two training schools for the mentally deficient and epileptic are provided by the Mansfield State Training school and hospital and the Southbury Training School.

In the field of corrections are the Connecticut State prison at Wethersfield and its adjunct, the Norris G. Osborn farm in Enfield; the Connecticut School for Boys in Meriden; the Long Lane school (for girls) in Middletown; the Connecticut reformatory in Cheshire; and the Connecticut State Farm for Women and State Prison for Women in Niantic.

THE ECONOMY

Agriculture.—Since about 1850 Connecticut has been an industrial state, but agriculture has remained of considerable economic and historical interest. More recently, while dairy, poultry and tobacco farming continued to be important, especially in the fertile Connecticut valley, agriculture as a whole has declined. The number of farms declined from about 21,000 in 1940 to about 8,000 in 1960. There was a corresponding, but somewhat slower, decline in the acreage under cultivation. Perhaps the principal cause of the decline of agriculture was urbanization which was increasing land values so greatly that farming was becoming unprofitable. In the early 1960s greenhouse and nursery products and tobacco were the most valuable crops. Potatoes and tomatoes were other important commodities. However, the poultry industry provided the largest income in the agricultural field, closely followed by dairy products.

Industry.—Manufacturing is notable for its early beginning. Iron products were manufactured throughout the 18th century, nails were made before 1716 and were exported from the colony, and it was in Connecticut that cannon were cast for the continental troops and the chains were made to block the channel of the Hudson river to British ships. Tinware was manufactured in Berlin, Hartford county, as early as 1740, and tin, steel and iron goods were peddled from Connecticut through the colonies.

The Connecticut clockmaker and clock peddler was the 18th-century embodiment of Yankee ingenuity. The most famous of the clockmakers were Eli Terry (1772–1852), who made a great success of his wooden clocks; Chauncey Jerome, who first used brass wheels in 1837 and founded in 1844 the works of the New Haven Clock company; Gideon Roberts and Terry's pupil and successor, Seth Thomas (1786–1859), who built the factory at Thomaston carried on by his son Seth Thomas (1816–88). As early as 1732 the London hatters complained of the competition of Connecticut hats in their trade.

From 1802 brassworks were in operation at Waterbury—the great brass manufacturing business there growing out of the making of metal buttons.

In 1768 paper mills were erected at Norwich, and in 1776 at East Hartford. In 1788 the first woolen mills in New England were established at Hartford and, about 1803, 100 merino sheep were imported by David Humphreys, who in 1806 built a mill in that part of Derby which is now Seymour and which was one of the first New England factory towns.

The period of greatest development of manufacturing began after the War of 1812. During the period 1850–1900, when the population increased 145%, the average number of wage earners employed in manufacturing establishments increased 248.3%, the number so employed constituting 13.7% of the state's total population in 1850 and 19.5% of that in 1900.

Connecticut usually ranks first among the states in the production of felt hats, firearms, clocks, silverware, nonferrous metal products, office machines, tools and insulated wire and cable. Other products manufactured in large quantities include needles, pins, brass products, ball bearings, typewriters, springs, hooks and eyes and slide and snap fasteners.

The growth of industry is illustrated by the fact that about half of the 900,000 employed persons in the state in the late 1950s were engaged in manufactures, three-fourths of the factory workers being engaged in metalworking industries.

The depression of the 1930s was felt very severely in the state. At its height in 1933 there were only 2,410 industrial establishments working in the state compared with 4,571 in 1919. By 1939, however, recovery was general and during World War II the state received government contracts in excess of $8,000,000,000 and facility contracts in excess of $553,000,000.

Transportation and Communication.—Transportation of products is facilitated by water routes and about 830 mi. of railways. The New York, New Haven and Hartford railroad controls the greater part of this railway mileage. Electric railways, which developed swiftly after 1895 and reached a peak mileage of 1,618 in 1922, had almost disappeared by mid-20th century. The state highway system, one of the best in the U.S., in 1960 was composed of nearly 3,400 mi. Connecticut's share of federal aid, under the comprehensive Federal-Aid Highway act of 1956, amounted to nearly $30,000,000 for the fiscal year 1961. The Merritt parkway and its continuation, the Wilbur Cross highway, provided quick motor travel from the New York line across the state to Massachusetts, most of it by a four-lane divided highway. A feature of this superhighway is the tunnel under West Rock ridge at New Haven. The Connecticut river is spanned by five bridges, four of modern type, allowing unimpeded transportation on the river.

About 25 daily newspapers were published of which the Hartford *Courant* founded in 1764 is one of the oldest in the United States. The state was also well supplied with standard and FM radio stations and television outlets.

Minerals.—The mineral industries of Connecticut have had a declining fortune. The early settlers soon discovered metals and began to mine them. About 1740 the production of iron became an important industry in the vicinity of Salisbury, and from that iron many of the American military supplies in the Revolutionary War were manufactured. Copper was extensively mined at Newgate. Some of the mines were worked during World Wars I and II when prices were high, but in peacetime operation became uneconomical. The quarries of granite near Long Island sound and those of sandstone at Portland and of feldspar at Branchville and South Glastonbury have furnished building materials. For many years, however, the greatest source of income from minerals has been ledges of traprock. The crushed stone obtained from them largely accounts for the state's excellent roads. Connecticut produces small but significant amounts of beryl and calcium metal.

Fisheries.—The fisheries, at mid-20th century, were not so important as formerly. Stream pollution was partially responsible for this. The raising of seed oysters had become the most important activity. Flounder, scup and shad were the chief fishes still exploited commercially.

See also references under "Connecticut" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year,* American edition. (E. E. Sr.)

CONNECTICUT RIVER, the longest river in New England, has its origin in Third Connecticut lake near the New Hampshire-Canadian border. After flowing about 9 mi. through New Hampshire it becomes the border between New Hampshire and Vermont for about 238 mi. and then crosses Massachusetts and Connecticut to Long Island sound. Total length of the river is 407 mi.; basin area 11,085 sq.mi. The 23 principal tributaries that flow into it are mostly short, swift streams in narrow valleys dotted with small power dams, storage ponds and factories. The lower 60 mi. are tidal and there is a 15-ft. channel to Hartford, Conn. The total fall in the river (2,190 ft.) and in its tributaries is so fully utilized that the Connecticut river is one of the most completely developed streams in the U.S. in terms of hydroelectric power.

The upper course of the Connecticut river flows across complex metamorphic rocks overlain by terraced lacustrine deposits dotted with dairy farms, and between the foothills and plateaus bordering the Green mountains, the White mountains and the eastern upland. In much of Massachusetts and Connecticut the river has cut a wider valley in the softer Triassic shales and sandstones where tobacco, dairy and truck farming are important.

The Connecticut valley has been traveled by Indians, colonists, soldiers, traders, educators, farmers and manufacturers for 200 years. Its significance as a manufacturing region is attested by the well-known manufacturing cities of Hartford, Conn. (aircraft, machine tools), Springfield and Windsor, Vt., and Claremont, Lebanon and Newport, N.H. (machine tools, ball bearings), the paper-producing centres of Groveton and Claremont, N.H., Ryegate, Vt., and Windsor Locks, Conn., and dozens of communities producing woolens and worsteds and products of the forests. (A. S. Cn.)

CONNECTING ROD: *see* Linkages; Internal-Combustion Engine.

CONNECTIVE AND SUPPORTING TISSUES, a group of tissues that support and bind together the organs, which in turn form the animal. All connective and supporting tissues have the same embryological origin, the mesoderm of the embryo. Though the connective tissue appears in different forms in different parts of the body, there is a fundamental similarity in the components, and any particular modification of form represents an adaptation to function.

Every organ has its capsule and stroma (a mattress) of connective tissue. The entire body is supported by the skeleton. Muscles are closely associated with tendons, connective tissues that transmit the mechanical force of muscle contraction to the bones, which are the levers. The lever function of bone is dependent on connective tissue in several ways: in the ligaments that hold together the joints; the cartilage that surfaces the joints; and the synovial membrane that lines the margins of the joint cavity and lubricates and nourishes the joint surfaces. The nourishment of tissues generally is closely associated with the connective tissue. In it are located the blood vessels. All nutrient materials and waste products exchanged between tissue cells and blood stream must traverse the intercellular spaces, and these spaces are filled with and maintained by the connective tissue.

Components of Connective Tissue.—Three major components are demonstrable and can be recognized in almost every one of the connective tissues thus far examined. These are: (1) the cells; (2) the extracellular fibres; and (3) the extracellular, nonfibrillar ground substance. It is the fibrillar and ground substance material, present in great abundance, that gives the connective tissues their main characteristics. The usual anatomical classification of connective tissues is based upon the appearance, situation and tactile quality of the several different types. These qualities are in turn related to the microscopic and molecular structure of the interstitial components and to the relative proportions of the several components or the particular component that predominates. Thus the hardness of bone is due to the heavy deposition of lime salts in the fibrous matrix; the toughness and flexibility of cartilage (gristle) is caused by the presence of an abundant jellylike material embedded in a tough fibrous mat; and the ropelike tensile strength of tendon is related to the dense bundles of collagen fibres of which tendon is composed.

Cells.—At one stage in its development the embryo of any vertebrate animal is composed of three primary germ layers, ectoderm, mesoderm and endoderm. Almost all the epithelial (that is, covering and lining) structures of the organism arise from the ectoderm and endoderm. The connective tissue of the body, with the exception of that in the central nervous system, is derived from a subdivision of the mesoderm called mesenchyme (middle infusion). Mesenchyme is a loose, soft tissue that infiltrates between the various structures in the body that are developing from the other sources. The cells of the mesenchyme have great potentiality for further differentiation. They eventually produce all the various cells of adult connective tissue. In the adult animal some fixed undifferentiated mesenchymal cells remain as a reserve source of the more highly specialized types. In form they resemble fibroblasts.

Fibroblasts are the most characteristic cells of nonrigid connective tissue. They are large cells with an elongated form having processes extending out from the cell body. These cells probably produce the major components of the collagen fibril. The macrophage (also called histiocyte), another cell type, has the property of phagocytosing particulate and colloidal material. Some students believe that these cells are capable under conditions of stress (*e.g.,* inflammation) of transforming into lymphoid cells or into fibroblasts. The reticular cells are a type seen mainly in tissues such as lymph nodes, spleen and bone marrow. They are associated with the reticular fibres, which form a main structural component of bone marrow, spleen and lymph nodes. These cells constitute a reserve of undifferentiated precursors for certain blood cells, and probably differentiate into the reticulo-endothelial cells. Reticulo-endothelial cells line certain blood

channels (sinusoids) in spleen, liver, lymph node and bone marrow, and have the capacities of phagocytosis and formation of reticulum fibres. Mast cells are found in connective tissues throughout the body. They secrete heparin and histamine. It is likely that they play an important role in relation to the function of the small blood vessels in vertebrates. Eosinophil cells are present and are particularly abundant in certain inflammatory conditions, mainly those presumed to be of allergic origin. The functions of the eosinophil had not been ascertained as of the early 1960s.

Plasma cells are common in the connective tissues, particularly the serous membranes and lymphatic tissue. They have been associated with the formation of antibodies.

Fat cells are a prominent component of certain connective tissues and may be the predominant cell type. They are characteristic and have a large globule of fat surrounded by a thin rim of cytoplasm (cell sap), containing the compressed elongated nucleus. Fat has several functions—as a storage depot of fatty acids and other substances for metabolic purposes; as a packing material in certain parts of the body such as the orbit of the eye, the spaces between muscles and between organs; as an insulating material against cold and physical stress beneath the skin.

Pigment cells have small dark-brown granules of melanin. These cells, called dermal chromatophores, are present in skin and probably receive their pigment from the epithelium.

Chondrocytes and osteocytes are special forms of connective tissue cells and are the main cells of cartilage and bone respectively.

Fibrillar Substance.—There are three main types: collagen, reticular and elastic fibres.

Collagen fibres are best seen in the tendon. They are white in the fresh state, relatively inelastic and of great tensile strength. These are the main constituents of the connective tissue layer of the skin, the dermis. Chemically treated (tanned) dermis is leather. Collagen is composed of groups of fibres varying in width from a few to several hundred microns. The individual fibres do not branch. Bundles of fibres have longitudinal striations and, after treatment with alkali, can be teased into fine fibrils. The electron microscope has shown that such a fibril is composed of even finer filaments. These filaments show a regular periodic structure with the main elements (bands) spaced 64 mμ apart. A still finer banding with a periodicity of 21 mμ has also been seen. It has been possible to dissolve the collagen of skin and tendon in weak acetic acid or in sodium citrate and by appropriate measures cause fibrils to reform. These have essentially the same periodic structure as the native collagen. Collagen dissolves in hot water and the product is gelatin. Native fibres are digested by pepsin and collagenase, a specific enzyme produced by certain bacteria. It is not digested by trypsin. The main component of collagen is a protein; it contains a large quantity of the amino acid, hydroxyproline, which makes it almost unique among proteins. The birefringence of the fibres indicates an orderly structure. It has been deduced from the chemical analysis and X-ray diffraction patterns that there is a periodic arrangement of the amino acids in a coiled chain. How the fibres are formed in life is not known. They are probably formed extracellularly from a precursor made in the fibroblast. A polysaccharide component probably forms a cement substance between the fibrils.

Reticular fibres are a fine extracellular fibrillary substance in the supporting stroma of many organs. They characteristically branch and join with one another to form a reticulum (network). They differ from collagen fibres in that they are not birefringent. Reticular fibres like collagen are dissolved by pepsin and collagenase. In the electron microscope the reticular substance is seen as a membrane composed of fine randomly oriented fibrils lying in an amorphous matrix. The fibrils show the main periodic banding of 64 mμ characteristic of collagen. The amino acid composition of the protein of reticular fibres is similar to that of collagen in having a high hydroxyproline content. Reticular substance protein is soluble in boiling water but no gel is formed on cooling concentrated solutions. Reticular fibres have a more abundant carbohydrate matrix than collagen.

Elastic fibres are characteristically yellow in adult animals. The fibres are long, narrow, branch and frequently are arranged in plates or perforated membranes as in the walls of large arteries. There is no fibrillar pattern visible in them. They are not birefringent until stretched. They are resistant to hot water, strong alkali and trypsin digestion. They are digested by the enzyme elastase found in the pancreas. During digestion by this enzyme fine intertwined fibrils appear with a diameter of 25 mμ. These are twisted together to form the larger fibres. Elastic fibres are composed of protein differing in composition from collagen and reticular fibres and probably have a fatty component. These fibres are like rubber bands—when stretched they snap back to their original state. They impart elasticity to such structures as lung, blood vessel walls, tendons and cartilage.

Amorphous Ground Substance.—This is the material that lies between and around the fibres and cells. It is most clearly seen in cartilage, in the Wharton's jelly of the umbilical cord and in the vitreous humour of the eye. Large carbohydrate molecules designated acid mucopolysaccharides form an important part of ground substance. The properties of two have been well established: (1) hyaluronic acid is composed of glucuronic acid and an amino sugar related to glucose, N-acetyl glucosamine; and (2) chondroitin sulfuric acid A is composed of equimolecular portions of N-acetyl chondrosamine, glucuronic acid and sulfuric acid. Other compounds of similar structure also have been found.

Solutions of hyaluronic acid are very viscous. The viscosity is reduced when the material is exposed to an enzyme, hyaluronidase, found in many bacteria and in extracts of sperm. When preparations of this enzyme are injected into the skin of animals it enhances the spreading of viruses, bacteria and other particulate matter injected simultaneously in the same location.

Ground substance is a gel composed of these large sugars, protein and salts. All substances passing to and from cells must pass through the ground substance; therefore, variations in its state and composition must have a rather profound influence on the life of the individual cells and tissues.

Anatomical Types of Connective Tissues.—*Areolar Tissue.*—This is composed of cells, collagen and elastic fibres in a loose arrangement with wide spaces filled with amorphous ground substance. Loose connective tissue is widely distributed as a whitish sticky mass in spaces between organs and following blood vessels into the interior of organs.

Adipose Tissue.—Adipose or fat tissue is a variant of loose areolar tissue in which fat cells are the major constituent. It is concentrated in certain regions of the body as indicated above. (*See* ADIPOSE TISSUE.)

Dense Fibrous Tissue.—This is composed of closely packed bundles of collagen, some elastic tissue fibres and their associated fibroblasts. Little amorphous ground substance is present. The fibres may be arranged in parallel bundles as in the tendons or may be disposed in several planes interwoven with one another to form a dense cohesive tissue. This is the character of the deeper layer of the skin, the dermis, and is also seen in the capsules surrounding the joints. Macrophages and undifferentiated mesenchymal cells are present.

Synovial Membranes.—These membranes are tubelike structures surrounding joints and closely applied to margins of joint surfaces. They are composed of thin vascular connective tissue. The synovial cells secrete a viscous fluid, synovial fluid, containing hyaluronic acid, protein and salts. This serves as a nutrient and lubricant for the joint surfaces. Tendon sheaths are similar structures surrounding tendons where they pass over bony prominences. (*See* JOINTS AND LIGAMENTS.)

Cartilage.—This group of substances represents nature's solution to the problem of constructing an almost rigid material that will withstand compression. Three types of cartilage are recognized anatomically. These are hyaline, elastic and fibrocartilage.

The glassy appearance of hyaline cartilage is due to the character of the large intercellular component. The fibrillar component, collagen, is immersed in a firm amorphous gel. A large element in this gel is chondroitin sulfate. Within this matrix the cartilage cells, chondrocytes, are situated in spaces called lacunae. With the exception of the surfaces of the joints, all cartilage is

surrounded by a membrane, the perichondrium, having an outer layer of fibrous tissue and an inner layer of flattened chondroblasts (forerunners of cartilage cells). This layer merges imperceptibly with the main cartilage mass.

New cartilage is formed in one of two ways—interstitial growth, by division of cells within lacunae, and appositional growth, by proliferation of new cells from the perichondrium. In the development of the vertebrates the skeleton is first laid down as hyaline cartilage and is gradually removed and replaced by bone. In the adult, hyaline cartilage is found in the articular cartilages at the ends of the long bones, in the costal cartilages uniting sternum to ribs and forming the flexible portions of the nose, the tracheal rings and bronchi. All forms of cartilage are without an integral blood supply; all nutrients and waste material travel to and from the cells by diffusion from vessels in the perichondrium or fluid in the joint space. This places a limitation upon the size which cartilaginous structures can attain. With advancing age the cartilage matrix may become calcified. Such a deposit is a usual thing in the superficial portions of the skeleton of cartilaginous fishes. Elastic cartilage contains, in addition to collagen, elastic fibres. This type is present in the external ear and the epiglottis, parts which are subjected to frequent bending as well as compressive stress.

Fibrocartilage is like hyaline cartilage except for a larger component of collagen fibres. These fibres are usually oriented in a plane parallel to the pull made on the structure, and the chondrocytes are disposed in rows between the fibre bundles. This cartilage has greater tensile strength than the other types. It is found in the intervertebral discs, at the edge of joint surfaces and at tendinous insertions to bone. (*See* also CARTILAGE.)

Bone.—The structure of bone is an elegant adaptation of components of simpler forms of connective tissues in the development of large supporting members for vertebrate animals. There are bones strong enough to support the weight of an elephant and others light yet rigid enough to give form and adequate leverage for wings of large birds.

Two formations are found in bone. The cortex (periphery) of bone is commonly compact osseous tissue, while cancellous or spongy bone is found in the medulla (marrow). Spongy bone consists of tubes, plates and bars forming a network. This network conforms accurately to the directions and lines of maximum pressures and tensions. The tubes, plates and bars, called trabeculae, are made up of a varying number of closely adjoining bone plates or lamellae. Within the interstitial substance are small spaces, lacunae, within which lie the osteocytes (mature bone cells). Lacunae intercommunicate with each other through a network of canaliculi (fine channels). The canaliculi of marginal lacunae extend to the surface of a trabecula. Small trabeculae have no blood vessels in them. They are bathed in the tissue fluid of the surrounding marrow, and from this through the canaliculi comes the nourishment to the osteocytes in the lacunae. The canalicular system can carry fluid at an adequate rate over only a relatively short distance. Hence the thickness that nonvascular trabeculae attain is limited. Trabeculae thicker than 0.2 mm. have blood vessels in special canals and the lacunar canaliculi communicate with vascular spaces.

Compact bone has a rich vascular network that is disposed in the framework of the bone in a system of tubes, Haversian systems, having laminated walls. The walls of the canals have a composition and structure identical to that of the trabeculae.

The intercellular substance of bone is collagen imbedded in a cement substance impregnated with calcium salts. The main component is calcium phosphate in the form of hydroxyapatite crystals. Carbonates and magnesium salts lie in the cement substance associated with these crystals. Osteoblasts form the fibres, the cement substance and phosphatase, an enzyme liberating inorganic phosphate from compounds (esters) of phosphate. Calcium in tissue fluid unites with free phosphate liberated locally in high concentration to form insoluble calcium phosphate crystals. In this way osteoblasts form about themselves their bony encasement, leaving projections in canaliculi. As mature osteocytes, they maintain the bone structure.

Bone is constantly being resorbed. How resorption occurs is not clear. The process is continuous in the absence of osteoblasts and osteocytes. Osteoclasts, once thought to be responsible for bone resorption, are believed to be degenerating osteoblasts which fuse to form these multinucleated giant cells.

Two types of bone formation, intramembranous and endochondral, are recognized. The fundamental process is similar in both. Intramembranous formation is observed in the bones of the skull which are formed in a connective tissue membrane whence osteoblasts arise and produce bone. Endochondral formation is seen in the major part of the skeleton, which is formed first in a cartilage model. Vascular connective tissue from the perichondrium invades the cartilage model, which undergoes a series of transformations including preliminary calcification and dissolution of cartilage matrix and lacunae. On the residual spicules of calcified cartilage new bone is formed.

This type of formation is seen in the diaphysis (shaft) of a long bone and continues in the epiphyseal plate at the end of the long bones until growth of the bones is complete (28th year in man). Epiphyseal growth is by formation of new cartilage at the outer ends of the plate and ossification on the inner. Circumferential growth of bone is of intramembranous type from the periosteum. Bone is a living object. It is maintained and remolded under continuous stress via the processes outlined.

All bones have cortex (an outer rind) and more or less medulla (spongy central cavity). In the medulla is the bone marrow. Yellow (fatty) marrow is present in the shaft of long bones. Red marrow is the site of formation of the red and white cells of the blood; mixed with a variable quantity of fat, it is present in the ends of long bones, vertebral bodies, ribs and sternum.

See BONE; BONE MARROW; SKELETON, VERTEBRATE; *see* also references under "Connective and Supporting Tissues" in the Index volume.

See A. W. Ham and T. S. Leeson, *Histology,* 4th ed. (1961); A. A. Maximow and W. Bloom, *Textbook of Histology,* 7th ed. (1957).

(E. P. BT.)

CONNECTIVE TISSUE, DISEASES OF (COLLAGEN DISEASES) are those maladies in which the connective tissue is involved diffusely. The connective tissue (its nature and functions are discussed in the article CONNECTIVE AND SUPPORTING TISSUES), because of its uniform morphologic composition and functional activity, can be regarded as a biologic system of the body or even as an organ, although it is diffusely dispersed throughout the living organism. It can be affected locally by inflammation, or its cells, stimulated to excessive growth, may form local benign or malignant neoplasms. Because of their localized character such morbid processes are not included in the concept of connective tissue or collagen diseases, the term being restricted to diseases in which the tissue is implicated diffusely.

The morphological criteria upon which the term collagen disease is based are alterations of the intercellular substances of the connective tissue, the collagenous extracellular fibres and, above all, the homogenous ground substance. The hallmark of the structural changes is a characteristic microscopic appearance, commonly referred to as fibrinoid connective tissue damage, caused by the deposition within the homogenous ground substance of a substance microscopically similar to but not identical with fibrin. The small blood vessels in various parts of the body are frequently and conspicuously affected by the deposition of this abnormal material. It is undoubtedly of glycoproteinic nature, but the proteins concerned have not been adequately identified.

According to the definition of connective tissue diseases given above, the following maladies may be included: rheumatic fever, rheumatoid arthritis, generalized necrotizing arteritis (periarteritis nodosa), diffuse scleroderma, systemic lupus erythematosus and possibly dermatomyositis. These clinically and pathologic-anatomically well-defined diseases are similar in that they all show systemic alterations of the intercellular connective tissue components and that their etiology is largely unknown. These similarities, however, do not justify the assumption that the fundamental nature of the diseases is identical. In the past they were often regarded as being engendered by hypersensitivity. This

hypothesis was proposed because fibrinoid connective tissue damage has been provoked in animals made hypersensitive to foreign proteins. But later experiments demonstrated that similar lesions, particularly fibrinoid vascular lesions, can be elicited by other, different mechanisms, such as constant or transient vascular hypertension. Furthermore, histopathologic investigations of these diseases indicate that the fibrinoid substances in the individual maladies are not identical in their chemical constitution.

The apparent similarity therefore does not justify the assumption that there is a common factor which unites these diseases etiologically. A disease is diagnostically well defined only if its basic cause and the mechanism by which it provokes the clinical symptoms and the characteristic structural alterations are known. The term connective tissue diseases has often been misconstrued. It has no diagnostic validity and reflects only the heuristic concept that systemic alterations of the connective tissue are meaningful for the comprehension of the aforementioned maladies, and that further investigations should aim at the disclosure of all the factors responsible for these tissue changes. (P. Kr.)

CONNELLY, CORNELIA (1809–1879), U.S. religious, founder of the Society of the Holy Child Jesus and centre of an acrimonious ecclesiastical controversy in the mid-19th century, was born Cornelia Peacock in Philadelphia, Pa., Jan. 15, 1809. She was brought up as an Episcopalian and married at the age of 22 an Episcopalian clergyman, Pierce Connelly. While serving as rector of Trinity church, Natchez, Miss., Connelly became interested in the Roman Catholic Church, study of which led to the conversion of both him and his wife by 1836. In 1840 Connelly became convinced that he had vocation to the priesthood, and his wife was encouraged to separate from him and become a nun. This mother of four children signed the deed of separation in 1844 and took up residence in the Sacred Heart convent of Trinità dei Monti in Rome. Connelly was ordained in 1845.

In 1846 Bishop Nicholas Wiseman asked Mrs. Connelly to come to England and found an order for teaching English girls. The first house was opened, and in 1847 she took religious vows and was installed as first superior of the Society of the Holy Child Jesus. When she refused to allow her husband any participation in the new congregation he filed suit in the English courts for restitution of conjugal rights. Failing to win his case, he left the Catholic Church and began a campaign of vilification that lasted until his death. Cornelia Connelly bore it all with great equanimity and equal determination. She died in England on April 18, 1879. Renewed interest in her work and virtues in the 20th century broke what was almost a conspiracy of silence following the publicity of the controversy.

See *The Life of Cornelia Connelly* (1922) by a member of the Society; Juliana Wadham, *The Case of Cornelia Connelly* (1956).
(E. R. V.)

CONNEMARA, an area in County Galway, Republic of Ireland, lies west of Galway city and Loughs Corrib and Mask; area 302.6 sq.mi. It is a country of ancient rocks which has been scoured of its earth by ice sheets, strewn with large stones and blocks of rock left by the ice, and mainly covered with peat bog. From the coastal lowland, running west for over 20 mi. from Galway, the land rises gradually to over 1,100 ft.; this area is traditionally called Iar Connacht and extends to Bertaghboy bay which has numerous islands. The largest of these islands, Lettermore, Gorumna and Lettermullan, are linked with the mainland by road. West of the bay the true Connemara begins, with a fine varied coast, scores of islands, vast peat bogs, hundreds of lakes and, to the north of the Clifden-Galway road, the sharp jagged-peaked quartzite ranges of the Twelve Bens and the Maamturks with numerous summits over 2,000 ft. high. The population lives mainly in a belt a mile or so wide from the shore, where the land was laboriously made from sand, seaweed and other manures, with small fields protected by high walls. Connemara ponies are numerous in the coastal area. The only town is Clifden (pop. [1956] 986), at the end of the 50-mi.-long road from Galway. This remote market town was the terminus of a light railway from 1895 to 1935 and once a small port. Roundstone is a small village and seaside resort. The government has introduced some light industries and a peat-fired power station at Screeb, on Bertaghboy bay. Under a tomato-growing plan, greenhouses have been built on many of the farms. (T. W. Fr.)

CONNOLLY, JAMES (1870–1916), Irish socialist who played a decisive part in launching the Easter rising of 1916, was born in County Monaghan on June 5, 1870. He was the first dynamic advocate of socialism in Ireland and became an ardent apostle of class warfare among the miserably underpaid women workers in Belfast and the dock labourers in Dublin and other ports. He was James Larkin's chief assistant in organizing the Irish National Transport Workers union, which aimed at enrolling all Irish workers in support of every labour dispute. After experiencing many such "sympathetic strikes," the Dublin employers determined to break Larkin's union by a ruthless lockout (1913). Connolly, with his formidable energy and intellectual gifts as a journalist and editor, gave powerful support to Larkin's campaign for help from the British trade unions. Labour demonstrations were brutally dispersed, and Connolly organized a citizen army at Liberty hall. On the outbreak of World War I in 1914 Larkin was in the United States and Connolly assumed charge. He soon committed the Irish labour movement to opposing the Allied war effort, claiming that peace could come only through the overthrow of all capitalist states. His reckless impatience to start an armed rising in Dublin caused much anxiety to the Irish Republican brotherhood, which was secretly planning the insurrection for Easter 1916. The plans miscarried at the last minute, but Connolly insisted that some attempt must be made, however hopeless. P. H. Pearse and other leaders set out with him from Liberty hall to capture the general post office, where the Irish republic was first proclaimed. The rising was put down with much bloodshed and Connolly was executed at Kilmainham jail on May 12, 1916. (D. G.)

CONNOR, RALPH (pen name of Charles William Gordon) (1860–1937), Canadian clergyman and writer of popular fiction. The son of a Highland Scottish Presbyterian minister, he was born at Indian Lands in Glengarry county, Ont., on Sept. 13, 1860. After graduating from the University of Toronto in 1883, he studied divinity at Knox college (Presbyterian), Toronto, and the University of Edinburgh. Ordained in 1890, he became a missionary in mining and lumbering camps of the Canadian Rockies. This experience and memories of his Glengarry childhood provided the major background for his fiction. He was minister of St. Stephen's church in Winnipeg, Man., from 1894 to 1936. During World War I he became a senior chaplain in Flanders. He was one of those instrumental in the formation of the United Church of Canada in 1925.

Skill in compounding a religious message with wholesome sentiment and adventure made his first book *Black Rock* (1898) a best seller. Also popular were *The Sky Pilot* (1899); *The Man From Glengarry* (1901); *Glengarry School Days* (1902); *Corporal Cameron of the North West Mounted Police* (1912); *The Sky Pilot in No Man's Land* (1919); and *The Girl From Glengarry* (1933). He died in Winnipeg on Oct. 31, 1937. His autobiography *Postscript to Adventure* appeared in 1938. (G. H. Ro.)

CONNOTATION. That the meaning of a name may not be identified with its *denotation* (*see* Name [in Logic]) is readily made clear by means of examples. Thus "the Morning Star" and "the Evening Star" are two names of the same planet. It would be possible, however, to know the meaning of both names and even to have seen and identified the Evening Star on one occasion and the Morning Star on another, without knowing that they are the same. For it is not apparent from casual examination of the heavens that the Morning Star and the Evening Star are the same, but this was rather an early astronomical discovery established by a series of careful observations. Once this discovery is made, it is natural to introduce a third name, "Venus," to mean *the heavenly body which is the Morning Star and is the Evening Star.* But this same planet has also other names, for example, "the second planet from the sun." And to see that this name and the name "Venus" have different meanings, it suffices to remark that if an intra-Mercurial planet were discovered, we would not then say either that Venus does not exist or that Venus is the planet which was

previously called Mercury, but only that we were mistaken in supposing Venus to be the second planet from the sun. But if it should be found that, by some unimaginable error, the Morning Star and the Evening Star are after all not the same, we would then indeed be obliged to say, Venus does not exist.

In the light of this, the names "the Morning Star," "the Evening Star," "Venus," "the second planet from the sun" are said to have each a different *connotation* (or *sense*). But if accepted astronomical facts are correct, the four names have the same denotation.

The distinction of connotation and denotation was introduced by J. S. Mill in 1843. And a similar distinction of sense (German *Sinn*) and denotation (German *Bedeutung*) was introduced by Gottlob Frege in 1892, without reference to Mill.

Mill has the credit of having discovered this important distinction of two kinds of meaning. But Mill's treatment is in several respects less satisfactory than Frege's. In particular, Mill applies the distinction primarily to common names and (unlike Frege) denies connotation altogether to a large class of singular names, including all simple abstract singular names such as "courage," "whiteness." And it was Frege who first pointed out the equivocal usage of natural language by which a name, besides its ordinary use, may have in some contexts an *oblique* use, denoting the same which in its ordinary use it connotes.

See further MEANING, and SEMANTICS IN LOGIC. (Ao. C.)

CONOID, in geometry, any surface traced by a conic section (*q.v.*) rotating around either of its axes. Hence there are more varieties of conoids than of conics. These include: (1) The ellipsoid, which may be (*a*) a prolate spheroid, shaped like a lemon, formed when an ellipse rotates around its major axis, or (*b*) an oblate spheroid, shaped like the earth, formed when the rotation is around the minor axis; a special limiting case is (*c*) the sphere, formed when the ellipse becomes a circle, all diameters then being equal. Archimedes (*c.* 287–212 B.C.) preferred the term spheroid to ellipsoid. (2) The paraboloid, generated by a parabola rotating about its axis. All rays emerging from the focus would be parallel to the axis and would be reflected from the paraboloid, considered as a mirror, as one immense beam—whence the construction of paraboloidal reflecting surfaces in automobile headlights and reflecting telescopes. (3) The hyperboloid, either of one sheet (nappe), formed by rotation around the conjugate axis; or of two symmetric congruent sheets, formed when rotation is around the transverse axis. *See* ANALYTIC GEOMETRY; ELLIPSOID; PARABOLOID; HYPERBOLOID; SURFACE.

The equations of the conoids are: $x^2 + y^2 + z^2 = a^2$, for the sphere; $x^2/a^2 + (y^2 + z^2)/b^2 = 1$, for the prolate spheroid; $(x^2 + z^2)/a^2 + y^2/b^2 = 1$, oblate spheroid; $y^2 + z^2 = 4px$, for the paraboloid; $(x^2 + z^2)/a^2 - y^2/b^2 = 1$, for the hyperboloid of one sheet; $x^2/a^2 - (y^2 + z^2)/b^2 = 1$, for the hyperboloid of two sheets.

CONON (d. 687), pope from 686 to 687, was probably the son of a Thracian soldier. Brought up in Sicily and ordained in Rome, he was elected in his old age to succeed John V. Consecrated on Oct. 21, 686, he died Sept. 21, 687.

CONON (d. *c.* 390 B.C.), son of Timotheus, Athenian general. After having held several commands during the Peloponnesian War, he superseded Alcibiades as admiral in 406 B.C. He was defeated by the Spartan fleet and blockaded in Mytilene. The Athenian victory at Arginusae rescued him (406), and as he had not been present at the battle, he was not tried with the other generals. In 405 when the Athenian fleet was defeated at Aegospotami, Conon escaped to Cyprus. On the outbreak of the war between Sparta and the Persians (400) he obtained from Artaxerxes II (*q.v.*) joint command with Pharnabazus of a Persian fleet. In 394 he defeated the Spartans near Cnidus, and thus deprived them of supremacy at sea. He restored the long walls and the fortifications of the Piraeus. Imprisoned by Tiribazus when on an embassy from Athens to the Persian court to counteract the intrigues of Sparta, Conon probably died in Cyprus about 390.

CONON (fl., at Rome, second half of 1st century B.C.), grammarian and mythographer, was the author of a collection of Greek myths and legends, a number of which referred to the foundation of colonies. The work, dedicated to Archelaus Philopator, king of Cappadocia, contained 50 *Narratives;* an epitome, with brief criticisms, has been preserved in the works of the Byzantine scholar Photius. Nicolaus of Damascus is said to have made considerable use of the *Narratives.*

See U. Hofer (ed.), *Konon* (1890).

CONON OF SAMOS, Greek astronomer and geometer (3rd century B.C.), made astronomical observations in Italy and Sicily, but settled in Alexandria. He was the friend of Archimedes, who survived him.

Conon is best known in connection with the Constellation Coma Berenices (Hair of Berenice). Berenice, the wife of Ptolemy Euergetes, had in accordance with a vow dedicated her hair in the temple of Arsinoë of Zephyrium as an offering on the safe return of her husband from his Syrian expedition. It disappeared from the temple, and was declared by Conon to have been placed among the stars. Callimachus wrote a poem on the subject, of which only a few lines are preserved, but the imitation of it by Catullus is extant.

Conon wrote on astronomy in seven books, and made a list of the observations of solar eclipses recorded in Egypt. He also investigated the question of the maximum number of points of intersection of two conics, and of a conic and a circle.

CONQUEST, in traditional international law, refers generally to the acquisition of territory by the victorious state in a war, at the expense of the defeated state. Some authorities identify conquest with the provisional occupation of territory resulting from successful military operations, and describe the legal process of transferring title as "subjugation," if the defeated state is totally annexed by the conqueror, or as "cession," if the defeated state retains its identity and agrees by treaty to the alteration of the territorial status quo in favour of the victor. According to another view, the term conquest is dissociated from the physical appropriation of territory during hostilities and used as a synonym for subjugation as described above.

In either case, conquest is associated with the principle of traditional international law that sovereign states may resort to war at their discretion and, by military victory, achieve territorial and other gains that will be recognized as having legal validity. The state acquiring territory by conquest is regarded as the successor, with certain qualifications, to the rights and duties previously appertaining to the territory. Private rights, interests and property in the territory are not affected by the change of sovereignty, and legal rules applicable to such matters remain in effect until altered by the legislative authority of the new sovereign.

The international legal significance of the doctrine of conquest and its derivative rules has been challenged in the 20th century by the development of the principle that aggressive war is contrary to international law. This change may be traced through the covenant of the League of Nations, the Kellogg-Briand pact of 1928, the charters and judgments of the International Military tribunals created at the end of World War II to try war criminals of the Axis powers, and numerous other multipartite treaties, declarations and resolutions. The logical corollary to the outlawry of aggressive war is the denial of legal recognition to the fruits of such war; this implication was officially drawn by the United States government in the Stimson doctrine, enunciated by Secretary of State Henry L. Stimson on Jan. 7, 1932. It was subsequently affirmed by the assembly of the League of Nations and on several occasions by conferences of the American republics. The draft declaration on rights and duties of states, formulated in 1949 by the International Law commission of the United Nations, contained in article 11 the rule that states are obligated not to recognize territorial acquisitions achieved by aggressive war.

Nevertheless, it would be premature to assert that the traditional provisions of international law regarding the rights derived from conquest have been abandoned. Wars, legal or illegal, produce changes in the actual possession and control of territory, and the modifications of legal principle effected since World War I have not diverted states, in practice, from the tendency to give legal acknowledgment to actual alterations of territorial boundaries even those achieved by allegedly illegal warfare. *See* also AGGRES-

SION; ANNEXATION; SUCCESSOR STATE. (I. L. C.)

CONRAD, the name of four German kings, one of whom was also western emperor.

CONRAD I (d. 918) belonged to the powerful Franconian dynasty known as the Conradines, who had annihilated their local rivals, the Babenbergs. On Nov. 10, 911, he was elected German king at Forchheim after the death of Louis the Child, the last of the East Frankish Carolingians. It is not clear whether Conrad was supported by all the German nobles east of the Rhine or only by the Franks and Saxons. The Lotharingian nobles, however, turned to the West Frankish Carolingian, Charles III. In 913 Conrad married Kunigunde, a member of the Alahofing family of Swabia. His reign was a bitter and bloody struggle to uphold the traditions of Carolingian kingship against the growing power of the Saxon, Bavarian and Swabian stem leaders. His attempt to mobilize the episcopate in this cause at the synod of Hohenaltheim (916) could not compensate for the adverse balance of his campaigns. Conrad was in fact unable to establish his family as the new royal house in the East Frankish kingdom, and shortly before his death (Dec. 23, 918) he is reported to have proposed his opponent, the Liudolfing Henry of Saxony, as his successor.

CONRAD II (*c.* 990–1039), German king and western emperor, the first king of the Salian dynasty, was the great-grandson of the emperor Otto I's daughter Liudgard and Conrad the Red. After the early death of his father, Count Henry of Speyer (d. *c.* 1000), Conrad received little of the family's fiefs and allods in Rhenish Franconia; and the emperor Henry II for a time saw in him an enemy. His election to the throne in 1024 by an assembly which recognized his exalted lineage was opposed by a group of Lotharingian princes and prelates, who proposed a younger cousin and namesake of Conrad's as king. He was, however, able to disarm their opposition as well as Saxon recalcitrances, and in 1026 he went to Italy, being crowned emperor in Rome on March 26, 1027. Back in Germany, he broke the rising of his stepson, Duke Ernest of Swabia, by drawing the loyalties of his vassals to himself. Perhaps the future of the kingdom of Burgundy was at stake in this conflict, as the empress Gisela, who descended from the Welf kings of Burgundy, was Conrad's wife and Ernest's mother. When King Rudolf III, the last of the Welfs, died in 1032, Conrad succeeded to Burgundy and thus secured control over the western Alpine passes. On the eastern frontiers of the *Reich* the emperor's campaigns and negotiations more or less restored German ascendancy over Poles, Bohemians and the heathen Slav tribe of the Liutizi. A second expedition to Italy (1036–38) failed to subdue a Milanese rising in support of Archbishop Aribert, whom Conrad had had deposed. The German army was greatly weakened by disease, and Conrad himself died at Utrecht on June 4, 1039.

The characteristic features of Conrad's reign were a tight-fisted acquisitiveness which rebuilt and enlarged the royal demesne and the advancement of a class of unfree royal servants known as *ministeriales*. Their functions in the king's household and their military services became increasingly important at this time. Lastly, though Conrad had risen from the middling lay aristocracy and was new to the theocratic ideas and practices of Ottonian kingship, the crown's reliance on the church did not grow any less. The contradictions between his role as "king and priest" and his lay warrior habits did not pass unnoticed among contemporaries, and he was the first emperor whose rough ways of using the personnel and wealth of the church were attacked on principle by reformers. Yet Conrad was the most successful king of his dynasty. He brought back to the throne something of the down-to-earth temperament of the early Saxon rulers before their new, cosmopolitan connections and the predominance of their learned clerical advisers had alienated them culturally from their feud-hungry nobles.

(K. J. L.)

CONRAD III (1093–1152), German king, second son of Frederick I, duke of Swabia, and Agnes, daughter of the emperor Henry IV, was the first king of the Hohenstaufen family. In 1105 his father died and in 1106 his mother married Leopold III, margrave of Austria. In 1115 his uncle the emperor Henry V appointed him duke of Franconia. In 1116, together with his elder brother Frederick II, duke of Swabia, he was left by Henry as regent of Germany, and when the emperor died in 1125 Conrad doubtless expected his brother to succeed to the throne. But the 40 electors, rejecting the hereditary principle, chose Lothair, duke of Saxony, an enemy of the Salian dynasty. By the end of the year Frederick and Conrad were in revolt, and on Dec. 18, 1127, Conrad was elected antiking at Nürnberg. Hastening across the Alps, he was crowned king of Italy at Monza in June 1128, and in spite of the papal ban was generally acknowledged in northern Italy. The rival popes Innocent II and Anacletus II both declared against him; the Romans repudiated him; and after failing to seize the extensive possessions left by Matilda of Tuscany he returned to Germany in 1132. He continued the struggle against Lothair till 1135, when he submitted, was pardoned and recovered his estates. In 1136 he accompanied the imperial forces to Italy as standard-bearer, and sought to win the favour of Pope Innocent II.

In Dec. 1137 Lothair died. A number of the electors meeting at Coblenz chose Conrad as his successor on March 7, 1138, in the presence of the papal legate. Crowned at Aix-la-Chapelle six days later, he was acknowledged at Bamberg by several of the South German princes; but Henry the Proud, duke of Bavaria and Saxony, the son-in-law and heir of Lothair, refused his allegiance. Conrad, for his part, refused to recognize Henry's claim to Saxony on the ground that no one should hold two duchies at once. Attempts at a peaceful settlement of this rivalry failed. Henry was placed under the ban of the empire and deprived of both his duchies in July 1138. War broke out in Bavaria and Saxony and Conrad was unable to make much headway, in spite of Henry's death (Oct. 1139). The king's half-brother Leopold IV (d. 1141), margrave of Austria, to whom Bavaria had been entrusted, was defeated by Henry the Proud's brother Welf, later duke of Spoleto and margrave of Tuscany. Conrad, however, defeated Welf at Weinsberg in Dec. 1140, and peace with the Welf family followed at Frankfurt in May 1142: Henry the Lion, son of Henry the Proud, was confirmed in the duchy of Saxony, while Bavaria was given to Conrad's half-brother Henry Jasomirgott, margrave of Austria, who married Gertrude, widow of Henry the Proud. In spite of this peace the rivalry of the Welfs and the Hohenstaufen dominated German history for the rest of the century.

The solitary success amid the general disorder in the empire was Conrad's expedition into Bohemia in 1142, where he restored his brother-in-law Vladislav II as prince. An attempt to perform the same service for another brother-in-law, the Polish prince Wladyslaw (son of Boleslaw III), ended in failure. There was great disorder in Saxony, Bavaria and Burgundy; and in 1146 war broke out between the Bavarians and the Hungarians.

Bernard of Clairvaux's preaching, however, sent many turbulent nobles on the second crusade, thus providing some respite. In Italy Roger II, king of Sicily, had won considerable authority on the mainland and refused to recognize the German king, while Pope Lucius II implored Conrad's help against the rebellious Romans. Conrad allied himself with the Byzantine emperor Manuel Comnenus, who in 1146 married his sister-in-law; but Conrad's departure on the second crusade prevented the contemplated campaign against Roger. In Dec. 1146 Conrad took the cross, secured the election and coronation of his young son Henry as his successor, appointed Henry I, archbishop of Mainz, as his son's guardian and, in the autumn of 1147, set out for Palestine. Marching with a large and splendid army through Hungary, he reached Asia Minor, where his forces were decimated by disease and defeat. Stricken by illness, Conrad returned to Constantinople at Christmas 1147, but set out to rejoin his troops in March 1148. Having shared in the fruitless attack on Damascus, he left Palestine in Sept. 1148 and passed the winter at Constantinople, where he consolidated his alliance with the Byzantine emperor for an attack on Roger of Sicily. He reached Italy by sea; but the news that Roger had allied himself with Louis VII of France and with Welf of Bavaria forced Conrad to hurry back to Germany. He was detained there and could not visit Rome, in spite of invitations from the Romans; thus he never received the imperial crown.

Conrad died on Feb. 15, 1152, at Bamberg, where he was buried. By his wife, Gertrude, daughter of Berengar, count of Sulzbach,

he had two sons, the elder of whom, Henry, died in 1150. Passing over his younger son Frederick on account of his youth, he designated as his successor his nephew Frederick III, duke of Swabia, afterward the emperor Frederick I Barbarossa.

(X.; R. H. C. D.)

CONRAD IV (1228–1254), German king from 1237 and king of Sicily from 1251, was born at Andria in Apulia on April 26, 1228, the son of the emperor Frederick II and his second wife, Isabella (Yolande) de Brienne. Heir to the kingdom of Jerusalem through his mother, he was also invested by his father as duke of Swabia in 1235. At Vienna in Feb. 1237 he was elected king of the Romans in place of his half-brother Henry VII, who had rebelled against the emperor in 1235. After Pope Gregory IX had excommunicated Frederick II in 1239, Conrad was opposed by a growing papal party in Germany, led by the archbishops Siegfried of Mainz and Conrad of Cologne. In 1245 Pope Innocent IV declared both Conrad and his father deposed and proclaimed a crusade against them. On Aug. 5, 1246, Conrad was defeated near Frankfurt by the antiking Henry Raspe. He continued to be supported, however, by the towns and by Otto II of Bavaria, whose daughter Isabella he married on Sept. 1, 1246. On Dec. 13, 1250, Frederick II died. Troubles in Sicily and the rising strength of the papal party in Germany under Henry Raspe's successor, William of Holland, forced Conrad to abandon Germany for Sicily late in 1251, when he took the title of king of Sicily. Conrad's position in Sicily was secured by his capture of Naples in Oct. 1253, but his efforts to reach an understanding with the papacy failed. Preparing to march to Germany through central Italy he died at Lavello on May 21, 1254. (C. C. BA.)

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(K. J. L.)

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(X.; R. H. C. D.)

Conrad IV: See J. Bühler, *Die Hohenstaufen* (1925); E. Maschke, by H. Kämpf (1940); S. Runciman, *The Sicilian Vespers* (1958).

CONRAD THE RED (d. 955), duke of Lotharingia and ancestor of the Salian dynasty of German kings, belonged to a family of Franconian counts with a rich patrimony in the country round Speyer and Worms. In the aftermath of the first great rising (937–939) against King Otto I he supported Otto and became one of his closest followers. Otto gave him the duchy of Lotharingia (*see* LORRAINE) in 944 and his daughter Liudgard in marriage three years later. From Lotharingia, Conrad assisted the Carolingian ruler of France, Louis IV, against Hugh the Great and others. He accompanied Otto on his first expedition to Italy in 951 and was left in charge there. When the king refused to back his policy of reconciliation with the defeated but not powerless Italian ruler Berengar II, Conrad joined his already disaffected brother-in-law, Liudolf of Swabia, and with a host of other malcontents they rose in rebellion (953–954). The rebels were at first successful, but a Hungarian invasion which they were accused of having instigated turned the scales against them. Conrad had to submit and lost his duchy but not his lands in Franconia nor his vassals. He fell at the battle of the Lechfeld on Aug. 10, 955, when the largest Hungarian army to enter Germany was destroyed; it seems that his services were decisive in giving Otto his great victory.

See P. Hirsch and H. E. Lohmann (eds.), *Die Sachsengeschichte des Widukind von Korvei* (1935); R. Holtzmann, *Geschichte der Sächsischen Kaiserzeit* (1941). (K. J. L.)

CONRAD, JOSEPH (JÓZEF TEODOR KONRAD NALECZ KORZENIOWSKI) (1857–1924), Polish-born writer who became one of the greatest novelists in the English language, was born at Berdichev in the Polish Ukraine, then under Russian rule, on Dec. 3, 1857. His father, a landowner of literary tastes, was exiled to northern Russia for participation in the movement for Polish independence; both Conrad's parents died before he was ten, leaving him in Cracow in the care of his uncle, Tadeusz Bobrowski.

Conrad first had the idea of going to sea in 1872, a strange decision for one whose family had no nautical tradition and whose country had no seacoast. At 17, he went to Marseilles, from where he twice sailed in French ships to South America. On his return he became involved in gunrunning for the forces of Don Carlos, pretender to the Spanish throne, and in a passionate love affair, both of which episodes he treated in *The Arrow of Gold* (1919), a novel which found favour with few critics. An unsuccessful attempt at suicide brought this period of his life to an end. After his recovery he shipped in an English vessel and landed at Lowestoft, Suffolk, in 1878, speaking only a few words of the language of which he was to become a recognized master.

He rose in the merchant service and in 1886 received his master mariner's ticket and his certificate of naturalization, shortly afterward obtaining his first command. During this period and for some years thereafter he served mostly in those eastern waters which were to form the background of his early works, though he also made one voyage up the Congo. He was at the time writing his first novel, *Almayer's Folly* (1895), and the experiences of the journey, which later took shape in his conte, *Heart of Darkness* (1902), were of immense significance to him. "Before the Congo," he once wrote in a letter, "I was just a mere animal." *The Mirror of the Sea* (1906), one of his two volumes of reminiscence, bears witness to the importance for him of his life as a sailor, and of the satisfactions of the stern duties which it laid upon him.

Almayer's Folly was followed in 1896 by *An Outcast of the Islands,* which repeats many of its themes. These two novels provoked a misunderstanding of his talents and purpose which dogged him the rest of his life. Set in the Malayan archipelago, they caused him to be labeled a writer of exotic tales, a reputation which a series of novels and short stories about the sea—*The Nigger of the "Narcissus"* (1897), *Lord Jim* (1900), *Youth* (1902), *Typhoon* (1903) and others—seemed only to confirm. But words of his own about the *Nigger* give the real reason for his choice of settings: "the problem . . . is not a problem of the sea, it is merely a problem that has risen on board a ship where the conditions of complete isolation from all land entanglements make it stand out with a particular force and colouring." This is equally true of his other works; the latter part of *Lord Jim* passes in a jungle village not because the emotional and moral problems which interest Conrad are those peculiar to jungle villages, but because there Jim's feelings of guilt, responsibility and insecurity—feelings common to mankind—work themselves out with a logic and inevitability which are enforced by his isolation. It is this purpose, rather than a taste for the outlandish, which distinguishes Conrad's work from that of many novelists of the 19th and early 20th centuries. They, for the most part, are concerned to widen the scope of the novel, to act, in Balzac's phrase, as the natural historians of society; Conrad aims at the isolation and concentration of tragedy.

It must be remembered also that he was a writer who drew extensively on his own experience, and that when he began writing he was more familiar with ships and tropical harbours than with London streets. He settled on shore in 1893, never making a specific decision to give up the sea, but finding that writing demanded his whole attention.

In 1896 he married Jessie George, by whom he had two sons. He was granted a small Civil List pension, but gave it up when the sales of his books assured his livelihood. Nevertheless he did not achieve popular success until the publication of *Chance* in

1913. His health was uncertain—he suffered from rheumatic gout which resulted from his voyage up the Congo—and his letters show the financial anxieties which beset him. Nor did writing come easily. He produced 13 novels, 2 volumes of memoirs and 28 short stories, many of considerable length, before his death at Bishopsbourne, Kent, on Aug. 3, 1924, and hardly one was written without agonizing struggles. He said when he completed the book which critics consider his masterpiece, "*Nostromo* is finished; a fact upon which my friends may congratulate me as upon a recovery from a dangerous illness."

Such a choice for his masterpiece would hardly have been made in his lifetime. In his own day he was praised for his power to depict life at sea and in the tropics and for qualities of "romance" —a word seeming generally to mean his power of using an elaborate prose style to cast a film of illusory splendour over somewhat sordid events. His reputation diminished after his death and revival of interest in his work directed attention to different qualities and, inevitably, to different books.

An account of the themes of some of these books should indicate where modern critics lay emphasis. *Nostromo* (1904), a story of revolution, politics and financial manipulation in a South American republic, centres, for all its close-packed incidents, upon one idea—the corruption of the characters by the ambitions which they set before themselves, ambitions concerned with the silver which forms the republic's wealth and which is the central symbol around which the novel is organized. The ambitions range from simple greed to idealistic desires for reform and justice. All lead to moral disaster, and the nobler the ambition the greater its possessor's self-disgust as he realizes his plight.

Heart of Darkness, which follows closely the actual events of Conrad's Congo journey, tells of the narrator's fascination by a mysterious personage who, by his eloquence and hypnotic personality, dominates the primitive savages. Full of contempt for the greedy traders who exploit the natives, he cannot deny the power of this figure of evil who calls forth from him something approaching reluctant loyalty. *The Secret Agent* (1907), a sustained essay in the ironic, deals with the equivocal world of anarchists, police, politicians and *agents provocateurs* in London. One of its chief characters, Mrs. Verloc—probably Conrad's most successful study of a woman, free from his usual sentimentally chivalrous adoration of his heroines—has a philosophy which underlies all these books; she believes that "things don't bear looking into very much."

Conrad's view of life is indeed deeply pessimistic. In every idealism are the seeds of corruption and the most honourable men find their unquestioned standards totally inadequate to defend them against the assaults of evil. It is significant that he repeats again and again situations in which such men are obliged to admit emotional kinship with those whom they have expected only to despise. This well-nigh despairing vision is embodied in the themes, the characters, the style and the symbolism of the works. It gains much of its force from the feeling that Conrad accepted it reluctantly; not with morbid enjoyment. "Believe me," Conrad wrote in a letter, "no man paid more for his lines than I have."

It was perhaps inevitable that such a vision was so desolating for him that he wished to deny it and, in such later works as *Chance, Victory* (1915) and *The Rover* (1923) this complex presentation of the good man haunted by an evil shadow is usually replaced by conflict between unbelievably good and unbelievably wicked men, expressed in lush rhetoric—always a temptation to Conrad—in an attempt to make it more convincing. But in four or five novels and rather more short stories Conrad presents an intense if, some would say, a one-sided vision of the world which places him among the greatest of English writers, and it is on these earlier works that his reputation is likely to rest.

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CONRADIN (CONRAD THE YOUNGER) (1252–1268), duke of Swabia, son of Conrad IV, king of the Romans, and grandson of the emperor Frederick II, was born at Wolfstein in Bavaria on March 25, 1252. After his father's death in 1254, he inherited a claim to the kingdom of Naples, but Frederick II's natural son Manfred, who had asserted his power in the kingdom already before Conrad's death, was crowned king in 1258, a rumour having spread that Conradin was dead. In 1262 Conradin took possession of the duchy of Swabia. After Charles of Anjou (*see* CHARLES I of Naples), whom Pope Clement IV had invested with Sicily, had at Benevento defeated Manfred, who perished in the battle (Feb. 1266), the Italian Ghibellines appealed to Conradin to come and conquer the kingdom from Charles, and Conradin entered Italy in Sept. 1267. Meanwhile, a revolt in his favour had broken out in Sicily; and in Rome the new senator, the infante Henry of Castile, declared himself openly for him. The Ghibelline cities of Verona (where he stayed nearly three months), Pavia, Pisa and Siena welcomed Conradin, and on July 24, 1268, he made a triumphal entry into Rome. He left Rome on Aug. 14 for the kingdom; on Aug. 23, he was defeated by Charles near Tagliacozzo, after victory had been all but assured to him. He fled to Rome, but there the Guelphs were gaining the upper hand; while attempting to escape by sea, perhaps to Genoa, he was arrested at Astura and handed over to Charles. Condemned to death for treason, he was executed on the Campo Moricino in Naples, together with his faithful companion Prince Frederick of Baden, on Oct. 29, 1268. With Conradin's death, the Hohenstaufen dynasty became extinct.

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CONRAD VON HÖTZENDORF, FRANZ, GRAF (1852–1925), the outstanding military figure and one of the most influential conservative political figures of Austria-Hungary, was born at Penzing, near Vienna, on Nov. 11, 1852. As a brigadier in Trieste in 1899 his observation of Italian Irredentist propaganda inspired him with a lasting mistrust of Italy's reliability in the triple alliance. In Trieste he also made the acquaintance of the archduke Francis Ferdinand (*q.v.*), whose ideas coincided with his own in many respects and through whose influence he was appointed chief of staff in 1906. Every spring he presented the emperor Francis Joseph with a plan for war.

Finding that the army was technically out-of-date, Conrad set himself to reorganize it, especially the artillery. His activities earned him the hatred not only of the German liberals but also of the Slavs and the Magyars, all of whom, though for different reasons, were opposed to an aggressive policy. Conrad's most serious conflict, however, was with the emperor and the minister of foreign affairs, Graf Aehrenthal. Conrad was convinced that Austria-Hungary could not avoid a conflict with Serbia and, further, that Italy must be considered as an enemy. Both before and after the annexation of Bosnia-Hercegovina he urged that the only solution of the southern Slav question would be the "preventive" annexation of Serbia. When Italy became involved in war with Turkey in 1911, he advocated a "preventive" war against his country's ally. This suggestion led to such a conflict of views with Aehrenthal that Conrad was forced to resign and was appointed inspector of the army. He was reinstated a few months later, in 1912, when events in the Balkans again grew critical.

Conrad's strategy in World War I, developed in the offensives against the Russians, is generally recognized as sound, though it was not successful. When the new emperor, Charles, took over command of the army from the archduke Frederick, he resented Conrad's assured manner and dismissed him. Conrad commanded an army group on the Italian front from March 1917 until July 1918.

Conrad's political views likewise aroused much controversy. He believed in the maintenance at all costs of the dynastic power of the Habsburgs and disregarded the probable repercussions of any military initiative on the structure of alliances. As a strategist he was bold and skilful but unlucky; his chief failing was an often faulty judgment of human character. He withdrew into pri-

vate life after 1918 and devoted himself to the composition of his memoirs: *Mein Anfang, 1878–82* (1925) and *Aus meiner Dienstzeit, 1908–18*, 5 vol. (1921–25). His military works include *Zum Studium der Taktik*, 2 vol. (1891); enlarged ed., 2 vol. (1894). He died at Mergentheim on Aug. 25, 1925.

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CONRART, VALENTIN (1603–1675), French man of letters, first secretary of the Académie Française, was born at Valenciennes in 1603. In 1627 he became councilor secretary to the king, and about the same time he began to invite writers to his house. From this circle the Académie Française came into being. Conrart played an influential part, entertaining numerous writers, lending them money and patching up their quarrels. He died in Paris, Sept. 23, 1675.

Conrart has no claim to be considered an original writer, and published only three prefaces. He did, however, write his own memoirs (published in 1825) and some notes on grammar. Yet his influence was great. He corrected books by Antoine Godeau, Vaugelas and Perrot d'Ablancourt line by line; and these corrections, prompted by his regard for clarity, economy and purity of style, provided the model on which French classical prose was based.

See A. Bourgoin, *V. Conrart et son temps* (1883); A. Adam, *Histoire de la littérature française au XVII siècle*, i, pp. 239–241; ii, pp. 156–157 (1948–56). (Ae. A.)

CONS, EMMA (1838–1912), English philanthropist best known for the work she did to provide good amusement at a cheap rate at the Royal Victoria hall, later popularly known as the "Old Vic." With assistance from Samuel Morley she rescued this theatre, which had a poor reputation, from melodrama and instituted programs of music, drama and lectures.

Emma Cons was born in London on March 4, 1838. Through an acquaintance with Octavia Hill she became interested in a number of housing schemes in London and was the first lady alderman to be elected to the London county council (1888). Her legal right to stand was, however, questioned and together with the two women councilors elected in 1889 she resigned in 1890.

She died at Hever, Kent, on July 24, 1912. Her house and 26 ac. of ground were given to the National Trust. (J. My.)

CONSALVI, ERCOLE (1757–1824), Italian cardinal who as secretary of state under Pope Pius VII played a considerable role in diplomacy during the Napoleonic period and was remarkable for the liberalism of his policy under the Restoration, was born at Rome on June 8, 1757, the eldest son of a noble family. During his early years, he enjoyed the protection and patronage of the cardinal duke of York (Henry Stuart), whose diocesan seminary at Frascati he attended. Entering the papal service as a privy chamberlain in 1783, he was made a domestic prelate in 1784 and appointed to the Congregazione di Buon Governo in 1786. After judicial experience as a member of the Signatura he reached the coveted post of auditor of the Rota in 1792. This office gave him the opportunity for other administrative work and he even undertook the reorganization of the papal military forces in 1797. However, the French occupation of Rome in 1798 interrupted his career: he was at first imprisoned by the French and then went into exile.

In Nov. 1799 the conclave which was to elect a new pope met in Venice under Austrian protection. With the co-operation of the French cardinal Jean Siffrein Maury, Consalvi, who was secretary to the conclave, succeeded in avoiding the election of the Austrian candidate and procured instead that of Pius VII (March 1800). In gratitude and friendship the new pope created Consalvi a cardinal-deacon and appointed him secretary of state (a position equivalent to that of prime minister). Consalvi now carried out two important tasks, the reform of administration and the negotiation of the concordat with France (July 15, 1801). The second was the more impressive and more exacting, and Consalvi's success in obtaining concessions from Napoleon Bonaparte is perhaps best shown by the issue of the "organic articles," the device by which Napoleon sought to interpret the concordat in a decisively Gallican sense. The administrative reforms inside the papal states were less lasting in their effect and encountered much opposition, but Consalvi succeeded both in introducing more laymen into the administration and in making some economic and fiscal improvements.

Although Consalvi had encouraged Pius VII to take part in Napoleon's coronation as emperor, Napoleon came to consider Consalvi as his enemy in Rome and forced his resignation from the secretaryship of state (June 17, 1806). In 1809, when Napoleon abolished the temporal power of the pope, Consalvi was compelled to go to Paris. There he showed great firmness in resisting the inducements by which Napoleon's ministers sought to persuade him to give some explicit or implicit recognition to the legality and justice of the emperor's treatment of the Holy See. His resistance was carried to the point of refusing, with 12 other cardinals, to attend Napoleon's marriage to Marie Louise, since he was unwilling to anticipate any judgment that the pope might make about the validity of Napoleon's first marriage. For this he was exiled to Reims, where he remained until Pius VII came to terms with Napoleon at Fontainebleau (Jan. 25, 1813).

In 1814 Consalvi was sent as papal plenipotentiary to the congress of Vienna. He was successful in obtaining the restitution of most of the papal territories (but not Avignon or the Comtat-Venaissin) and subsequently returned to Rome to take up again the office of secretary of state. Besides presiding over the negotiation of a number of important concordats, during 1817–23, he also strove to restrain the reactionary *zelanti* among the restored hierarchy and to minimize the interference of Austria with the Holy See and its possessions. A *motu proprio* of July 6, 1816, indicated clearly his liberal intentions, and tolerance was shown to those who had served Napoleon and Joachim Murat. Unfortunately, the subversive activity of secret societies made it impossible for Consalvi to counteract the influence of the reactionary party or to press on with practical reforms such as the colonization of the Campagna. He did much, however, to embellish Rome itself.

Pope Leo XII, who succeeded Pius VII in 1823, was violently opposed to Consalvi's moderate measures and removed him from the position of secretary of state. He was appointed prefect of the Propaganda but his period of effective office was at an end. He died at Anzio on Jan. 24, 1824. There are editions of Consalvi's memoirs by J. Crétineau-Joly, 2 vol. (1864); and of his correspondence with Metternich, from 1815, by C. van Duerm (1899) and with Cardinal Pacca, in 1814–15, by I. Rinieri (1903).

See E. L. Fischer, *Cardinal Consalvi* (1899); M. Petrocchi, *La Restaurazione: il cardinale Consalvi e la riforma del 1816* (1941) and *La Restaurazione romana (1815–1823)* (1943). (J. M. Rs.)

CONSANGUINITY, in law, the connection or relation of persons descended from the same stock or common ancestor, as distinguished from affinity, which is the connection by reason of marriage between each of the spouses and the relations of the other. Consanguinity is either lineal or collateral. Lineal consanguinity exists between persons who are descended in a direct line, one from the other, such as father-son-grandson, while collateral relations, such as uncle-nephew, descend from a common ancestor but not in direct line. In the law of inheritance the question of consanguinity is especially significant in determining the distribution of the property of a person who has died without leaving a will (*see* Inheritance). Consanguinity is also important in marriage law, where two persons may be so closely related that marriage between them is prohibited (*see* Marriage, Law of). Similarly, sexual intercourse between persons within certain degrees of consanguinity may constitute the crime of incest (*q.v.*). *See* also Intestate Succession; Kinship.

CONSCIENCE, HENDRIK (1812–1883), Flemish romantic novelist, who dominated the birth and development of the Flemish novel, was born at Antwerp, Dec. 3, 1812, the son of a French father and a Flemish mother. During his delicate childhood his imagination was roused by the stories told by his mother, the old books he found in the attic and with which he learned to spell, the slapstick plays he saw at the Punch and Judy show and the

reading of cheap popular literature about medieval life. After his mother's death (1820), when he and his father went to live outside the town walls, the boy discovered nature, which was to remain a constant solace and which inspired him to write the remarkable *Enige bladzijden uit het boek der natuur* ("A Few Pages From the Book of Nature"; 1846).

After several years as an assistant teacher, he enlisted in the army in 1831. He soon fell under the spell of the Campine, a quiet region of pinewoods and heather. About this time he was introduced to French romanticism and began to write French verse. Demobilized in 1836, he entered the enthusiastic literary and artistic life of Antwerp, then strongly influenced by national romanticism: he was fascinated by his country's past and wrote (1837) *In't wonderjaar* ("In the Year of Miracles") a series of 16th-century historical scenes. With *De Leeuw van Vlaanderen* ("The Lion of Flanders"; 1838)—the epic story of the revolt of the Flemish municipalities against France, and their victory at the battle of the Golden Spurs (1302)—he became not only the creator of the Flemish novel but the author of one of the outstanding novels of European romanticism.

To earn a living, Conscience then worked successively as a clerk of the provincial administration, a gardener's helper and a clerk-recorder at the Academy of Fine Arts. From 1841 to 1857 he also took an active part in local politics. After 1840 he turned more and more to an idyllic realism and wrote novels and tales about urban and rural life, often trying to point a moral—*Wat een moeder lijden kan* ("What a Mother Can Suffer"; 1844); *Siska van Roosemael* (1844); *Baas Gansendonck* (1850); *Houten Clara* ("Wooden Clara"; 1850); *De arme edelman* ("The Poor Gentleman"; 1851); as well as incomparable village idylls—*Blinde Rosa* (1850); *De Loteling* ("The Conscript"; 1850); *Rikke-tikke-tak* (first published serially, 1845; as a book, 1851). At the same time his historical novels (*e.g., Jacob van Artevelde;* 1849) took a more definite shape. He was now at the height of his genius, and his works became widely known through translations. In 1856 he became district commissioner for Courtrai and in 1868, curator of the Wiertz museum in Brussels. But, although his circumstances were improved, his spendthrift manner of life and the burdens of an expensive household caused him to write more, sometimes to the detriment of his style. Some of the many books of this last period are of interest, among them *Het Goudland* ("The Land of Gold"; 1862), the first Flemish adventure-novel, and *De Kerels van Vlaanderen* (1871), a historical novel. The publication of his 100th book in 1881 led to unprecedented demonstrations, and in 1883 a statue was set up in his honour in Antwerp. He died in Brussels, Sept. 10, 1883.

Conscience's influence on his compatriots cannot be overestimated. He was the most important and popular artificer of both the literary and the national Flemish renaissance in the 19th century. His narrative art, his inexhaustible imagination, his life-like portrayal of people and events, and, above all, his rich sensibility, go far to compensate for the impurities of his language and his restricted means of expression. His historical novels will stand comparison with those of Sir Walter Scott, the elder Dumas, Victor Hugo and Manzoni. In his rural tales he deliberately simplifies and purifies life: what Frank Harris calls his "sweet healthfulness" is a conscious expression of his idealistic philosophy. His village idylls of the Campine—real pastorals in prose—evoke a small world full of kindness and humanity, which never fails to charm the reader, who enters it as he would an unspoiled part of nature.

BIBLIOGRAPHY.—There are numerous translations of the individual novels into English, French and German; collected translations include *Short Tales,* 13 vol. (1856–75) and *Tales,* 10 vol. (1888–75). Two volumes of letters, *Briefwisseling van, met en over Hendrik Conscience . . . 1837–1851,* were ed. by A. Jacob (1913–14). *See* also G. Eckhoud, *Henri Conscience* (1881); R. Zellweger, *Les débuts du roman rustique, 1836–1850* (1941); E. de Bock, *Hendrik Conscience en de opkomst van de Vlaamsche romantiek,* 2nd ed. (1943); F. Smits, *Henri Conscience et le romantisme flamand* (1943); G. Degroote and Jan de Schuyter, *Hendrik Conscience en zijn uitgevers* (1953); G. Degroote, *Wat een schrijver lijden kan* (1957). (R. F. Ls.)

CONSCIENCE, a philosophical term used both popularly and technically in many different senses for that mental faculty which decides between right and wrong. In popular usage "conscience" is generally understood to give intuitively authoritative decisions as regards the moral quality of single actions; this usage implicitly assumes that every action has an objective or intrinsic goodness or badness, which conscience may be said to discern much in the same way as the eye sees or the ear hears. Moralists generally, however, are agreed that in all moral judgments of this character there is an implied reference to moral laws, the validity of which is in some ethical systems the true subject matter of conscience. The part played by conscience in relation to general moral laws and particular cases will vary according to the view taken of the character of the general laws. If, on what is called the "jural" theory, these laws are regarded as deriving their authority from an external source, the operation of conscience is so far limited. It may be held to recognize the validity of divine laws, for example; or it may be confined to the deductive process of applying those laws to particular cases, known as "cases of conscience" (*see* CASUISTRY). If, on the other hand, the general laws are regarded as intuitive, then the discernment of them may be taken as the true function of conscience. In either theory, conscience may be understood as the active principle in the soul which, in face of two alternatives, tells a man that he ought to select the one which is in conformity with the moral law. Apart from the two functions of discerning between right and wrong, and actively predisposing the agent to moral action, conscience has further a retrospective action whereby remorse falls upon the man who recognizes that he has broken a moral law. (*See* CHARACTER; ETHICS.)

There are certain special uses of the word conscience. A conscience clause is the term given to a special provision often inserted in an English act of parliament to enable persons having religious scruples to absent themselves from certain services or to abstain from certain duties, such as war service as a combatant, otherwise prescribed by the act. Conscience money is the name given to a payment voluntarily made by a person who has evaded his obligations, especially in respect of taxes and the like. This usage derives from the last function of conscience mentioned above. Conscience courts were local courts, established by acts of parliament in London and various provincial towns, for the recovery of small debts, usually sums under £5. They were superseded by county courts (*q.v.*).

See also references under "Conscience" in the Index volume.

CONSCIENTIOUS OBJECTOR, one who is opposed to bearing arms or who objects to any type of military training and service. In some cases, conscientious objectors refuse to submit to any of the procedures of compulsory conscription. Although all objectors take their position on the basis of conscience, they have varying religious, philosophical or political reasons for their beliefs. Legal provision for conscientious objection is made in most of the English-speaking and Scandinavian countries, but in only a few other nations which employ compulsory conscription.

Religious objections to military service developed as a major emphasis of the Mennonites (*q.v.*) in various parts of Europe in the 16th century, the Society of Friends in England in the 17th century (*see* FRIENDS, SOCIETY OF), and in the 18th century the Church of the Brethren (*q.v.*) in Germany and the Dukhobors (*q.v.*) in Russia. These groups were persecuted at times for refusal to bear arms.

United States.—During the American Revolution and the American Civil War conscientious objectors were required to provide a substitute for military service or pay a commutation fee. In World War I conscientious objectors were exempted by law from combatant service. When several thousand refused to perform any type of military service they were detained in army camps and many were court-martialed. During the last five months of the war about 1,300 were assigned to agricultural or relief work.

The Selective Training and Service act of 1940 granted exemption from combatant training and service or from all military service to persons who were opposed to participation in war "by reason of religious training and belief." During World War II religious beliefs were construed by the courts to include humanitarian beliefs of atheists. A presidential report estimated that

25,000 conscientious objectors served in noncombatant duty, chiefly in the army medical corps. There were 12,000 assigned to civilian public service, where they worked in land reclamation and farm work, public sanitation, forest fire fighting, state and veterans' mental hospitals; a few served as test subjects in medical experiments. They received no pay or accident compensation. Their food and maintenance were paid by themselves or by the churches, with the exception of a few conscientious objectors who preferred to work in three government-operated camps. All religious groups were represented, but the largest numbers during World War II were the Mennonites, Seventh-day Adventists, Jehovah's Witnesses, Church of the Brethren and Society of Friends. Of the 5,800 imprisoned for violation of the Selective Service act, 4,300 were Jehovah's Witnesses. Although the provisions were broadened greatly compared to World War I, the government's policies resulted in a larger number of convictions.

The Universal Military Training and Service act of 1948 added a definition of religious training and belief as an "individual's belief in a relation to a Supreme Being involving duties superior to those arising from any human relation, but does not include essentially political, sociological or philosophical views or a merely personal moral code." Under this act recognized objectors worked for government or nonprofit agencies on approved projects contributing to the national health, safety or welfare.

By the Immigration and Nationality act of 1952 alien applicants for citizenship who declared themselves conscientious objectors to all forms of military service were permitted to become naturalized citizens of the United States. (E. J. M.)

Great Britain.—In World War I, when compulsory military service was brought into operation in Great Britain, any man could apply to a specially established local tribunal for exemption on the grounds that he had conscientious objection to undertaking combatant service. There was an appeal to an appeal court. Exemption might be absolute, or conditional on the applicant's engaging in some work which in the opinion of the tribunal was of national importance.

A noncombatant corps was established but many conscientious objectors refused to belong to it and it was alleged by religious bodies that during 1916–19 out of 16,000 known conscientious objectors at least 5,793 were court-martialed, and that 1,500 conscientious objectors refused to accept conditional exemption and elected to stay in prison rather than be released for alternative service. The Society of Friends established the Friends Ambulance unit which many conscientious objectors were allowed to join.

More satisfactory arrangements were made in World War II. Local tribunals were established under the National Service act of 1939, each with a judge as chairman. Three types of exemption could be granted: (1) unconditional; (2) conditional on the undertaking of civil work specified by the tribunal; (3) exemption only from combatant duties. Under the National Service act of 1941 conditionally registered conscientious objectors became liable for civil defense. Conscientious objectors registered during the war years represented 0.77% of the total number of men registered. When national service was extended to women in 1941 the provisions as to conscientious objection were applied to them. The proportion of women who so registered varied from 0.16% to 0.45% in each year.

The tribunals considered approximately 60,000 cases. They were given no guidance by statute or regulation on which to reach decisions, and each case was in their discretion subject to appeal to an appellate tribunal. About 80% of the claims for exemption were allowed. Decisions adverse to objectors resulted in about 5,700 civil prosecutions and more than 1,500 courts-martial. Under the National Service act of 1948 provision was made for placing persons subject to registration on a list of conscientious objectors. A person so registered is not liable to be called up for service. (Jn. M.)

Other Countries.—Legal provision for conscientious objectors is made in all countries of the Commonwealth of Nations that have conscription, and in the colonial territories. Usually, objectors may be called upon for noncombatant service and are liable to punishment, ranging from a heavy fine to a period of imprisonment, for failure to register. In some cases they are also called upon for civil defense duties, to which no conscientious objections are allowed.

In the countries of continental Europe, practices varied widely in the early 1960s. Belgium, France, Greece, Italy, Luxembourg, Poland, Portugal, Spain, Switzerland, the U.S.S.R. and Yugoslavia had no legal provisions for conscientious objectors, and in some countries, notably France, Greece (where objectors had been shot) and Yugoslavia (where the penalty was 12 years in the mines) penalties for objectors were severe. In the U.S.S.R., although there was no legal provision, some types of objection were recognized administratively.

In the German Federal Republic, provision for conscientious objectors was made for the first time when the 1957 conscription law was passed. There was no conscription in the German Democratic Republic. All the Scandinavian countries recognized objectors, although Sweden enforced civil defense duties and allowed no appeal against them.

The only Latin-American country to recognize conscientious objectors was Paraguay, which had special regulations for Mennonites. Another interesting case was that of Israel, where women were subject to conscription unless they objected to military service on religious and moral grounds. (X.)

See also Conscription; Pacifism: *Conscientious Objection.*

Bibliography.—*The Parliamentary History of Conscription in Great Britain* (1917); Denis Hayes, *Challenge of Conscience* (1949) and *Conscription Conflict* (1949); G. C. Field, *Pacifism and Conscientious Objection* (1945); E. L. Allen *et al., The Case for Pacifism and Conscientious Objection* (1946); F. M. Stratman, *War and Christianity Today* (1956).

CONSCIOUSNESS. The word "conscious" has been used in many different senses. By origin it is a Latin compound, meaning "knowing things together," either because several people are privy to the knowledge or (in later usage) because several things are known simultaneously. By a natural idiom it was often applied, even in Latin, to knowledge a man shares, as it were, with himself; *i.e.*, self-conscious or attentive knowledge. The first to adopt the word in English was Francis Bacon (1601), who speaks of Augustus Caesar as "conscious to himself of having played his part well." John Locke employs it in a philosophical argument in much the same sense: "a man, they say, is always conscious to himself of thinking." And he is the first to use the abstract noun. "Consciousness," he explains, "is the perception of what passes in a man's own mind" (1690).

As a Substance.—In the early 19th century, psychology, which then began to emerge as a separate branch of natural science with a name of its own, was frequently defined as the "science of consciousness"; and the noun thus came into regular use as a convenient generic label to cover (according to William James, who borrows this definition of psychology) "sensations, mental images, thoughts, desires, emotions, volitions, and the like"—in a word, all the miscellaneous elements of experience of which we are aware at any one time. The older empiricists called them "ideas" (using this term in a rather wide sense), and described them as "in the mind" or as the "basic units of the mind." And consciousness was thus treated as itself a sort of "mental stuff," a peculiar sort of substance, quite different from the material substance of which physical objects are composed.

As an Attribute.—Later writers used the word in a looser and more general sense. A simplified version of the old scholastic notion of a "scale of nature" led to the doctrine, most clearly formulated by Carolus Linnaeus, of three natural "kingdoms"—mineral, vegetable and animal. This recognized three progressive types of being: first, the merely material (stars, planets, the earth and its various inorganic contents), lifeless and mindless; second, material bodies characterized by life but not by sensation or voluntary movement (*i.e.*, the plants); and finally those characterized by sensation and voluntary movement as well as life (*i.e.*, animals and human beings). And the adjective "conscious" was adopted as the most appropriate term to designate this last group of properties. A little later it was used to characterize the difference between animals or men in their normal waking state

as contrasted with their condition when asleep, or in a coma, or under the influence of an anesthetic drug; the latter condition was then described as a state of "unconsciousness." This usage treats consciousness not as a concrete substance but as an abstract attribute, a property of the brain, according to the materialists, or of the mind, according to the Cartesian school.

However, when consciousness is regarded as either a substance or an attribute, several almost insuperable difficulties arise, partly philosophical, partly psychological. From the philosophical standpoint it would seem that, if consciousness is a self-contained entity or the attribute of such an entity, then it is difficult to understand how we can ever get outside it so as to discover the existence of physical objects; as the idealist school contended, we can know only our own "ideas." (*See* also IDEALISM.) From the psychological standpoint there is the further problem of determining what can possibly be the connection between mind or consciousness and the body or brain.

As a Relation.—These difficulties were to some extent met by an alternative analysis of consciousness, proposed by Franz Brentano (1874) and based on the old scholastic doctrine of *intentio* (ways of "intending" or referring to an object). The first British psychologists to adopt it were James Ward, in his article PSYCHOLOGY in the 9th edition of *Encyclopædia Britannica* (1886), and his pupil G. F. Stout. They and their followers emphasized that such semiabstract terms as "consciousness," "sensation" and "perception" tended to confuse two things, first the act or relation of sensing, and second the content or object sensed—*i.e.*, the "sensum."

A similar view was elaborated by William James in *The Principles of Psychology* (1890). In opposition to the idealists, James began by arguing that relations are not "abstract constructions of the mind neither experienced nor felt" but (at least in many cases) a matter of direct experience. "So surely as relations between objects exist in nature, so surely do feelings exist to which these relations are known." When I see that the red spot A is to the right of the blue spot B, I directly perceive a space relation between the two. James then went on to point out that one such group of relations are those that are called consciousness; for example, "the relation of knowing—the most mysterious thing in the world." It is unique; and, like space relations, it can be directly apprehended. Closer introspection reveals that there are different species of cognitive relation; and James distinguishes two main modes—"direct acquaintance" (as when I am aware of the colours red and blue or of relations of space and time) and indirect cognition ("knowledge about"). Remembering, imagining, thinking and believing seem to imply the existence of other modes of cognition. Moreover, in addition to the various cognitive types, most English psychologists commonly recognize two other forms of conscious relation—the affective (*e.g.*, being pleased or displeased with the object) and the conative (*e.g.*, wanting the object).

As G. E. Moore, one of the first of the new realists, attempted to show in his *The Refutation of Idealism* (1903), this relational view of consciousness overcomes many of the chief philosophical difficulties inherent in the older doctrines, for it makes possible the ready acceptance of the notion that an object may continue to exist even when no longer perceived, just as a woman may continue to exist after she has been divorced from her husband. Moreover, this newer interpretation is in keeping with the general trend of modern science and modern logic. The earlier views tacitly assumed that all phenomena may be described in terms of the traditional logic of subject and predicate; *i.e.*, substances and attributes. Modern logic, however, insists on the supreme importance of a third category over and above those of subject and predicate, namely, the category of relation; and modern science is built up by arguments that consist chiefly of relational propositions rather than of predicative propositions.

Sense Data.—Brentano described the objects of the cognitive relations—the things that we sense—as parts of the *physical* world. Similarly, most of the new realists held that the colour that I see when I look at my table, and the smoothness that I feel when I touch it, are parts of the surface of a real material table. However, it is difficult to take the same view of the sounds we hear, or the pains we feel, or the illusory images seen in a mirror or in double vision. Later writers therefore, among them Stout, C. D. Broad and H. H. Price, distinguish between sensory contents that are directly apprehended and the physical objects that older writers held were in some way indirectly inferred and that most modern writers would prefer to say are "perceived" rather than "sensed." And the majority of psychologists who adopt this distinction (though not all philosophers) hold that sense data are essentially *mental*, like the "ideas" of the older empiricists. They form the contents of conscious experience, a continuous field or flowing stream, and thus constitute an important and legitimate subject for psychological study by introspection and experiment.

In his textbook James frankly recognized that the doctrine of consciousness as a unique relation or set of relations seemed to entail an irreducible duality between mind and matter, and pointed out that the excessive preoccupation of earlier psychologists with the introspective study of consciousness had often led to a misinterpretation of both human and animal behaviour. Eventually in 1904, in a famous essay headed "Does Consciousness Exist?" he completely abandoned the position he had previously held, and put forward a hypothesis of neutral monism. "The word consciousness," he maintained, "is just a loose way of indicating that certain sensory occurrences form part of my life-history." Bertrand Russell in his *The Analysis of Mind* (1921) adopted a similar view. He finds no evidence either for the subject of the cognitive relation (the mind or self) or for the cognitive relation itself. There are simply a number of self-existent events (the so-called sense data). When arranged in a causal order in space, they are described as material things; when arranged as life histories, they are called mental. Even so, Russell seems forced to admit a dualism of relations, since one type of arrangement is based on causal relations and the other on some kind of noncausal relation, never precisely specified.

Therefore, however we try to overcome or evade it, the undeniable facts of conscious awareness and its utter incongruity with the common conception of matter seem inevitably to confront us with an irreducible dualism, either of substances, attributes or relations (*see* BODY AND MIND). Russell himself puts the argument most clearly when he points out that while a blind man can know the whole of physical science (*i.e.*, the science that deals with what is material) a man with normal vision is aware of many things that the blind can neither perceive nor conceive. It may be added that the increased interest in unconscious mental processes and in the study of drugs that will produce a local or general unconsciousness has in its turn led to a marked renewal of interest in the peculiar nature and conditions of conscious processes in and for themselves. (Cy. B.)

The Behaviourist View.—In behaviourist psychology, consciousness is a concept referring in a general way to the behaviour of organisms characterized by alert awareness and responsiveness as contrasted with the lack of awareness and relative unresponsiveness of deep sleep or anesthetic coma. Between these extremes are varying degrees or levels of consciousness. A person is more conscious when he is dozing than he is in deep sleep but less conscious than he is when wide-awake solving a mathematical problem. Thus consciousness describes a state of an organism in terms of the readiness and facility of discriminative behaviour.

Consciousness defined in terms of behaviour originated in the psychology of J. B. Watson and was subsequently developed as operational or methodological behaviourism (*q.v.*). The more traditional view, still significantly embodied in everyday thinking, defines consciousness as the direct awareness or immediate experience of the contents and processes of mind. The method of observing consciousness, so defined, is introspection (*q.v.*), and introspectionist psychologists considered the chief business of a scientific study of mind to be the rigorous description of consciousness. The introspectionists' formulation by definition, however, makes consciousness a private event; no two observers can describe the same consciousness. Public confirmation of observational facts is impossible. Introspectionism accepted the fact that

children, mentally deranged persons or even the ordinary man on the street could not be depended upon to give reliable descriptions of consciousness, but the limitations of introspectionistic psychology became strikingly apparent when it was found that trained observers in the laboratory could not agree on fundamental observations. Such was the case in a famous controversy about the consciousness of thought processes. The controversy was never resolved and is in principle unresolvable within the introspective formulation. Introspectionistic views of consciousness have few advocates in mid-20th-century psychology.

Behaviourism in defining consciousness emphasizes its uniqueness as an aspect of human behaviour, which sets human behaviour apart from the behaviour of other organisms. Man is not merely capable of discriminative behaviour of a complex order; in addition he learns to respond discriminatively to his discriminative behaviour, for the most parts in terms of the symbolic responses of language. Man is not only aware, he is aware that he is aware. He is said to be conscious in so far as his verbal behaviour indicates knowledge of his own awareness. Such knowledge of awareness exists in all degrees of reliability and validity as inferred from the consistency of relationships between verbal behaviour of subjective referrent and larger patterns of conduct. We learn to discriminate aspects of the sensory awareness of vision and hearing more easily and reliably than the awareness from organic sensation; verbal responses regarding feelings and emotional experiences are generally vague and variable.

Nonetheless the definition of consciousness as awareness of awareness has merit with regard to problems of human psychology. Instances of disturbances of consciousness can be interpreted as discrepancies between awareness (discriminatory behaviour) and awareness of awareness (verbal responses). A hypnotic subject is given an illustrated magazine and told by the hypnotist that there are no women portrayed in the magazine, that the page has turned blank wherever a woman is pictured. The subject looks, and reports only men and things—and blank spaces. Yet clearly he must see the woman in order to report that he does not see her. He is aware, but not aware that he is aware.

Discussions of where in the hierarchy of animals or at what point in the development of a child consciousness first appears are clearly terminological. If awareness of the environment, indicated by discriminatory reactions, is the criterion of consciousness, then even the protozoans are conscious. If awareness of awareness is required, then it is doubtful whether the great apes and human infants are conscious.

Neurophysiological Mechanisms.—That consciousness depends on the function of the brain has been known from ancient times. Although detailed understanding of the neural mechanisms of consciousness has not been achieved, correlations between states of consciousness and functions of the brain are possible. Levels of consciousness in terms of levels of alertness or responsiveness are correlated with characteristic patterns of electrical activity of the brain (brain waves) recorded by the electroencephalograph from electrodes placed on the scalp (*see* ELECTROENCEPHALOGRAPHY). During wide awake consciousness the pattern of brain waves consists of rapid irregular waves of low amplitude or voltage. In contrast, during sleep, when consciousness can be said to be minimal, the brain waves are much slower and of greater amplitude, often coming in periodic bursts of slow waxing and waning amplitude. Intermediate levels of consciousness can often be related to intermediate patterns of brain waves. When electroencephalographic records are made continuously during normal sleep, occasional periods will be observed during which the brain waves approximate the waking pattern. If the person is awakened at such a time, he will almost always report that he was dreaming. On the other hand if he is awakened during a period of deep sleep as indicated by the brain waves pattern, he almost never reports a dream.

Both behavioural levels of consciousness and the correlated patterns of electrical activity are related to the function of a part of the brain located in the brain stem called the reticular formation (*see* also BRAIN). The reticular formation consists of a central core of gray matter extending from the medulla oblongata to the upper end of the midbrain and, functionally at least, it may be said to extend on through the middle region (intralaminar) of the thalamus. The reticular formation is primarily neither motor nor sensory in function, but it does receive collateral fibres from the incoming sensory pathways, and nerve fibres extending from the reticular formation to the spinal cord conduct impulses which modify excitability of neurons in spinal reflex centres. There is also a diffuse projection system of fibres from the reticular formation to the cerebral cortex which conducts impulses modulating cortical functions related to consciousness. Electrical stimulation of the ascending reticular system from indwelling electrodes arouses a sleeping cat to alert consciousness and simultaneously activates its brain waves to the waking pattern.

Extensive development of the cortex of the cerebral hemispheres is the most notable feature observed when comparing the human brain with brains of animals lower in the phylogenetic scale. Consequently, it was commonly supposed that the neurophysiological mechanisms subserving consciousness and the higher mental processes must reside in the cortex. It is more likely that the cortex serves more specialized functions integrating patterns of sensory experience and organizing efferent motor patterns and that the ascending reticular system represents the neural structures most critically related to consciousness. Destruction of various parts of the cortex through accident, disease or surgical intervention may result in motor paralysis, loss of sensory capacity, decreased intellectual function or other symptoms, but consciousness itself is not markedly disturbed. Lesions in the upper brain stem reticular formation, on the other hand, are often associated with altered consciousness as evidenced by somnolence or coma.

The brain stem reticular formation should not be called the seat of consciousness. It represents an integrative focus, functioning through its widespread interconnections with the cortex and other regions of the brain. Animals from which all of the cortex has been excised show only limited responsiveness to the environment and thus can be called conscious at only a very low level. If the cortex of the human brain were destroyed, an even more profound loss of conscious responsiveness would undoubtedly result. Function of neurons of the ascending reticular system represents a necessary but not sufficient condition for conscious behaviour. *See* also PERCEPTION; UNCONSCIOUS.

See also references under "Consciousness" in the Index volume.

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CONSCRIPTION. The use of the word conscription to mean compulsory enrollment for military or naval service dates from the early 19th century. The word came into common usage in connection with the mass national armies employed by the French in the Napoleonic Wars, and by all the major belligerents in the Franco-German War of 1870 and in World Wars I and II. For the earlier history of the idea of national service, *see* the articles ARMY and MILITIA.

The French Revolution of 1789 saw the beginning of mass armies and of conscription, or compulsory national (military) service, as it is known today. After attempts to meet the country's needs by voluntary enlistment and by a levy had failed, the Directory in 1798 passed the first law of conscription requiring the registration by classes of all able-bodied men between 20 and 25 for military service. Later this system enabled Napoleon, who extended it to include all able-bodied men, to enroll 2,613,000 conscripts between 1800 and 1813. This was an immense figure for those times, although it was to be dwarfed by the vast armies of World Wars I and II. (*See* FRANCE: *Defense.*)

In order to explain the working of conscription in the form it took in the 19th and early 20th centuries, it is necessary to go back to the battle of Jena in 1806. After this victory Napoleon restricted the size of the Prussian army and this gave birth to

the idea of using a small cadre of professional soldiers as a "sausage machine" to train batches of conscripts in a short time and pass them to the reserve. This method enabled Prussia, in a few years, to build up a large reserve of trained men without infringing the conditions restricting the size of the standing army. This was the system on which the continental powers based their armies in preparation for World War I—a comparatively small corps of professional officers, and a cadre of long-service noncommissioned officers and soldiers, who were responsible for operational and administrative staff work and for instructing the conscripts forming the bulk of the army—who served for one, two or three years as full-time soldiers before passing to the reserve. By this means France, Russia, Germany and Austria-Hungary were, in 1914, able to deploy large forces within a few days of mobilization and to follow these up quickly with reserve divisions composed of conscript reservists.

The armies recruited by conscription were mostly confined to the countries of continental Europe, up to World War I. The United States had no land frontiers liable to attack and maintained only a small professional army. The United Kingdom based its defense on its insular geographical position and on the Royal Navy. It had to provide garrisons for India and other overseas possessions, but these were small in numbers by continental standards and required long-service soldiers. The British Dominions had no threatened land frontiers and maintained only small regular forces. Even in the first decade of the 20th century, when Britain became associated with France in an *entente cordiale*, British commitments on the continent were so small, and so vague, that no attempts to increase the size of the army were made, although great improvements in organization took place (*see* GREAT BRITAIN: *Defense*).

World War I.—Since the days of Oliver Cromwell's major-generals the British people had resolutely opposed any form of compulsion for military service. It was therefore satisfactory for the British government when in 1914–15 the number of volunteer recruits for the armed services equaled, if they did not exceed, the numbers which could be properly trained and equipped. As the war progressed, however, and the casualty lists increased, it became apparent that the army could not be maintained at the required strength by voluntary enlistment. Moreover, Britain's allies became somewhat critical of its reluctance to adopt the compulsory measures which they had known for generations. There was another aspect to the problem which had been overlooked in the enthusiasm of the early months of war. Many key men in industry had joined the forces and their loss was detrimental to the production of munitions and other work indirectly connected with, but essential to, the prosecution of the war. It was clear that enrollment in the fighting services should be selective and based on methods that would result in men doing the jobs in which they would be most useful. This was possible only under conscription. It is, however, a measure of the British people's dislike of compulsory military service that it was not until Jan. 1916 (17 months after hostilities began) that conscription was introduced. With the end of the war in Nov. 1918 the British at once reverted to the voluntary system of enlistment and to an army of much the same size and pattern as in 1914. Germany was limited by the armistice terms to a long-service army of 100,000 men. The U.S.S.R., still suffering acutely from the effects of the revolution of 1917, continued conscription into the Red army, but it was loosely applied and for many years inoperative in the more remote provinces. France alone among the powers continued conscription on pre-1914 lines.

World War II.—By 1939 the pattern of war, and the equipment of the armed services, had undergone radical changes which had altered the conception of conscription: some acquaintance with these changes is necessary for a proper understanding of the problem. It was clear that war would require a combined effort by all three fighting services—on land, at sea and in the air. The recruitment of personnel for the service would affect all three and not be mainly an army problem. Within the services a high proportion of men would have to be skilled workers, with skills analogous to their trades in civil life, in order to operate and maintain the tanks, aircraft, complicated warships, radio sets and other mechanical devices which science and the engineer had placed in the hands of commanders in all services. Moreover, the manufacture of these machines had assumed increasing importance and it was necessary that the armament firms—as well as other key undertakings such as coal mining, steelworks, farming and transport—should retain at least a proportion of their skilled workmen. The best military opinion, which proved to be correct, forecast that in contrast to World War I, the next war would be one of high mobility in which the air would play a great part. Machines would take the place of men to an increasing extent in battle, and a much higher standard of tactical and mechanical skill would be necessary. Under these conditions conscription had to be selective and applied in a highly scientific manner.

It was in these conditions that the Commonwealth of Nations, and the continental powers of Europe, in 1933 (when Adolf Hitler came into power in Germany) considered the problems of preparing for World War II. In France, Poland, the U.S.S.R. and Italy conscription already existed. Germany adopted compulsory service nominally when it repudiated the disarmament clauses of the Versailles treaty in 1935; but in practice it had evaded the restrictions on the size of its forces for some years before that. The first 18 months of hostilities demonstrated conclusively that the right kind of machines, properly handled by a few men, had largely taken the place of mass armies as the tactical means of victory. Poland was conquered in three weeks, France in 35 days and Greece in 18 days. In the winter of 1940–41 a small British force destroyed an Italian army of 220,000 men in two months in North Africa. In these decisive successes tanks and aircraft played the major part. It soon became clear, however, that large numbers of infantry, supported by artillery and engineers, were required to consolidate victory and occupy the vast areas overrun by the new mechanized formations.

To summarize, it can be said that in World War II, although machines conserved manpower on the battlefield, they increased the number of men required for supply and maintenance, and in the factories to produce the new equipment. The length of the war—nearly six years—and the vast areas of operations in all parts of the world, resulted in all belligerent countries, except the United States, suffering acute manpower shortages in the services and in the factories.

An interesting development in Great Britain in World War II was the introduction of conscription for younger women, who were liable to call-up from Dec. 1941 until Jan. 1947.

Conscription after 1945.—The era of freedom from the fear of war which had been expected after World War II did not come. Under the new grouping of east and west practically all the countries of Europe and the United States continued compulsory military service.

The emergency of a world war is sufficient to convince most people of the necessity for conscription; but this is not always possible in peace. Dictatorships have an advantage over democracies in this respect. In the former, conscription can be imposed under whatever conditions are considered best to meet military requirements. Compulsory service is never popular, however, in a democracy, and any party advocating it must convince the electors that conscription is a necessity in order to be sure of gaining power. There is therefore always a temptation for political parties to advocate the abolition of conscription, or some easement in the conditions of service, which is not justified on military grounds, but which may catch votes.

Conscription takes three forms: (1) Universal National Service, as in Great Britain, France and the U.S.S.R. in which all fit young men on reaching a given age, usually between 17 and 20, become eligible for a considerable period of full-time service, followed by a period of part-time service in a nonregular unit, or on the reserve. In Israel, unmarried women are also conscripted for military service on the same basis as men. (2) Selective National Service, as in the United States, where only a proportion of young men are drafted for full-time service, partly according to the needs of the armed services and partly according to their occupation, schooling, or family status. (*See* below, *The United*

States.) (3) Part-Time National Service, where most of a young man's service is part-time, as in Australia.

The following were the conditions for compulsory service in Great Britain and some other countries in the late 1950s.

Great Britain.—Under the National Service act of 1947–48 (as amended 1948–49, 1950 and 1955) Britain adopted universal military service for a full-time period of two years (except for a short time when it was reduced to 18 months) followed by three-and-a-half years in the territorial army or emergency reserve. Early in 1956 the system was altered by increasing the age of call-up, on a sliding-scale principle, so that by about March 1958 it would be at 19 instead of at 18 years of age. The two-year full-time period was retained, but the part-time period became only one year. In April 1957 plans were announced for ending compulsory national service by 1960. The age of call-up would continue to be raised gradually, to 20 or even 21. It was intended not to call up all those born between 1938 and 1940 who had registered for service, but they would remain legally liable.

An idea of the numbers affected by peacetime conscription can be gained from studying the figures for 1955. In this year 232,766 men registered for service, of whom 120,286 stated a preference for the army, 82,449 for the air force and 26,263 for the navy. Of the remaining 3,768, there were 733 (0.3%) accepted as conscientious objectors, and the remainder expressed no preference. The actual number called up was 156,833, the rest being either medically unfit or exempt for some special reason. They were allotted as follows: army, 108,656, air force 42,072, navy 6,105.

Contrary to the forebodings of many, peacetime national service in the British fighting services was successful. Many national service officers and men distinguished themselves in Korea, Malaya and other operational theatres in which the British army was involved after 1945.

Other Countries.—*France.*—Eighteen months' full-time service usually begins at the age of 20, followed by a period on the reserve.

German Federal Republic.—After the recognition of the sovereignty of the German Federal republic in May 1955, which carried with it the right to rearm, and the country's simultaneous entry into the North Atlantic Treaty organization and Western European union, which laid it under an obligation to provide forces for European defense, plans were made for the introduction of conscription. A bill was passed in 1956, despite considerable political opposition within the country, providing for compulsory military service for men between 18 and 45, for 18 months. The period was later reduced to 12 months.

U.S.S.R.—Compulsory service begins at the age of 16 when boys enroll as cadets. This is followed by full-time military service at the age of 18 or 19. The period of service is two years for privates and three for N.C.O.'s (army); four years for privates and N.C.O.'s in the air force or coast defense units; five years in the navy. These periods are followed by periods on the reserve up to the ages of 35, 45 and 50 according to physical fitness.

Australia.—Youths become eligible for national service on attaining the age of 18. They serve for 14 weeks full-time in their first year plus another two years part-time in the citizen military forces.

New Zealand.—Youths are called up at the ages of 18 for 10½ weeks training in their first year and 14 days camp and 6 other days training (during weekends) for the next two years. They then pass to the reserve for six years.

There is no form of compulsory military service in Canada, India or Pakistan.

See also Conscientious Objector.

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THE UNITED STATES

Revolution and War of 1812.—During the Revolution and the War of 1812 the volunteer system failed to procure the men required for military purposes. To stimulate voluntary enlistments, bounties of money, land and clothing were granted to recruits. Massachusetts and Virginia resorted to conscription in 1777. On Feb. 6, 1778, two-thirds of the authorized continental army being recruited, congress recommended that the other colonies follow the example set by Massachusetts and Virginia. The aid extended by France, however, averted the necessity for conscription. During the latter part of the War of 1812, when volunteers failed to fill the depleted ranks of the army, congress considered several methods of conscription, but none was adopted.

Civil War.—Conscription for military service in the United States during the Civil War embodied some of the worst rather than the best features of European practice. While the Confederacy had replaced volunteering by universal conscription as early as April 1862, the North deferred similar action until 1863. After the policy of obtaining recruits through calling up the militia and through volunteering had failed, congress passed the Enrollment bill (March 3, 1863). It was a measure designed less to channel the nation's manpower into the armies than to stimulate volunteering. Applied only in areas which had not produced their quota of volunteers, it led to so-called draft riots and armed resistance against federal registrars.

Both northern and southern conscription included features of class legislation. In the North a drafted man could hire a substitute or buy exemption for $300. Substitute brokers brought much corruption into the application of the draft, tending to strengthen popular belief that the conflict raging was "a rich man's war and a poor man's fight." The Confederacy shared this hiring of substitutes for a time and by such exemptions as that of owners of 20 (later 15) slaves, who were declared vitally necessary in their supervisory function, helped to break the unity of interest and feeling on which its strength was based.

In the North the draft was almost exclusively applied by federal authorities, such as the hated federal registrars, 98 of whom were killed as victims of popular wrath during the first four months of the application of the law; this unpopularity was increased by their simultaneous task of apprehending deserters and spies whose odium the draftees shared to some extent. The results of the draft were disappointing: while 1,120,000 were said to have been drafted, a mere 42,000 were actually inducted.

The lessons drawn from these experiences were impressive, if mostly negative. In subsequent applications of the draft in the United States, federal interference was kept at a minimum; conscription was introduced at or before the beginning of war without waiting for results from volunteering; bounties and purchasing of substitutes were prohibited; and the hunt for spies and deserters was separated from the task of draft authorities and left to federal police.

World War I.—Shortly after the start of World War I, congress passed the Selective Service act of May 18, 1917. To procure the necessary military and naval manpower and still not deplete the nation's war-productive forces, the law provided that the whole adult male population of the land, only enemy aliens excluded, between the ages of 21 and 30 inclusive (later extended to include the 18-to-45 group), were made a reservoir from which to draw recruits by lot. Altogether, 24,000,000 were registered by the end of the war.

Of these, 2,810,296 men were inducted through selective service, beginning in Sept. 1917, while the total military forces raised between April 1, 1917, and Nov. 11, 1918, amounted to 3,891,540 men; approximately 1,000,000 had enlisted voluntarily in the army. To obtain the total of the armed forces of the U.S. the 605,952 men in the navy and marine corps, most of them volunteers, must be added. These numbers point to the undoubted fact, as Gen. Enoch H. Crowder, the chief draft executive, put it,

that "recruiting played havoc for a time with the orderly process of selection. . . . The volunteer plan took no heed of economic value; it received as readily the men indispensable to production as it did the industrially worthless." To obtain a better division of manpower, a presidential order of July 27, 1918, forbade further enlistments by the navy or marine corps of Class I registrants, men immediately liable to call; later all recruiting by navy or army was suspended.

The act provided for a number of exemptions, some mandatory and others at the discretion of the president. The former group included the legislative, executive and judicial officers of the union and the several states, territories, etc.; ordained ministers, theological students preparing for the ministry, and conscientious objectors, these to be exempt from combat duties. As regards the group of exemptions at the discretion of the president, he was authorized to exempt persons of the following groups: county, municipal, customs-service, mail officials; workmen in armouries, arsenals, etc.; merchant mariners in actual employ; "persons engaged in industries, including agriculture, found to be necessary to the maintenance of the military establishment or the effective operation of the military forces or the maintenance of the national interest during the emergency"; persons with obligations toward dependents which made their exemption or discharge advisable; persons physically or morally unfit.

The president was empowered to draw upon the services of agents and officers of the state governments, and most of the administration of the act was through state executives, 155 district and 4,648 local selection boards, with the main burden of work and decision falling on the latter. These consisted of three members (usually including a physician) all of whom were civilians and residents of the districts where they served, appointed by the president upon recommendation by the state governor. They processed registrants under a fixed procedure for hearing and resolving claims for exemption and deferment and taking into account the results of physical examination. Eventually they arranged available manpower in four classes in accordance with industrial usefulness, liability toward dependents, etc., with the first class containing those most readily called and whose withdrawal was least likely to upset war-essential industry and the family structure of the nation; in Classes II to IV registrants were graded in order of availability for the armed service; the exempt were placed in a fifth group. This classification resulted in the following distribution:

Total registrants classified after Dec. 15, 1917	9,052,735
Placed in Class I	2,979,465
" " " II	989,568
" " " III	407,125
" " " IV	3,026,178
" " " V	2,123,825
Undistributed	426,574

Altogether 65% of the total registrants were exempt or given a deferred status, with dependency accepted as the chief reason. To determine the order for calling up selectees and at the same time exclude possible local fraud or favouritism, a central lottery in Washington, D.C., was used to fix from time to time the call numbers of registrants. The first of these drawings took place on July 20, 1917.

None of the earlier conscription laws and practices included attempts to provide effective disposal of manpower for the purposes of war in all its sectors. This feature was introduced by the industrial demands of World War I. Selective service, after filling the cadres of the armies, had to channel a necessary part of available manpower, fortunately ample, into war industries, which doubtless attracted numbers of unsuitable workers eager "to get out of the draft." Aside from the silent pressure exerted by the act, a "work or fight" order, issued May 17, 1918, was aimed at employees, of deferred status, in certain nonessential occupations, such as sales clerks, waiters, doormen and domestics. By this order deferred registrants in Classes I to IV who were idle or in nonessential jobs were threatened with loss of preferred status unless they found war-essential employment.

The so-called Stone amendment of June 15, 1917, provided that all men serving under the Selective Service act were to be discharged within four months after conclusion of peace; the act itself made enlistments in the regular army and the federalized national guard expire on the termination of the emergency.

World War II.—The National Defense act of 1920 provided for a possible return to conscription in an emergency by making it the duty of the war department general staff to prepare plans for mobilization. The research and planning undertaken by a joint army and navy selective-service committee, getting under way in 1926, were embodied substantially in the Selective Training and Service act of 1940. It was the first conscription law accepted by the United States in time of peace, ahead of war.

The senate voted for the bill 47 to 25 and the house 232 to 124. On Sept. 16, Pres. Franklin D. Roosevelt signed it—and by proclamation called upon all males from 21 through 35 years of age, residing in the U.S. and its territories, to register on Oct. 16 for selective compulsory military training. The act was to become inoperative on and after May 15, 1946, unless continued by congress. The president could not induct more men than congress should specifically appropriate from time to time. Not more than 900,000 men were to be in training at one time. They were to serve and be trained for 12 months, unless congress declared a national emergency keeping them with the colours for longer periods, after which they were to retire to a reserve component of the army or navy for ten years. This compulsory transfer to a reserve, a new feature in U.S. military legislation, was not enforced, however.

The Service Extension act of Aug. 18, 1941, declared the national interest imperiled and authorized extension of the training-service period to as much as 18 months. Men inducted were not to be employed beyond the limits of the western hemisphere and the U.S. possessions including the Philippines, a limitation removed Dec. 1941, following entry of the U.S. into the war.

Many features of the 1940 act were in substance taken over from the 1917 act. An entirely new principle was directed at job insurance for the inducted men, provisions requiring employers, private or public, under certain conditions to reinstate the returning serviceman in his former or a similar position without loss of rank, seniority or reduction in pay. Administration of the draft, though somewhat more strongly centralized than it had been during World War I, closely resembled that of 1917–18 in most respects, as in the use of state and local government agencies, or the exclusive use of civilians in local boards.

Eventually, the Selective Service system included a headquarters in each state, 6,443 local boards, one for each area of about 30,000 inhabitants, and 505 appeal boards; the latter were to have jurisdiction over a territory with about 70,000 registrants as the result of the first registration. The national organization was headed by a director of selective service, with Clarence A. Dykstra, appointed Oct. 15, 1940, the first incumbent. Dykstra was succeeded by his deputy, Brig. Gen. Lewis B. Hershey, on July 31, 1941.

Registration.—On Oct. 16, 1940, and later days in the territories, 16,632,146 men were registered in about 125,000 registration places. Six subsequent registrations under the act as amended were held in 1941 and 1942. After that men were required to register with their local board on attaining their 18th birthday. As during World War I, the cards of registration were forwarded to the local Selective Service boards for processing, including serial numbering, to be used in the national lottery. The first lottery to determine the order numbers for induction was held in Washington on Oct. 29, 1940.

To all registrants, in the sequence of their order numbers, the local boards then sent a questionnaire, and on the basis of information elicited, and of medical examinations, began to classify each registrant according to availability and fitness. Class I comprised men available for military duty, with Class I-A containing those fit for general duty, I-B those fit for limited service only and I-C those actually in the armed services. In Class II were put men necessary to the war work in their civilian capacity, in Class III men with dependents, and in Class IV officials deferred by law, nondeclarant aliens, ministers and divinity students, conscientious

objectors and those physically, mentally, morally unfit. Appeal was open to every registrant as well as to government appeal agents, and also to other parties interested, such as an employer or a dependent. No appeal against the medical classification, however, was admitted.

Those found physically, mentally or morally unfit for service, and therefore rejected and put in Class IV-F, varied from 31.4% for Jan. 1943 to 46.9% for Dec. 1943.

Classification was followed by selection and induction. The first call for men was issued early in Nov. 1940 and comprised a mere 19,670 of the 800,000 who were to be inducted through Selective Service by July 1, 1941. The numbers required by the armed services were prorated among the states.

With the declaration of war against the Axis powers, new and vaster demands upon U.S. manpower arose. Legislation removed remaining restrictions and prolonged the service period to the duration of the war plus six months. The ages of registration were extended to include ages 18 to 65, though only the 20-to-45-year groups were at the time made liable to service. The existing board system was found elastic enough to cope with increased demands for manpower raised by the armed forces on the one hand, whose monthly calls rose from 99,929 in Jan. 1942 to 450,000 in Dec. 1942, and by war industries and agriculture on the other. However, a more complete and central direction seemed needed; for one year, from Dec. 1942 to Dec. 1943, the all-inclusive administration through the War Manpower commission was made to include the Selective Service system, which was then returned to its independent status. As in World War I, it was found necessary to end voluntary enlistment, at least for persons 18 to 38 (executive order of Dec. 5, 1942), for both services. Registrants with a dependency status were notified early in 1943 that they would lose deferment unless they changed to war-essential work from about 20 occupations defined as nonessential. To provide for dependents of inducted breadwinners congress passed the Servicemen's Dependence Allowance act of 1942 and the Pay Allowance act.

Not long before V-E day, on March 1, 1945, the status of United States manpower under Selective Service was as follows: of the 22,085,000 registrants, 18 through 37 years old, nearly 50% had been inducted or had enlisted, while 25% were disqualified because of physical disability, extreme hardship to dependents or statutory exemption. Of the remaining 25% more than four-fifths were deferred because of essential occupations and about one-sixth were in the I-A class, available at the time for immediate induction.

After World War II.—After much debate, congress passed and Pres. Harry S. Truman signed on May 14, 1946, a measure to extend the existing draft law until July 1. Induction of fathers and of youths 18 and 19 years old was stopped at the same time. On June 25, 1946, congress extended the Selective Training and Service act of 1940 to July 1, 1947, and Selective Service itself to March 31, 1947. This legislation marked the first postwar extension of the principle of conscription in United States history. The amended law exempted the 18-year-old group from the draft. Beginning Oct. 1, 1946, all inducted men were to serve for a training and service period of 18 consecutive months.

Congress ended the Selective Training and Service act of 1940 on March 31, 1947, but provided for the continuance of a skeleton organization in the Office of Selective Service Records. The following year, congress passed the Selective Service act of 1948, the nation's second peacetime draft law, to run for two years. The act required all male residents between 18 and 26 years of age to register on dates fixed by the president; exemptions were few. The period of service was to be 21 months, followed by a maximal 5 years' membership in the reserve. The act allowed a maximum number of 161,000 men of 18 to enlist for one year on condition of a subsequent membership for six years in the reserve during which they might be called up for training periods not exceeding 30 days annually. The exemptions covered most veterans of World War II, though not wartime members of the merchant marine. Deferments were provided for members of the reserve and of the R.O.T.C., public officials during their term of office, married men and men with dependents, high school and college students.

Calls for induction, beginning with the 25-year group, were issued by the armed forces in Sept. 1948, and the first groups were inducted in Nov. 1948. Because of the subsequent increase in voluntary enlistments, however, no one was inducted after Jan. 1949 and most inductees were released. In Aug. 1949 congress reduced the Selective Service system to a skeleton organization. By Feb. 1950, all those inducted under Selective Service had been released and the U.S. armed forces were once again on an all-volunteer basis of recruiting.

Korean War.—After the start of the Korean War in June 1950, the Selective Service act of 1948 appeared inadequate to bring the armed forces up to the required level of 3,300,000. It was amended in September 1950 by the so-called "doctor draft" to help meet the needs of the armed services for doctors, dentists, and allied specialists. In June 1951, the Universal Military Training and Service act was enacted. This law lengthened the required term of service from 21 to 24 months; reduced the minimum age of liability for service from 19 to 18½; reclassified registrants deferred for dependency whose only dependents were wives; reduced the mental standards for service; continued until age 35 liability for service for most deferred registrants; and expanded the use of conscientious objectors in civilian work.

From June 1950 until the Korean armistice in July 1953, annual requirements for the armed forces exceeded 1,000,000 men. Inductions averaged 45,000 a month. This volume of inductions, plus the large number of men who enlisted, and the high rejection rate, caused the supply of registrants available for military service to decline from 3,000,000 in June 1950 to 1,000,000 in June 1953.

Reserve Forces Act.—With the immediate demands of the Korean War ended, the department of defense and congressional leaders discussed means of improving the utilization of military manpower. After nearly two years of discussion, the Reserve Forces act of 1955 was passed. One of its main purposes was to strengthen the nation's reserve forces. The new law liberalized the alternatives available to young men in fulfilling their military obligations and permitted properly qualified men to defer training until completing their education. Its basic requirement was six years of military duty, counting both active and reserve duty. When a young man was drafted, or enlisted in a branch of his own choice, he might serve from two to five years on active duty, followed by further service in the ready reserve or stand-by reserve. If, for example, he served for two years on active duty he would be obligated to spend two years in the ready reserve followed by two years in the stand-by reserve for a total of six years.

The ready reserve consisted of organized and trained individuals and units, including the national guard and the air national guard; they were normally subject to 48 weekly drills and a maximum of 17 days active duty annually. Members of the ready reserve were also subject to call to immediate active duty whenever the President declared a national emergency. The stand-by reserve consisted of men not in organized units. Such men were subject to call to active duty only upon the authority of congress and only after the Selective Service system had determined on an individual case basis whether they were available for call.

The act also offered short-term alternatives to active duty. Draft-eligible young men, before reaching the age of 18½, might enlist in the national guard or volunteer for six months of active duty. Those who chose the six months of active duty were, after completion of their tours, placed in the ready reserve for three years and the stand-by reserve for four and one-half years. Those who chose the national guard might be required to attend weekly drills and summer encampments until the age of 28. This service could be reduced to eight years at any time if the individual volunteered for three to six months of active duty. Beginning in the fall of 1957, men with no prior military service who enlisted in the national guard were required to take a minimum of six months of active duty training in a federal status. Those enlisting in the air national guard were required to take a minimum of 11 weeks of basic training with the active air force.

Men with critical skills, such as geologists and engineers, or

men employed in vital industries, could apply for a special training program that permitted three to six months of active duty training, followed by seven and one-half years in the stand-by reserve.

Anyone in the ready reserve might be placed in the stand-by reserve if his work was of such a vital nature as to make it probable that he would not be available for military service at the time of mobilization.

See TRAINING, MILITARY; VOLUNTEERS; *see* also references under "Conscription" in the Index.

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CONSECRATION is an act by which a person or a thing is separated from secular or profane use and dedicated permanently to the service of God by prayers, rites and ceremonies. Consecration is distinguished from blessing, or benediction, and from dedication in that consecration effects an intimate transformation in the essence of the object, and that it is permanent and can be neither revoked nor repeated. The Roman pontifical treats of the consecration of a bishop, of a fixed altar, of an altar stone, of a church and of a chalice and paten. The ordinary minister of a consecration is a bishop, and the ordinary minister of a blessing is a priest. At a consecration, holy oils are used; at blessings, customarily holy water.

In the Old Testament, which has served as the basis for many kinds of consecrations in Christianity, among the persons consecrated were priests (Ex. xxix), kings (I Sam. [I Kings] x, 1) and prophets (I Chron. [I Paralipomenon] xvi, 22). Among things consecrated may be mentioned the pillar or stone of Bethel (Gen. xxviii, 18), vessels of the Tabernacle (Lev. viii, 10–11), the altar of holocausts (Ex. xxix, 36) and the second Temple (Ezra [I Esdras] vi, 16–17), which is commemorated at Hanukkah, the Feast of Dedication.

Consecration of the Eucharist.—In the Roman Catholic Church the word is used in a special sense to signify what takes place when the words of Jesus Christ at the Last Supper are pronounced during the Mass: "This is my body"; "This is the chalice of my blood." These words are repeated at the altar in the name and in the person of Jesus Christ. The substances of bread and wine then become the body and blood of Christ, only the appearance of bread and wine remaining (as defined by the Council of Trent; *see* TRANSUBSTANTIATION). Jesus Christ is here regarded, at one and the same time, as both the priest and the victim of the eucharistic sacrifice.

The Orthodox Churches and Eastern Rites of the Roman Catholic Church use a distinct invocation of the Holy Spirit after the words of consecration. Some Orthodox scholars consider this invocation or epiklesis essential for the consecration; other Orthodox authorities and the Eastern Rites of the Roman Catholic Church do not. In the Anglican liturgy, generally, the prayer of consecration merely sets apart for sacred use the bread and wine, no substantial change taking place: they do not become the body and blood of Christ. Some Protestants hold that the only effective consecration is the original words of the Last Supper, and that they included potentially every subsequent celebration of the Eucharist.

Consecration of Bishops.—From the earliest times, the discipline of the church ordered that there be at least three bishops for the consecration of a new bishop. The consecration takes place by the imposition of hands, as mentioned in the New Testament (Acts xiii, 3; II Tim. i, 6).

In all ancient liturgies, Syriac, Maronite and Coptic, the theme is the same: along with the imposition of hands, prayer is offered to the Holy Spirit that he may make the candidate worthy of his office as priest and pastor in the sacrifice of prayer and the Eucharist, the conferring of orders and other episcopal prerogatives. There is also an anointing with chrism (*q.v.*). Those Orthodox rites which omit the unction make a triple sign of the cross on the head or on the forehead to remind the candidate that he must bear the image of Christ. All the rites, Latin, Greek and Syriac, include the imposing of the Gospels on the neck and shoulders of the elect. The ring and crosier are also given as a mark of the office.

The Roman Catholic ceremony of episcopal consecration begins with the reading of authorization for the ceremony, the mandate of the pope, to whom the bishop-elect pledges loyalty. In the Anglican ceremony, a combination of religious and civil ceremonies, the royal mandate for the consecration is read and the oath touching the acknowledgment of the royal supremacy is taken by the bishop-elect.

Consecration of a King.—The anointing of kings antedates Christianity. Christian records reveal the most ancient of these ceremonies occurred in Gaul. Theodosius II, who died in A.D. 450, was consecrated king by the patriarch of Constantinople, and Pepin and his two sons were anointed kings by Pope Stephen II (III). (*See* further CORONATION.)

Consecration of Churches and Synagogues.—From antiquity, church law required that a new church be solemnly consecrated, or at least dedicated to God by a blessing, before divine services could be held. In Judaism, a formal consecration ceremony takes place patterned after the traditional dedication ceremony of Solomon's Temple. The doors are formally opened during the reading of certain psalms. The perpetual light is then kindled and the scrolls of the Torah are put in their place. In the United States the tendency is to centre these dedication ceremonies about the sabbath service. In Protestant churches the dedication consists in reading from Scripture, prayers and sometimes anointing. Consecration of a Roman Catholic church includes anointing the walls with chrism, the places of anointings being indicated by 12 crosses.

See also ANOINTING.

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CONSEQUENS, a Latin word meaning "consequent" or "following," used in traditional logic to designate that part of a hypothetical proposition which states the result or consequence of the condition or antecedent (*antecedens*, "preceding"). Thus the general form of such a proposition can be expressed as "If *A*, then *C*" ("If the *antecedens*, then the *consequens*"); *e.g.*, "If it rains, then the streets are wet." If a given hypothetical proposition is sound, then the fulfillment of the condition specified in its *antecedens* entails the result specified in its *consequens*, but the realization of the phenomenon specified in the *consequens* does not conversely entitle one to conclude that the *antecedens* has been fulfilled. To do so is to fall into the "fallacy of *consequens*." Thus, on the basis of the proposition already cited, when it is raining one may logically expect the streets to be wet; but when the streets are found to be wet the proposition by itself does not logically justify the assumption that it must have been raining.

CONSERVATION: *see* NATIONAL PARKS AND NATURE RESERVES; NATURAL RESOURCES, LAWS CONCERNING (U.S.); WILDLIFE CONSERVATION.

CONSERVATISM, a term commonly used in politics to denote a preference for the old and tried in the civil social order rather than for the new and untried. The word was first used to describe certain political beliefs and practical measures adopted in France during the era that followed the fall of Napoleon. From France it spread in the 1820s and 1830s throughout western Europe, to England, and by the 1840s had reached the United States.

As a coherent body of ideas about politics, conservatism is a modern attitude or movement. It is about as old as the different body of ideas called liberalism, and some decades older than the

ideologies called socialism, communism and anarchism. The roots of conservative thought, nevertheless, extend deep into the history of ideas and of social institutions. The title of "conservator" was given in various medieval states to guardians of the laws or guardians of particular groups. English justices of the peace originally were styled *custodes pacis*—conservators of the peace. Thus when French politicians and writers were seeking for some name to describe their movement toward a social order which would reconcile the best in the old Europe with the necessities of the 19th century, they hit upon the concept of the *conservateur*, the guardian of the heritage of civilization and of the principles of justice. The word conservative was popularized in England by George Canning and the *Quarterly Review* in the 1820s, and entered American usage only some years later when John C. Calhoun and Orestes A. Brownson began to employ it.

Though Edmund Burke's writings furnished both continental and English-speaking conservatives with their principal theories, Burke himself did not employ the word "conservative." Because Burke's thought and career also influenced 19th-century liberalism, there at first existed no sharp demarcation between the terms "conservative" and "liberal": in France, philosophical statesmen as varied in opinion as Chateaubriand, Guizot and Tocqueville often were called—and called themselves—both conservative and liberal. But the revolutionary movements of 1829–30 and of 1848 established better-marked party lines, emphasizing the differences among conservatives, liberals and radicals. Throughout Europe "conservatism" came to mean hostility toward the principles of the French Revolution, with its violent leveling innovations, while "liberalism" implied sympathy with the revolutionary concepts of liberty, equality, fraternity and progress. In the sardonic definition of Ambrose Bierce (*see* his *Devil's Dictionary*), a conservative is "a statesman enamored of old evils, as contrasted with the liberal, who would replace them with others."

First Principles.—Conservatism is not, strictly speaking, a political system but rather a way of looking at the civil social order. Although certain general principles held by most conservatives may be described, there exists great variety from nation to nation and from age to age in the application of these doctrines. Thus conservative views and parties exist under monarchical, aristocratic and democratic regimes, and in a considerable range of economic systems. The conservatives of Peru, for instance, differ greatly from those of Australia; they may share a preference for the established order but the institutions and customs they desire to preserve are not identical.

Unlike socialism, anarchism or even liberalism, then, conservatism offers no universal pattern of politics for adoption everywhere. On the contrary, conservatives maintain that social institutions must always differ from nation to nation, since any country's politics in large part must be the product of that country's historical experience, dominant religion and ancient habits. Conservatism, in brief, is a body of convictions but not an ideology; it does not advocate a simple, universal program for establishing a perfect social order.

Though it is not an ideology, conservatism may be defined reasonably well by listing a number of basic opinions that most eminent conservatives have shared. The following first principles are best discerned in the theoretical and practical politics of British and U.S. conservatives, but apply in considerable degree to western conservatism generally, and even to those Asian and African states that adopted European vocabularies and approaches in politics.

1. *The principle of natural law.* Most conservatives have held, with Plato and Cicero, that there exists a natural law, of an origin more than human, to which any society ought to conform. The object of the political philosopher is to ascertain as best he can this norm of justice, of which man-made law is at best a bad copy. A divine intent, however dimly discerned, is at work in men's lives and in their society. This point of view contrasts strongly with the liberal's utilitarian view of the state (most consistently expressed by Jeremy Bentham) and with the radical's detestation of theological politics. Modern conservatives seek to maintain a society in which each man receives the things that are suited to his nature: social equality and uniformity, conservatives think, are contrary to the real nature of man and are basically unjust.

2. *The principle of continuity.* "When it is not necessary to change, it is necessary not to change," Lord Falkland said during the English Civil Wars. This is an axiom among conservatives, who generally prefer the devil they know to the devil they do not know. Order and justice and freedom, the conservative feels, are the artificial products of a very long and painful human experience, the products of many centuries of trial and error and reflection. Human society is a kind of spiritual corporation, like the church; or, as some 19th-century conservatives maintained, it is an organic growth like a tree. Certainly human society is not a machine and cannot be treated mechanically. It is of the first importance that the continuity, the lifeblood, of a society must not be interrupted. Radical reformers, in George Santayana's phrase, never know how close to the root of the tree they are hewing. As the human body casts off old tissue and takes on new, so human society, too, must alter. Burke's model of a statesman was one who combined a disposition to preserve with an ability to reform. But necessary change ought to be gradual and reluctantly undertaken, lest the delicate constitution of any society, the essential continuity of human relationships, be badly disturbed.

3. *The principle of prescription.* "The wisdom of our ancestors" is one of the most important phrases in the writings of Burke, who found it, perhaps, in the pages of Richard Hooker. With Fulbert of Chartres, conservatives feel that modern men are dwarfs on the shoulders of giants, able to see further than their ancestors only because of their ancestors' high stature. Thus the conservative emphasizes the importance of what Burke called "prescription"—ancient rights, moral precepts and customs. Conservatives argue that men are unlikely to make any great new discoveries in morals or politics or taste. Society is more secure when its members are accustomed to refer to inherited wisdom, the legacy of civilization, rather than to weigh every ephemeral issue on the basis of private judgments and private rationality. "The individual is foolish, but the species is wise," Burke declared. In politics, we will do well to refer often to precedent and precept and even prejudice, for "the great mysterious incorporation of the human race" has learned truths about the soul and about community living that no single man can hope to attain unaided in his few brief years of life.

4. *The principle of prudence.* Any measure ought to be judged by its probable long-run consequences, not merely by temporary advantage or popularity: this is the real statesman's art, according to the conservative. Liberals and radicals, the conservative thinks, are imprudent, for they dash at their objectives without considering that their reforms may bring in their train abuses worse than the evils that reformers aspire to abolish. Human society being complex, remedies cannot be simple if they are to be effective. The conservative declares that he acts only upon due reflection and after weighing the consequences; sudden and slashing reforms are as perilous as sudden and slashing surgery.

5. *The principle of variety.* The philosophic conservative feels affection for the proliferating variety and intricacy and mystery of long-established social institutions and modes of life, as distinguished from the narrowing uniformity and deadening egalitarianism of most radical systems. For the preservation of a healthy diversity in any civilization, there must be various orders and classes, differences in economic condition and many kinds of inequality. The only true equality is equality before God's judgment; all other attempts at leveling lead to stagnation, at best. Society longs for able leadership, and if natural and institutional distinctions among men are destroyed, presently some tyrant fills the vacuum. Similarly, the conservative upholds the institution of private property as productive of human variety; without private property, liberty is almost impossible and society becomes a life-in-death.

6. *The principle of imperfectibility.* Human nature, the conservative is convinced, suffers irremediably from certain great

flaws or faults, which the Christian calls original sin. Men being imperfect, no perfect social order ever can be created. Because of man's native restlessness, indeed, mankind would grow restive under any utopian domination and once more break out in violent discontent—or else expire of boredom.

To aim for utopia is to end in disaster, the conservative reasons: we are not made for perfect things. All that we reasonably can expect is a tolerably ordered, free and just society, in which there must always be some evils and maladjustments and suffering. By proper attention to prescription and prudence, we may hope to preserve and even to improve this tolerable order. But if the old institutional and moral safeguards of a nation are forgotten in an impatient snatch at perfection, then the anarchic and violent impulses in man break loose, and the fabric of a high civilization is in imminent peril.

Such are the major premises of what Walter Bagehot called "reflective conservatism." This conservative social theory found its first systematic spokesman in Burke and was added to by a series of men of intellectual power. Friedrich Gentz spread these ideas in German-speaking lands, Juan Donoso Cortes in Spain. Reflective conservatism continued to find its literary and philosophical champions most influential in England, however, with Walter Scott, S. T. Coleridge, John Henry Newman, Benjamin Disraeli, J. F. Stephen, W. E. H. Lecky, Henry Maine, W. H. Mallock, Arthur Balfour, T. S. Eliot, and many other conservative writers. In the United States, for a long while, a comparative immunity to European social conflicts and the process of westward expansion allowed the expression of conservatism—as of liberalism—to remain somewhat amorphous. The federal constitution and the early state constitutions, nevertheless, were successful expressions of conservative minds. Among the more eminent American conservative thinkers were John Adams, John Quincy Adams, John Marshall, John C. Calhoun, Orestes A. Brownson, John Randolph, James Fenimore Cooper, Nathaniel Hawthorne, James Russell Lowell, Henry Adams (with partial exceptions), Irving Babbitt, P. E. More and George Santayana.

Popular Conservatism.—Popular journalists often use the word "conservative" in a sense somewhat different from the intellectual conservatism described above. Among many people unfamiliar with the works of Burke or the Adamses there exists a body of opinion which Walter Bagehot once unflatteringly described as "the ignorant Democratic Conservatism of the masses." This also has been called "shop-and-till conservatism," or mere attachment to things established, out of fear that radical political measures would injure or destroy the material interests of anyone possessing property. This "party of order," as it was called in France and elsewhere in Europe about the middle of the 19th century, is animated by fear, Bagehot wrote—"dread that their shop, their house, their life—not so much their physical life as their whole mode and sources of existence—will be destroyed and cast away." The French Revolution—and later, the Russian Revolution and other 20th-century upheavals—produced among middle-class people especially a reaction against violent and abstract innovation that greatly increased the popular strength of conservatism.

Of such a character was the conservatism of the *juste-milieu* during the reign of Louis Philippe in France. The middle-of-the road course declared by the Eisenhower administration in the United States nearly a century later also displayed characteristics of this sort of conservative polity. Because such political administrations dislike extremes and endeavour to steer a course between reaction and radicalism, the word "conservative" has acquired a popular meaning of compromise and of search for some political golden mean. A desire for reasonable conciliation and a distrust of extreme measures have indeed been characteristic of conservatism. Yet it does not necessarily follow that conservative statesmen always must pursue a middle path: moderation scarcely was dominant in Burke, nor in such conservative American leaders as John Randolph or Theodore Roosevelt.

As socialists have tended to draw their votes from the labouring classes, so conservatives have tended to find strong support among the modern middle classes. But it is not easy to show a close correspondence between political conservatism and personal prosperity. At times the Conservative party in Britain has won the votes of several million trade-union members, and millions of hard-pressed small farmers in the United States generally are conservative in their voting. That rural populations tend to be relatively conservative is less difficult to prove.

Conservative movements also have tended to attract persons of strong religious feelings, particularly during the reaction against the "age of reason" of the French revolutionaries, and in the 20th century as the Communist, Nazi and other collectivist ideologies displayed a character unmistakably antireligious.

During placid times, popular conservatism often lapses into complacency or apathy, only to revive suddenly when the mass of men is confronted by some tremendous threat to old ways of life. As F. J. C. Hearnshaw observes, "It is commonly sufficient for practical purposes if conservatives, without saying anything, just sit and think, or even if they merely sit." After 1914, however, mere inertia rarely sufficed to maintain prescription and tradition; and after the end of World War II a reasoned conservatism made some headway in a popular sense.

Conservative Parties and Factions.—Under various names, political parties founded on conservative concepts appeared throughout most of Europe at the beginning of the 19th century. In France, these organizations often were closely associated with the clergy, military officers and landed proprietors; they also enjoyed a good deal of support from peasants and from part of the middle classes. In northern Europe these parties were sustained principally by the landed gentry; in the Austrian system and in southern Europe, loyalty to the monarch and to the Roman Catholic Church was their rallying point. In the face of liberal organizations and revolts, the conservatives gradually lost ground; and after the revolutions of 1848, with the flight of Metternich from Austria and of Louis Philippe from France, conservative factions either lost power to nationalists and liberals or clung to influence only in coalition with other groups.

The coming of modern industrialism, too, hastened the decline of old-style conservatism, transferring wealth and power to new hands and breaking the "cake of custom." It undermined the habitual acceptance of things established, which is bound up with conservative doctrines of community, authority, prescription and tradition. Between 1830 and 1880, roughly speaking, liberalism won repeated victories over the conservative order.

Only in Britain did a party avowedly conservative retain great power throughout the 19th century, receiving the support of about half the electorate. Originally taking form as a coalition of Tories and Portland Whigs during William Pitt's war ministry, the English conservatives began to use the label Conservative in 1831 and 1832. Though shaken by the Whig Reform bill of 1832 and by the passage of other Whig and Liberal measures that undermined the power of the agricultural interest, they were rescued by the fertile imagination and astute management of Benjamin Disraeli. At the end of the century they stood seemingly at the summit of their popularity. The overwhelming Liberal victory in the general election of 1906 terminated this ascendancy—but only temporarily, for the rise of socialism was pressing the Liberals hard, and the Labour victory of 1924 meant the end of the Liberal party as an effective force. During the next four decades the Conservatives formed the government most of the time. In part, the success of the British Conservatives—now the oldest political party in the world—was a result of its having absorbed large successive segments of the old Liberal supporters, beginning in 1886. With these accessions came also some elements of Liberal policy, so that the Conservative party became a union of old Tory and Liberal factions, combined against Labour. (*See* also LIBERAL PARTY [BRITISH].)

In the English-speaking dominions conservative parties enjoyed a surprising revival late in the 1950s, after being eclipsed for nearly three decades: conservatives, or coalitions with policies substantially conservative, took office in Canada, Australia and New Zealand.

Modern European Conservatism.—After suffering suppression and other persecution under the dictatorial regimes of the

1930s and during World War II, European conservative groups began to regain vitality about 1946. Soviet power had extirpated effectual conservatism in Poland, Hungary, Czechoslovakia, Yugoslavia, Rumania, Bulgaria and lesser states; but to the chagrin of the western European socialists, conservative parties—or, more commonly, Christian Democratic parties in which various conservative and liberal elements were leagued—won national elections in several countries. By the 1960s conservative or quasi-conservative governments prevailed in the republics of France and West Germany, and in the Netherlands, Greece and elsewhere. In Italy and Austria, Christian Democratic politicians held office in coalition with socialists and smaller parties. In the Spanish and Portuguese dictatorships, conservative groups like the Spanish Tradicionalistas exerted a moderating influence. Socialism retained a secure hold only in Scandinavia.

This revived conservatism, however, was shorn of many of its old aristocratic associations and had come to terms, in most countries, with old-fashioned economic liberalism. Paradoxically, the conservatives' success was produced by the menace of Communism: after the failure of the Nazi and Fascist regimes, and the ineffectuality of postwar socialism, many Europeans turned once more to conservative policies as the only discernible alternative to a totalitarian order. Of these national governments, in some respects the most clearly conservative was that of General de Gaulle in France, with its appeals to tradition, the sense of community and national honour.

United States.—Although no major U.S. political party ever has assumed the name "Conservative," from the first years of the republic conservative ideas have been at work in American politics. Both the Federalist party of New England and the Republican party of Virginia exhibited different aspects of conservative thought and practice—the first with its emphasis on order and security, the latter with its attachment to the rural interest. During the Civil War, spokesmen for both North and South declared that theirs was the truly conservative stand.

The term "liberal" was seldom employed in the United States until the coming of World War I and did not become truly popular until the first administration of Pres. Franklin D. Roosevelt. During the Roosevelt years and World War II, however, conservatism became what Prof. Raymond English calls "the forbidden faith," the word carrying connotations of stupidity and selfishness. But about 1948 the spirits of conservatives began to revive; several books by reflective conservatives gained wide attention; and political leaders began once more to use the word approvingly. Among them was Sen. Robert A. Taft, who described himself as a "liberal conservative."

The failure of a really radical party to win the votes of any considerable number of Americans probably accounts for the lack of formal organization of American conservatives: the challenge was not strong enough to break down the barriers between the established Republican and Democratic parties. In the past, the absence of a distinct aristocracy and the numerous opportunities for personal advancement tended to discourage in the United States the formation of theoretical or class parties, whether conservative, liberal or radical. As the United States entered intimately into world affairs, however, and stood opposed to the threat of Soviet Communism, there became evident in America a growing desire for some political philosophy to oppose Marxism; and, as in Europe, the renewed popularity of conservative doctrines resulted. In practical politics, the popularity of Sen. Barry Goldwater of Arizona, the most vigorous figure among conservative politicians of the early 1960s, was an indication of this altered climate of opinion.

In the United States, as elsewhere, the particular forms assumed by the conservative impulse tend to be determined by the nation's traditional politics and social institutions. An American political conservative, at least in popular usage, is a person who believes strongly that the old pattern of American society ought not to be much altered. Typically, he holds by the federal constitution and maintains that it should be fairly strictly interpreted; he endeavours to oppose the tendency toward political centralization; he dislikes organizations on the grand scale, whether in government, labour or business; he is a defender of private property and looks uneasily upon the increase of taxation and the "welfare" roles of the state; he is, of course, strongly opposed to Soviet power and international Communism; he emphasizes the individual personality as against collectivizing tendencies in 20th-century education and community life. In former years, this typical conservative was a Protestant; but from the early 1940s, for several reasons, American Roman Catholics tended toward conservatism in their politics and sometimes took the lead in conservative movements.

Along with a revival of conservative ideas during the late 1950s and early 1960s there was an emergence or reactivation of various groups of the "radical right," sharing some opinions with conservatives but looked upon with suspicion or distaste by many conservatives because of the virulence of their language or the impracticality of their views. The influence of such organizations was probably exaggerated both by their own members and by their liberal or radical opponents. In actuality, these groups appeared to be less powerful than they had been before World War II.

The most widely discussed of such associations was the John Birch Society, founded by Robert H. W. Welch, Jr., a Boston businessman, in 1958 and named for a U.S. intelligence officer killed by Chinese Communists soon after the end of World War II. Unlike most other "radical right" groups, the John Birch Society tended to attract a good many people of substance and education, including doctors, dentists and lawyers. Though its chapters existed in nearly every state, the society nevertheless remained comparatively small in membership, and enjoyed practical political success almost nowhere but in southern California. The movement's basic manual was *The Blue Book of the John Birch Society;* it was supplemented by a monthly bulletin called *American Opinion.* These publications asserted that Communism is a gigantic conspiracy to enslave mankind and that its main threat to the United States is not from Soviet military power but from internal subversion. Welch and some of his associates went so far as to declare that Dwight D. Eisenhower, Charles de Gaulle, and other eminent western statesmen were agents of Communist subversion. These extreme views were repeatedly ridiculed by leading American conservatives, as well as by liberals.

By the 1960s conservative societies had been formed by undergraduates on some 200 college campuses in the United States—an interesting reversal of the campus radicalism of the 1930s. The menace of the totalitarian society, it appeared, had begun to produce serious political discussion among members of the rising generation. Conservative opinions were also in the ascendancy in both major political parties. Out of this new pattern of politics, in both the United States and Europe, conceivably new general terms might arise to supplant, after a century and a half of use, both "conservative" and "liberal."

See also BURKE, EDMUND; CONSERVATIVE PARTY (BRITISH); LIBERALISM; LIBERAL PARTY (U.S.).

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(R. K.)

CONSERVATIVE PARTY (BRITISH). In Great Britain, beginning about 1830, the name Conservative, traditionally ascribed to John Wilson Croker in an article published Jan. 1, 1830, was applied to the direct descendants of the old Tory party (*see* WHIG AND TORY). In common use "Conservative" never entirely superseded "Tory." Its characteristic principles were the maintenance of existing institutions, political and ecclesiastical, the correction of proved abuses and resistance to violent change. With the secession of the Liberal Unionists from the Liberal party in 1886, the term "Unionist" also came into use, first applying to both the Conservative and Liberal Unionist parties and later, as the distinction between these disappeared,

as a further name, particularly in Scotland and Northern Ireland, for the party as a whole.

Party Organization.—Party organization developed directly from the constitutional or conservative associations established throughout the country after the Reform act of 1832. The National Union of Conservative and Constitutional Associations formed a confederation in 1867. From this grew the National Union of Conservative and Unionist Associations, with its constituency organizations grouped in 12 areas in England and Wales, and separate bodies for Scotland and Northern Ireland. After the general election of 1868, which followed the second Electoral Reform act of 1867, Benjamin Disraeli (afterward earl of Beaconsfield) devoted himself while out of office to the task of strengthening the party machine. One of his innovations was the setting up in 1870 of a Conservative central office. The National Union and the central office were for a short time distinct and separate bodies. In 1872, however, an arrangement was made by which the work of the National Union—which continued nevertheless to maintain its own individuality—became more closely associated with that of the party generally and its headquarters were moved under the same roof as the central office, where they have remained ever since. In 1911 it was decided to create the post of chairman of the party organization, to take over the duties at the central office performed until then by the chief whip (*q.v.*).

Members of both houses of parliament taking the party whip, adopted candidates and the executive committee of the National Union are responsible for electing and if necessary removing the leader of the party. The leader, who is the prime minister when the party is in office, is personally responsible for policy. He controls the parliamentary party through the whips. He appoints the chairman of the party organization, and through him has his contacts with the party in the country and the central office. He appoints the chairman of the Conservative research department, and through him controls the party's policy-forming committees.

The Conservative party by mid-20th century had acquired a remarkable record of internal loyalty. The effect of independent developments, such as the "Fourth party" in the parliament of 1880 and "Tory reform" during World War II, was stimulating rather than disruptive. The Primrose league and other similar outside organizations acted as co-operating agencies.

PARLIAMENTARY HISTORY

From the Reform Act to World War I.—Between 1832 and 1915 political power alternated between Conservatives and Liberals. Liberal ministries predominated up to 1886 and Conservative ministries thereafter. In the earlier period Sir Robert Peel and Disraeli were the outstanding Conservative leaders. It fell to Peel to adapt Toryism to the changed conditions resulting from the Reform act of 1832 which had put the middle class in power. His policy, combining recognition of reform with proposals for economic and social improvement, was set out in the Tamworth manifesto of 1834. The election of 1841 gave the Conservatives a comfortable majority and Peel the opportunity to carry out his plans, but the prospect of a long period of Tory rule disappeared in 1846 when the repeal of the corn laws (*q.v.*) split the Conservative party. They did not have another clear majority until 1874. Disraeli, who had entered parliament in 1837 and had led the opposition to Peel on the corn law question, reorganized the party after this defeat. Convinced that further constitutional reform must come and that the future of the party lay in "Tory democracy," he used his influence to secure the passage of the Reform act of 1867. In his second administration (1874–80) he carried out an impressive program of social legislation.

The Conservatives lost the election of 1880 but in 1886, when the Liberal party split over Home Rule for Ireland, they formed a permanent alliance with the Liberal Unionists, led by Joseph Chamberlain. Thus reinforced, they held office for all but 3 of the next 20 years, led first by Lord Salisbury and then from 1902 to 1905 by Arthur Balfour. Electoral defeat, when it eventually came in 1906, was severe, being aggravated by a temporary but serious division within the party on Joseph Chamberlain's policy of tariff reform. The new parliament contained only 157 Conservative and Liberal Unionist members. The party then went into opposition until May 1915 when, led by Andrew Bonar Law, who had succeeded Balfour in 1911, they joined H. H. Asquith's wartime coalition government.

Between World Wars I and II.—In Oct. 1922, at a meeting of Conservative members of parliament at the Carlton club, it was decided to fight the coming election as a separate party. The wartime coalition, led since 1916 by David Lloyd George and maintained at the "coupon" election of 1918, was dissolved. The election of Nov. 1922 gave the Conservatives 344 seats and a comfortable majority. Bonar Law became prime minister. From this time, apart from the two short-lived minority Labour governments of 1923–24 and 1929–31, the Conservative party was in office either alone or as the largest party in coalition governments until the election of July 1945.

The Labour party meanwhile replaced the Liberals as the main alternative administration. Up to the outbreak of World War II, Stanley Baldwin and Neville Chamberlain were the leading Conservative figures. Baldwin, who succeeded Bonar Law on the latter's resignation because of ill-health, was prime minister in 1923, 1924–29 and 1935–37. By virtue of his parliamentary majority he also held effective power in J. Ramsay MacDonald's National government of 1931–35. At the peak of his career Baldwin achieved an extraordinary ascendancy over both country and party, and is remembered particularly for his personal contribution to industrial conciliation after the general strike of 1926 and for his handling of the abdication crisis of 1936. Chamberlain, who succeeded him in 1937, had an impressive record as an administrator and social legislator, having been an outstandingly successful minister of health. He was the first chairman of the Conservative research department, which he founded in 1929. Like his father, Joseph Chamberlain, he believed in protection and fought persistently and eventually successfully for its reintroduction after the Conservative defeat on this issue in the election of 1923. On his conduct of foreign affairs, strong and differing opinions were held and the verdict of history is still uncertain. What is certain is that the bulk of the country supported the Munich agreement at the time.

The Wartime Coalition.—In May 1940, at the crisis of World War II, Winston Churchill succeeded Chamberlain as prime minister and formed a coalition in which the Conservatives, who at this time held 372 seats, were by far the strongest party. This was a memorable administration. During its five years of office, the war in Europe was won and the war in the far east set on the road to victory. Legislation, such as the Education act, 1944 (known as the Butler act), and the Family Allowances act, 1945, and a whole series of studies, of which the Beveridge report and the Employment Policy White Paper were the best known, planned for the social and economic development of postwar Britain. When, in the summer of 1945, the coalition was dissolved and the time for an election came, it was widely felt that this record, coupled with the immense personal prestige of Churchill, who had become leader of the party on Chamberlain's death in Nov. 1940, would ensure a Conservative victory. But the Conservatives had been in uninterrupted power for 14 years and the tide had now turned against them. Their defeat in the general election of 1945 was comparable in magnitude with those of 1846 and 1906. The parliament which met in Aug. 1945 contained only 189 Conservative members.

In Opposition, 1945–51.—In parliament, Conservative opposition was concentrated on the Labour government's nationalization and planning measures. In the country at large, the party reorganized itself and rethought its approach. Lord Woolton, as chairman of the party organization, put new life into the constituency organizations and new talent into the central office. Membership was increased, finances strengthened and a new appeal made to the young through the foundation and rapid expansion of the Young Conservative movement and the encouragement of younger parliamentary candidates by the removal of the financial barriers to candidature. Meanwhile, under R. A. Butler as

chairman of the Conservative research department and of the party's advisory committee on policy and political education, the party's attitude to the changed and rapidly changing conditions of the postwar world was set clearly before the nation in a series of policy statements of which the first and best known were the Industrial charter (1947) and the Agricultural charter (1948). The setting up of the Conservative political centre in 1946, working in close harmony with the research department, and the foundation of Swinton Conservative college a few years later gave the party better facilities than ever before for long-term political education. Under the stimulus of these reforms, the party rapidly regained confidence and strength, and having reduced the Labour government's majority from 140 to 6 in the general election of Feb. 1950, returned to power in the general election of Oct. 1951 with a majority of 17.

In Office 1951–55.—Winston Churchill's peacetime administration was pledged to "set the people free" and, having dealt with the immediate balance of payments crisis with which it was faced on taking office, was mainly notable at home for the liberalization of trade, the abolition of food rationing, the progressive removal of physical controls, an appreciable reduction in taxation, a major house-building program, and the return to private enterprise of the steel industry and road haulage. In commonwealth and colonial affairs, the period was principally one of preparation for advance: the return of law and order in Malaya and Kenya, the creation of the Federation of Rhodesia and Nyasaland, and the first steps toward the West Indies Federation. In foreign affairs, diplomatic initiatives by the foreign secretary, Anthony Eden, helped to break the deadlock in Korea and Indochina, to solve the Trieste dispute and to achieve agreement on the Austrian treaty. Despite strong Soviet pressure, Federal Germany's membership of the Western alliance was ratified in the London-Paris agreements (1954), and from this strong position negotiations were set in train for the summit conference of 1955. When, therefore, in the spring of 1955, Sir Winston Churchill resigned and Sir Anthony Eden, his successor as prime minister and leader of the party, went to the country, the Conservatives after less than four years in office could present themselves to the electorate as a united party with an impressive record of achievement both at home and abroad. The Labour opposition, however, was deeply divided on defense and other major issues. After a quiet election campaign, the Conservatives were returned for a second term of office with a majority increased to 59. The new parliament contained 345 Conservative and National Liberal members.

Second Term 1955–59.—Conservative party fortunes varied spectacularly between 1955 and 1959. At home, the government was soon in difficulties with a recurrence of inflation. The summit conference at Geneva in 1955 proved a disappointment. In the middle east the Suez crisis of 1956 confronted the government with the most dangerous and difficult situation since World War II, and its decision to intervene had world-wide repercussions. When, on Sir Anthony Eden's resignation in Jan. 1957, Harold Macmillan became prime minister and leader of the party, Conservative fortunes were at a low ebb and there was no early recovery. For the strict monetary measures enforced to defeat inflation, culminating in the 7% bank rate of Sept. 1957, and the Rent act, 1957, only added to the government's unpopularity. In 1957 and early 1958 a series of by-elections at North Lewisham, Rochdale, Kelvingrove and Torrington went against the Conservatives, the first three seats being won by Labour and the last by a Liberal.

Recovery, when it came, was rapid. Its causes were various: a general impression of wise leadership and strong government radiating gradually from Westminster and Whitehall to the country at large; economic recovery from both inflation and trade recession, bringing a welcome combination of stable prices and rising production and living standards; appreciation of the prime minister's efforts in early 1959 to lessen world tension and bring about another meeting of heads of government at the summit; the widely held impression that the Labour party was divided on vital issues and irrevocably wedded to out-of-date policies of nationalization and control. At the general election of Oct. 1959 the Conservative program, *The Next Five Years,* stressed the fundamentals of a strong pound, expanding trade and national unity if Great Britain were to fulfill its responsibilities at home and abroad. It contained an assurance that pensioners would continue to share in growing national prosperity and proposals for expanding educational opportunity, stepping up slum clearance, hospital building and the road program, and for the reform of out-of-date social laws. At the end of a hard-fought campaign in which new techniques in television, press relations and advertising were widely used by all parties, the Conservatives were re-elected, with their majority over all parties increased to 100. Never before, since the Reform act of 1832, had a political party won three successive general elections, twice increasing its majority, while continuously in office. In the general election of Oct. 1964, however, the Conservatives were narrowly defeated by Labour, winning only 304 seats against Labour's 317 and the Liberals' 9.

See ENGLISH HISTORY; *see* also references under "Conservative Party (British)" in the Index volume.

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CONSERVATORY, MUSICAL, a public institution for instruction in music. The word derives from the Italian word *conservatorio* (workhouse), which in the Renaissance period was used to describe a type of orphanage sometimes attached to a hospital or hostel. The foundlings (*conservati*) were given instruction in music, and the *conservatori* were thus the first secular institutions equipped for musical tuition. Sixteenth-century schools of this kind were De' Poveri di Gesù Cristo and Della Pietà dei Turchini at Naples where Nicola Porpora and Leonardo Leo were pupils respectively, and Sant' Onofrio at Venice where Don Angelo Durante was a teacher.

The first secular school of music for the public at large was established in Paris by the Convention Nationale on Aug. 3, 1795, as a result of the efforts of the bandmaster, Bernard Sarrette. This was originally to have been called the Institut National de Musique, but the name Conservatoire de Musique, borrowed from the Italian, was decided upon to avoid confusion with the Institut des Sciences et Arts. The purpose of the Paris Conservatoire was, however, radically different from that of the Italian schools. Formed during the Terror, its aim was to train musicians to take part in public concerts, fêtes and celebrations organized by the republic. A state subsidy was granted, admission was by competitive examination and tuition was free. Later the curriculum was enlarged to include all branches of composition as well as all forms of instrumental and vocal technique. Classes were held in acting, thus enabling students to train for the Opéra, the Opéra-Comique and the Comédie Française. Similar institutions were founded in the French provinces, and important prizes, scholarships and publications were sponsored, including the great *Encyclopédie de la Musique et Dictionnaire du Conservatoire* founded by Albert Lavignac and edited after his death in 1916 by Lionel de La Laurencie. Though many famous pupils of the conservatoire revolted against its academic severities it became the acknowledged centre of musical practice and erudition.

Throughout the 19th century the French model was copied, with modifications, in most European countries and in the United States. Conservatoires were founded in Milan (1807) and Naples (1808) and later in other Italian towns. Prague followed in 1811, Vienna in 1817 and in 1843 Mendelssohn and Schumann founded the Leipzig Konservatorium. Not all the German schools, however, followed the principles of the Conservatoire, and this was also true of similar institutes for musical education in Great Britain, of which the most notable were the Royal Academy of Music and the Royal College of Music (*see* MUSICAL SOCIETIES AND INSTITUTIONS). In the United States, among many schools of music owing their name to the French institution, the Boston Conservatory of Music (1867), the Peabody Conservatory of Music in Bal-

timore (1868) and the National Conservatory of Music, founded in New York in 1885, are the most important. Conservatories were also founded in Australia (the Adelaide Conservatorium, 1898) and Canada (the Toronto Conservatory of Music, 1886).

See C. Pierre, *Bernard Sarrette et les origines du Conservatoire National de Musique et de Declamation* (1895). (E. Lr.)

CONSETT, an urban district (1937) in the Consett parliamentary division of Durham, Eng., 12 mi. S.W. of Newcastle upon Tyne. Pop. (1961) 38,927. It stands on high ground by the right bank of the Derwent. At Shotley Bridge, a German colony of metalworkers, making swords and knives, was established in the 17th century. Coal mining, metalworking, iron smelting, coking and the making of furnace linings are the main industries. A Roman road crossed the Derwent at nearby Ebchester.

CONSIDÉRANT, VICTOR PROSPER (1808–1893), French socialist, was born at Salins (Jura) on Oct. 12, 1808. Educated at the École Polytechnique in Paris, he entered the French army as an engineer, rising to the rank of captain. He resigned his commission in 1831 in order to devote himself to advancing the doctrines of F. M. C. Fourier. On the death of Fourier in 1837 he became the acknowledged head of the movement, and took charge of *La Phalange,* the organ of Fourierism. He also established *phalanges* at Condé-sur-Vesgres and elsewhere. During this period he published his *Destinée sociale* (1834–38), undoubtedly the most able and important work of the Fourierist school. After the revolution of 1848 he was elected to the constituent assembly for the *département* of the Seine. Considérant's share in the "demonstration" under the leadership of Alexandre Ledru-Rollin on June 13, 1849, made it necessary for him to leave France. He made Brussels his headquarters and from there made his visits to the United States. On the second of these visits he founded near Dallas, Tex., the short-lived communistic colony of La Réunion. He returned to Paris in 1869 and died there on Dec. 27, 1893. The most important of Considérant's other writings were *Exposition du système de Fourier* (1845), *Principes du socialisme* (1847), *Théorie du droit de propriété et du droit au travail* (1848). *See* also Fourier, François Marie Charles.

CONSISTORY, a gathering of ecclesiastical persons for the purpose of administering justice or transacting business. The term (Lat. *consistorium,* literally, a "standing place," hence meeting place) first was applied to the audience chamber in which the emperor received petitions and gave judgment; it soon came to mean also the persons who took part in the deliberation, and, by an extension of meaning, a tribunal or jurisdiction. But it has long been employed exclusively to denote ecclesiastical meetings, most particularly meetings of the college of cardinals with the pope as president.

The "consistory" was a form of consultation adopted by the popes when, about the 13th century, particular Roman councils ceased to be held. In earlier times dogmatic and disciplinary questions were discussed in such councils or, if the matter was less important or the bishops could not be convened, in an assembly of the Roman clergy, called the *presbyterium.* As the institution of the cardinalate (*see* Cardinal) became more significant and authoritative, especially under Nicholas II (1058–61), the college of cardinals, assembled in regular meetings called consistories, became the stable counselors of the popes. In the course of time more complicated business came to be assigned to various commissions of cardinals and, with the formal organization of the Roman congregations by Sixtus V (1585–90), the active function of the consistories diminished. In modern times the consistories, which continue to be held at irregular intervals, are largely ceremonial. The limited matters they deal with have already been arranged by the pope himself or by the Sacred Congregation of the Consistory, and the request for the opinion of the cardinals ("Quid vobis videtur?") is a formality; in reality such consistories are a form of solemn promulgation of certain special papal acts.

There are three kinds of consistory: the secret consistory, in which only the cardinals take part; the public consistory, to which are admitted persons from outside and a fairly large audience; and finally, the semipublic consistory, in which the bishops present in Rome take part with the cardinals and are invited to state their opinions. The secret consistory, which corresponds most closely to the original concept, deals with such matters of general interest as the creation of cardinals, appointments to dioceses and other higher benefices (hence called "consistorial"), the creation, union or division of dioceses, the conferring of the pallium, etc. These are held in the Hall of the Consistory, where, after all noncardinals have left the room, the cardinals range themselves in a circle about the pontiff in a complicated pattern of precedence, so that the senior cardinal bishop is at his right and the senior cardinal deacon at his left. It is called a secret consistory only in the sense that participation is limited to the cardinals. Actually the proceedings are published in the official journal of the Holy See, *Acta Apostolicae Sedis.* The pope customarily opens the meeting with a discourse, or "consistorial allocution," devoted to current issues or events of greater moment directly or indirectly affecting the church as a whole.

The public consistory now is held only for the ceremony of conferring the hat on newly created cardinals; formerly the popes used to receive in public consistory sovereigns and certain other great persons, but in this case the consistory was not deliberative in form. The only semipublic consistory is that immediately preceding a canonization (*see* Canonization).

In the Church of England the term consistory court denotes the bishop's court for administration of church law in his diocese. Consistory court or kirk session is the lowest court in some Presbyterian churches, consisting of the minister and elders of the congregation. *See* also Ecclesiastical Law (English).

(J. J. Re.)

CONSISTORY COURTS: *see* Ecclesiastical Law (English).

CONSOLS, an abbreviation of Consolidated Annuities, a form of British government stock that originated in 1751. The first issue of Consols carried a 3% interest rate until the conversion operation of 1888 reduced the rate to 2¾% for the next 14 years and thereafter to 2½%. Between Dec. 1926 and March 1932, 4% Consolidated Loan stock was issued, also known as Consols. Before World War I, Consols formed the larger part of Britain's "funded debt"; *i.e.,* that portion of the national debt the redemption of which is at the option of the government. By March 31, 1961, however, the national debt had, as a result of loans raised through two world wars, reached £28,254,000,000, and at that date 2½% Consols, of which £275,720,800 were outstanding, represented only 1% of the total. At the same date £378,554,381 of 4% Consols were outstanding. After Feb. 1, 1957, the latter were redeemable by the government on three months' notice; the 2½% stock, since April 5, 1923, has been in theory redeemable at any time at the government's option, but in practice it is virtually an irredeemable stock whose price tends to vary inversely to the bank rate. (B. P. W.)

CONSORT, in general, a partner or associate, but more particularly a husband or wife. The word is also used in conjunction with some titles, as "queen consort," "prince consort." Under British law, the queen consort is a subject, but has certain privileges. By the Treason act, 1351, plotting and imagining her death is high treason, as is also the commission of adultery with her. With regard to the acquisition and disposal of property, the incurring of rights and liabilities under contract, suing and being sued, a queen consort is regarded as a feme sole or a single woman (Queen Consort act, 1540; Crown Private Estate act, 1800). In other words she may sue and be sued as a private subject but has her own ceremonial officers and appears in the courts through her own attorney general and solicitor general. When the husband of a queen consort dies, she becomes a queen dowager.

A queen regnant, holding the crown in her own right, has all the prerogatives of a sovereign. At common law the husband of a queen regnant is an ordinary subject with no special privileges or precedence in the absence of specific conferment. Hence the position of the husbands of queens regnant in British history has varied. When Queen Mary I married Philip of Spain, every conceivable precaution was taken to ensure that the queen alone should exercise the powers of the crown, although official docu-

ments were to be issued under joint names. The husband of Queen Mary II occupied the throne jointly with her as William III, but the husband of Queen Anne, George of Denmark, occupied no definite position apart from the special nature of his naturalization in 1689. The position of Prince Albert of Saxe-Coburg-Gotha, the husband of Queen Victoria, was somewhat similar, he being naturalized shortly before the marriage, but he was granted precedence next to the queen immediately after the marriage, and in 1857 was given the formal title of prince consort. This title was not conferred upon the duke of Edinburgh after the accession of his wife as Queen Elizabeth II, but in 1952 he was invested with precedence next to the queen. (M. C. Me.)

CONSPIRACY, in Anglo-American law, is usually described as an agreement between two or more persons to commit an unlawful act or to accomplish a lawful end by unlawful means. This definition is delusively simple, however, for each of its terms has been the object of extended judicial exposition. Criminal conspiracy is perhaps the most amorphous area in the Anglo-American law of crimes. It has never been subjected to precise definition either by courts or legislatures. In most jurisdictions, for example, the "unlawful" end of the conspiracy need not be one which would be criminal if accomplished by a single individual; but courts have not always agreed as to what constitutes an "unlawful" objective for these purposes. Ordinarily conspiracy is the object of criminal prosecution. In some situations, however, it may provide the basis for a tort suit by the injured party.

In the old English law, the crime of conspiracy consisted of abuse of the processes of criminal justice and is related historically to the tort of malicious prosecution. Thus the third Ordinance of Conspirators (33 Edw. I, 1305) condemned conspiracy to bring a false and malicious presentment or to procure a false appeal. The modern conception of conspiracy as an agreement to produce any unlawful or oppressive end did not emerge until the 17th century and is the product of law and procedures developed in the star chamber. Not until after the Restoration did the common-law courts recognize the offense in its modern form. In the 18th century, agreements of workmen for concerted action to raise their wages were defined as criminal conspiracies. Prosecutions for conspiracy in labour disputes continued in England until the Conspiracy and Protection of Property act of 1875 excluded ordinary trade-union activity from the definition of the offense. (*See* Labour Law; Strikes and Lockouts; Labour [Trade] Union.)

United States.—The law of criminal conspiracy in the United States derives directly from the law that emerged in England during the 17th century. As in England, the early history of conspiracy law is closely associated with labour disputes. In 1806 a Pennsylvania court declared criminal a combination of journeymen cordwainers to raise wages. This precedent was followed in other U.S. jurisdictions. In 1842 the Massachusetts court, through Chief Justice Shaw, reached a contrary result in the celebrated case of *Commonwealth* v. *Hunt,* 4 Met. 111. The right of employees to engage in "concerted activities for the purpose of collective bargaining or other mutual aid or protection" was affirmed by congress in the National Labour Relations act of 1935.

Administration of the law of criminal conspiracy in the United States has given rise to a number of recurring issues. In many of the states the objective of the conspiracy need not be a criminal act. Thus, in the case of *Commonwealth* v. *Donohue,* 250 Ky. 343 (1933), a sharply divided court held criminal a combination of persons who had loaned money at usurious rates of interest, even though no crime of usury was recognized in the state. The question of what kind of criminal intent must be established has raised questions, the issue being whether it must be shown that defendants were aware that the object of the combination was unlawful. The chief problems, however, are associated with the definition of the conspiratorial agreement. It is clear that the agreement need not be accompanied by any particular formalities and even that individual conspirators need not know the identity or of the existence of all the other conspirators.

Conspiracies often take one of two primary forms or a combination of both. The "chain conspiracy" involves a series of transactions all directed to a common unlawful objective. Thus in *U.S.* v. *Bruno,* 105 F. 2d 921 (1939), illegal narcotics were brought into the country by smugglers who sold the drugs to middlemen who, in turn, sold to retailers. All these persons were held to be part of the same conspiracy to violate the federal narcotics laws, even though the smugglers did not know the identity of the retailers. The second characteristic form is the "wheel conspiracy," in which illegal contacts with a single individual at the "hub" of the combination are deemed a sufficient nexus to unite in the same conspiracy all persons making such contacts. Thus in the English case of *Rex* v. *Meyrick and Ribuffi,* 21 Cr. App. R. 94 (1929), three night-club operators who bribed the same police officer were held to have conspired with each other to effect public mischief, even though each was ignorant of the identity of the other. With concepts so elastic, definition of the conspiratorial relationship is the source of difficulty and even unfairness.

The law of criminal conspiracy in the federal system is entirely statutory. Many of the regulatory statutes, such as the Sherman Anti-Trust act, have special conspiracy provisions designed to enforce the policy of the particular statutes of which they are a part (*see* Monopoly: *Legal Aspects*). In addition, the federal criminal code contains a general conspiracy section applicable to situations not covered by the special provisions. Under the general statute the object of the conspiracy must be to defraud or commit an offense against the United States. The scope of the offense is narrowed further by the requirement that at least one of the conspirators must commit some overt act to effect the object of the conspiracy before the combination is punishable. Finally, under the general statute criminal conspiracies are felonies except when the object of the conspiracy is a misdemeanour. In the latter case the conspiracy is punishable only as a misdemeanour. Conspiracy prosecutions are more frequently brought in the federal practice than in most state systems of criminal justice. (F. A. A.)

England.—At common law, conspiracy is an indictable misdemeanour, but by s. 4 of the Offences Against the Person act (1861) conspiracy to murder, whether the victim be a subject of the king or not, and whether he is within the king's dominions or not, was declared also a misdemeanour and is punishable by penal servitude not exceeding ten years. Conspiracy to commit treason is treason. It is also interesting to note that the legislature interfered in the case of illegal agreements with respect to bidding at auctions and made it an offense for a dealer to abstain from bidding for a consideration (Auctions Bidding Agreements act, 1927).

Criminal conspiracy may be classified as follows: (1) to cheat and defraud; (2) to injure by wrongful acts other than fraudulent acts; (3) to commit any offense punishable by law; (4) to do any act with intent to pervert the course of justice; (5) conspiracies or combinations in relation to trade and employments. A husband and a wife cannot commit the offense as they are legally one person, but they can conspire with a third person.

The most important question in the law of conspiracy, apart from the statute law affecting labourers, is how far things which may be lawfully done by individuals can become unlawful when done by individuals acting in concert.

The same question arises in the law of tort. Since *Crofter Hand Woven Harris Tweed Co.* v. *Veitch* (1942 Appeal Cases 435), there can be no doubt that a conspiracy in given circumstances can in itself constitute an actionable wrong if damage ensues. In his judgment in this case Lord Simon drew the distinction between the crime and the civil wrong: "The crime consists in the agreement, though in most cases overt acts done in pursuance of the combination are available to prove the fact of agreement. But the tort of conspiracy is constituted only if the agreed combination is carried into effect in a greater or less degree and damage to the plaintiff is thereby produced." Lord Simon also defined the boundary line between the lawful and the unlawful agreement: "I am content to say that, unless the real and predominant purpose is to advance the defendants' lawful interests in a matter where the defendants honestly believe that those interests would directly suffer if the action taken against the plaintiffs was not taken,

a combination wilfully to damage a man in his trade is unlawful. Although most of the cases have dealt with trade rivalry in some form or other, I do not see why the proposition as to the conditions under which conspiracy becomes a tort should be limited to trade competition."

An important exception to the general law relating to conspiracy and interference with trade is created by s. 3 of the Trade Disputes act, 1906, which provides that an act done by a person in contemplation or furtherance of a trade dispute shall not be actionable on the ground only that it induces some other person to break a contract of employment or that it is an interference with the trade, business or employment of some other person, or with the right of some other person to dispose of his capital or labour as he wills. The words "in contemplation or furtherance," "trade dispute" and "interference with the trade, business, or employment of some other persons" necessitated a good deal of judicial interpretation. The judgments in *D. C. Thomson* v. *Deakin* (1953 Chancery 646) contain useful summaries of the relevant authorities, but important issues of interpretation are involved in the case of *Rookes* v. *Barnard and others* (1962) and are likely to be decided eventually by the house of lords. (W. T. Ws.)

Other Countries.—No conception of conspiracy as broad as that recognized in the Anglo-American legal system is to be found in any of the continental codes. In some of the European countries, such as France, punishment of crimes may be enhanced when the offense was committed by more than one person acting in concert. In most civil-law countries the punishment of agreements to commit offenses irrespective of whether the criminal purpose was attempted or executed is largely confined to political offenses against the state. Some extension of the conspiracy idea in other areas has occurred, however. Thus in the Italian code of 1930 association for the purpose of committing more than one crime was made criminal. The Yugoslav code of 1951 makes criminal the organization of a group for the purpose of committing any offense punishable by more than five years' imprisonment. As early as 1932 Germany punished agreements to commit "major crimes against life." None of these provisions, however, has the generality of the Anglo-American concept. None, for example, condemns agreements to commit acts not otherwise criminal. (F. A. A.)

CONSTABLE, ARCHIBALD (1774–1827), Scottish publisher of the *Encyclopædia Britannica* and works of Sir Walter Scott, was born in Carnbee, Fifeshire, on Feb. 24, 1774. After local schooling and an apprenticeship to a bookseller, he lived briefly in London, then opened a rare-book shop in Edinburgh in 1795. In that year he also became a publisher with a commercially successful account of bloody riots in Granada. Shrewd and hard-driving, he soon came to be called in Edinburgh's literary circles the "Napoleon of Publishing" and "The Crafty." In 1802 he founded the *Edinburgh Review and Critical Journal*, a smart, savage and witty magazine whose notable contributors were headed by Sir Francis Jeffrey and Sydney Smith. Constable flouted tradition by paying contributors as much as £1,000 for a philosophical dissertation or £20 for a single-page book review. His regular list of authors included Sir Walter Scott, of whose works he published *The Lay of the Last Minstrel*, the *Waverley* novels and *Marmion*, for which he paid Scott 1,000 guineas.

From 1810 to 1814 Constable gradually acquired ownership of the *Encyclopædia Britannica* from the heirs of Andrew Bell. His prime accomplishment as its publisher was the issuance of a six-volume supplement to the 4th, 5th and 6th editions from 1816 to 1824, generally heralded for its scholarship and authority (*see* ENCYCLOPAEDIA). Through overspeculation and failure of his London agents in 1826, Constable went bankrupt, the debacle also involving Scott. In debt for about £250,000, Constable started anew, issuing in 1827 *Constable's Miscellany of Original and Selected Works in Literature, Art and Science*, one of the first efforts to popularize wholesome literature in inexpensive editions. That same year, on July 21, he died in Edinburgh. His son, Thomas (1812–1881), later maintained the company with his own son, Archibald, who retired in 1893. The firm continued as T. and A. Constable.

See Thomas Constable, *Archibald Constable and His Literary Correspondents*, 3 vol. (1873); Herman Kogan, *The Great EB* (1958). (HN. K.)

CONSTABLE, HENRY (1562–1613), English poet whose sonnet sequence *Diana* shows French influence, but whose spiritual sonnets are of a much higher quality, was born in 1562. He visited Scotland and Europe in 1583–85 in the service of Sir Francis Walsingham. He became a Roman Catholic in 1589 and remained abroad after serving in the earl of Essex' expedition to Rouen, France, in 1591. In 1598 he was sent by the pope to Scotland to indicate the terms on which James VI would be supported in his claim to the English throne. He went to England in 1603 but was arrested in May 1604 and was frequently in prison until he left England in 1610. He died at Liège, Belg., on Oct. 9, 1613.

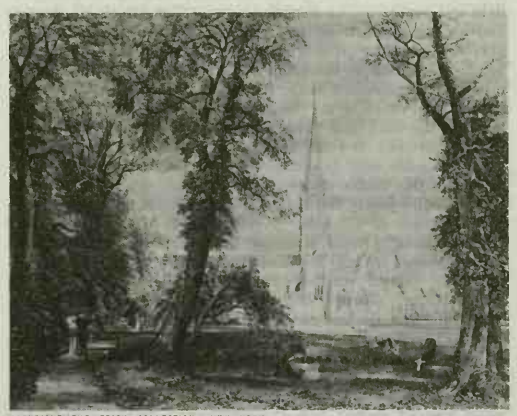
In 1589 he published anonymously in Paris *Examen pacifique de la Doctrine des Huguenots*, translated into English and published in 1623 as *The Catholike Moderator*. His *Diana, the praises of his Mistress in certain sweet sonnets, by H.C.* (1592) contains 23 poems. The 1594 reprint contains 76 poems, many by other hands. He himself said that he wrote 63 secular poems.

The second edition of *Diana* was reprinted by E. Arber in *The English Garner*, vol. ii (1879). Sixteen *Spirituall Sonnettes* found in manuscript and attributed to Constable were edited by Thomas Park in *Heliconia*, vol. ii (1815). Constable's works were edited by W. C. Hazlitt (1859).

See L. I. Guiney, *Recusant Poets With a Selection From Their Work* (1938); G. Wickes, "Henry Constable, Poet and Courtier," *Biographical Studies 1534–1829*, vol. ii, no. 4 (1954). (M. H. D.)

CONSTABLE, JOHN (1776–1837), one of the greatest English landscape painters, was born at East Bergholt, Suffolk, on June 11, 1776, the second son of a wealthy miller, Golding Constable. Originally intended for the church, he began to take an interest in landscape painting while he was at Dedham grammar school, which he left about 1793 to work for his father. During his spare time he studied painting and met Sir George Beaumont, a dilettante painter and patron, whose collection included drawings by Thomas Girtin and Claude Lorrain's "Hagar and Ishmael," the sight of which fired Constable's enthusiasm. His keen artistic interest was such that his father allowed him to visit London in 1795, where the engraver John Thomas Smith taught him etching. Constable's biographer, C. R. Leslie, relates that he also sought advice from the landscape painter Joseph Farington (1747–1821) in 1795, but Farington's *Diary* gives Feb. 25, 1798, as the date of their first meeting.

Recalled to his father's countinghouse in March 1797, Constable was unable to follow his vocation until 1799, when in December he was listed as a probationer of the Royal Academy schools, and in Feb. 1800 became a full student. After two failures he exhibited



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"SALISBURY CATHEDRAL FROM THE BISHOP'S GARDEN," BY JOHN CONSTABLE. IN THE FRICK COLLECTION

his first landscape at the academy in 1802. A year previously John Reade had commissioned him to paint the "Old Hall, East Bergholt" (formerly Misses K. and M. Gore collection), a topographical picture that was described by Farington (*Diary*, July 13, 1801) as influenced by Beaumont, but that in the fresh, liquid painting of the trees and sky already hints at a distinctive style: Constable was by now convinced that there was "room enough for a natural painter." Nevertheless, his development was slow, and he remained largely self-taught, studying "truth at secondhand" in the works of Jacob van Ruisdael, Claude, Richard Wilson and Thomas Gainsborough. Some marine drawings in the manner of W. van de Velde were executed at Deal in 1803, and in 1804 and 1808 he painted altarpieces for the churches at Brantham and Nayland, which stylistically owe much to Benjamin West, for whose early encouragement Constable was always grateful. He it was who saved Constable from the drudgery of a drawing-mastership, offered by the kindly intentioned archdeacon John Fisher, another of the artist's lifelong friends and patrons. In 1806 Constable toured the Lake district, and the sketches of this date are strongly influenced by the work of J. R. Cozens and Girtin. Between 1807–08 he copied paintings in Lord Dysart's collection, including portraits by Sir Joshua Reynolds, an artist whom Constable always admired. Besides copying, he was compelled to supplement his slender income by portraiture until 1814. By this time, however, he had acquired an assistant, John Dunthorne (1798–1832), the son of an East Bergholt plumber and glazier with whom Constable as a schoolboy had first studied painting.

The year 1811 marked a turning point in his career. He then exhibited the large "Dedham Vale" (Maj. R. G. Proby collection) at the academy, an ambitious panoramic view of Essex countryside seen at midday in brilliant early summer sunlight. This contains the almost fully matured features characteristic of his art. He also fell in love with Maria Bicknell, whom he was not allowed to marry until 1816, after the death of his father had assured him a measure of financial security and nullified the Bicknell family's objections. By 1819 two legacies each of £4,000 alleviated domestic anxieties, and his genius was at least acknowledged by his election in November to the associateship of the academy.

During the years 1811–26 Constable unwaveringly pursued a lonely road of experiment and discovery, against the accepted teaching of his day, in the means of rendering the observed appearance of landscape. The evidence of this search lies in the series of over 300 drawings and oil studies which in 1888 were bequeathed to the Victoria and Albert museum, London, by the painter's daughter Miss Isabel Constable. These studies show the artist steadily acquiring a bolder, freer handling of paint, to record, within traditional schemes of composition, the fleeting aspects of landscape as perceived under varying conditions of light and weather. The disparity between Constable's oil sketches and his big finished pictures which occurs so frequently—the nervous, trembling brushstroke and emotional tension on the one hand, as opposed to the calm, reflective quality on the other—may best be explained as the artist's recreation of a mood, of a remembered vision, in the tranquillity of his studio. A comparison between the study for "The Hay Wain," *c.* 1821 (Victoria and Albert museum) and the finished composition in the National gallery, London, with its additions and alterations, shows the working out of this double creative process, which is also described in Wordsworth's poetry and is typical of the Romantic revival in art and literature as a whole. Notable works of this period are "Boat-building" (Royal Academy, 1815; Victoria and Albert museum), painted entirely in the open air, near Flatford mill; "Flatford Mill" (Royal Academy, 1817; Tate gallery, London); "The White Horse" (Royal Academy, 1819; Frick collection, New York), his first six-foot canvas; "The Hay Wain" (Royal Academy, 1812; National gallery); "Salisbury Cathedral From the Bishop's Grounds" (Royal Academy, 1823; Victoria and Albert museum), the first of several versions; and "The Leaping Horse" (Royal Academy, 1825; Diploma gallery, Royal Academy), for which a grand, unified, full-scale study exists in the Victoria and Albert museum. The "Salisbury Cathedral" of 1823 is painted in a new technique of blobs and pure colour, with scumblings and heavy impasto, and contains those elements so prized by Constable: "my light—my dews—my breezes—my bloom and my freshness"—qualities as yet absent from landscape painting. During 1821–22, Constable painted a series of cloud studies remarkable for their close accuracy of observation and sustained quality. This intensive study of the atmosphere was inspired by the researches of Luke Howard, fellow of the Royal society, whose standard classification of cloud structure provided Constable with a scientific framework to serve his pictorial ends. Constable's admiration for the older masters of landscape—Rubens, Ruisdael, Titian and above all Claude—steadily increased, and in 1823 he spent six weeks copying landscapes in Beaumont's collection.

The French were the first to acclaim Constable publicly, when at the Paris Salon of 1824 he showed three paintings, including "The Hay Wain," and again at Lille in 1825, where he exhibited "The White Horse." On both occasions he was awarded a gold medal. "The Hay Wain" had been purchased by John Arrowsmith, an Anglo-French dealer who, with the print seller Schroth, imported many Constables into France. Not until 1829 did the Royal Academy grudgingly admit Constable as a full academician, by which time it came as a hollow honour. Although early in 1828 he had inherited £20,000 from his father-in-law, this new-found security was soon blighted by the death of his wife later that year.

The work of the last ten years of Constable's career shows greater diversity of development, and he attempted to infuse more of the spontaneity of his sketches into the larger compositions, such as the windswept, impressionistic "Hadleigh Castle" of 1829 (large study in the Tate gallery). Alternating with these broadly treated atmospheric works are carefully detailed paintings as "The Valley Farm" (1835; Tate gallery), or "The Cornfield" (1826), purchased by private subscription and presented to the National gallery soon after Constable's death. The most ambitious achievement of this period was the "Waterloo Bridge From Whitehall Stairs" (Royal Academy, 1832; Lord Glenconner), projected about 1819 (in 1824 he exhibited a smaller "Waterloo"), a sparkling, light-filled composition in which the distant vista of the bridge is framed by a foreground of trees, boats and buildings in the manner of Claude. As in many works of this date, Constable made extensive use of a palette-knife technique, notably in "The Cenotaph" (Royal Academy, 1836; Tate gallery), with which he pays tribute to Reynolds, to whose memory the cenotaph had been erected at Coleorton (Beaumont's house), and reflects in its gentle melancholy his own sombre mood. In 1833 David Lucas had published a splendid series of mezzotints after Constable's paintings entitled *English Landscape*. Constable's sudden death on March 31, 1837, could be attributed to no discoverable disease.

Constable's importance lies in his having brought to the art of landscape painting a highly original creative vision of such power as to convey to the spectator his own direct passion. Apparently mundane, trivial objects were seen afresh and painted with the devoted concern of a naturalist's observation. Naturalism for Constable meant indeed an aversion to the ideal landscape and to borrowed ideas. He may truly be considered the father of modern landscape painting and a liberating force on mid-19th century French landscape tradition. *See* also PAINTING; LANDSCAPE PAINTING.

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CONSTABLE, the title of a great officer of state in western European countries from medieval times, and of certain executive legal officials in Great Britain and the United States.

Officers of State.—The title of *comes stabuli* (*see* COUNT) is found in the Roman and particularly in the East Roman or Byzantine empire from the 5th century A.D. as that of the head of the stables at the imperial court. The Franks borrowed the title

and under the Merovingian and Carolingian kings of western Europe the *comes stabuli* was in charge of the royal stud, with the marshal (*marescallus*) as his subordinate officer. Both these important palace officials sometimes deputized for the king in command of the army. In the 11th century the constable (*connétable*) of France became one of the five great officers of state, with certain limited powers of jurisdiction and with command of the cavalry. With the decline of the office of seneschal (*q.v.*) the constable's military duties and judicial powers increased till by mid-14th century he held supreme military command of the army: at the height of his power, he possessed the right to be addressed as "cousin" by the king and took precedence immediately after him. After the treason of constable duc de Bourbon (1523), however, the kings distrusted the office, and for many years in the 16th century it was allowed to remain vacant. Suppressed in 1627, after the death of François de Bonne, duc de Lesdiguières, it was revived by Napoleon I, who appointed his brother Louis Bonaparte constable. It was finally abolished on the restoration of the Bourbons.

The constable and marshal in France both held courts to implement their judicial powers. Having similar duties, they fused into one body (*connétablie et maréchaussée*) during Louis XI's reign. Until the middle of the 14th century the constable and the marshal personally presided over their courts, but as military operations increased a lieutenant conducted duties in their name. Early in the 15th century he assumed the title of *lieutenant général*. In addition to civil and criminal jurisdiction, which included all military persons and causes, the court's jurisdiction extended to include persons with no legal domicile, previously convicted criminals, murder, robbery and other acts of violence. This often resulted in disputes with the ordinary courts. After the 15th century the court's power declined, and its duties were principally administrative, but it survived until the Revolution.

The kings of Castile, of Navarre, of Naples and of Portugal also had their constables. The hereditary title of constable (*condestable*) of Castile belongs to the house of Velasco, that of grand constable of Navarre to the dukes of Berwick and Alba. The Colonna family became hereditary grand constables of Naples in 1450. In Portugal, Nuno Álvares Pereira (1360–1431) was appointed constable in 1385. His daughter's marriage to King John I's bastard son Afonso gave rise to the ducal line of Braganza, who were hereditary grand constables until the 8th duke succeeded to the throne in 1640.

In Scotland the office of constable, introduced in the 12th century, became hereditary in the Comyn family in the 13th century and in the Hay family (later earls of Erroll) from 1314. Their status was fixed by an act of parliament in 1681, when the lord high constable was given precedence before every other hereditary honour after the blood royal and rank in all royal armies next to the king. His judicial powers extend to all disorders committed within four miles of the sovereign's person or of the parliament or council representing him, and he has the charge and guarding of the king on ceremonial occasions.

In England the office of constable, which was similar to that of the pre-Conquest *staller*, was in existence in Henry I's reign. The constable and marshal were principally in command of the army, though they had duties at the king's court. The office was hereditary in the family of Milo of Gloucester (earls of Hereford from 1141), then in the Bohun family (earls of Hereford from 1199 to 1373). Edward Stafford, 3rd duke of Buckingham, claimed the office of lord high constable as heir of the Bohuns, but after his attainder (1521) it was revived only occasionally. Lord high constables are now appointed only for coronations. The constable and marshal's court, also known as the court of chivalry, came into existence at least as early as the reign of Edward I.

Local Officers.—Officers with important military commands and in control of garrisons and castles were also known as constables; *e.g.*, the constables of Windsor, Dover, Caernarvon, Conway, Harlech and Flint castles and of the Tower of London, still existing in the 20th century. Sometimes the appointment was coupled with that of conservator (later justice) of the peace, who assisted the sheriff in enforcing the law. This gave rise to constables exercising civil jurisdiction. Under the Statute of Winchester (1285) the civil and military organizations were linked. A chief or high constable was appointed in every hundred or franchise, who was responsible for suppressing riots and violent crimes and for arming the militia to enable him to do so. Under him were petty constables in each tithing or village. The high and petty or parish constables remained the executive legal officers in counties until the County Police acts of 1839 and 1840 allowed justices in quarter sessions to establish a paid police force. The office of high constable, which latterly had chiefly been concerned with inspecting weights and measures, suppressing cattle disease and levying and collecting the county rate, was abolished in 1869. In Scotland, bodies of high constables, formed to curb riots, etc., still exist at Edinburgh, Leith, Perth and Holyroodhouse, the last-named being prominent on state occasions.

By the Parish Constables act of 1842, constables were to be concerned only with the security of persons and property and no longer with the keeping of the peace. Vestries (later parish councils) were allowed to decide if one or more of these should be paid. By the Parish Constables act of 1872 appointments were no longer to be made unless required by a resolution of general or quarter sessions or requested by the resolution of a vestry. (*See* further POLICE.)

Special constables are peace officers appointed to act on emergencies when the ordinary police force is thought insufficient.

In the rural districts of the United States the constable had the same status as in England before the act of 1842, but during the 20th century gradually lost most of his power in criminal matters to the uniformed police, being thereafter chiefly concerned with the issuing of writs, processes and election notices. Virginia totally abolished the office, as also did many counties in other states. Candidates for election were often not forthcoming. The office of high constable existed in Philadelphia and New York—in the latter city until 1830. (P. W. M.-S.)

CONSTANCE (KONSTANZ), a town of Germany which after partition of the nation following World War II was in the *Land* (state) of Baden-Württemberg in the Federal Republic of Germany. It lies 1,312 ft. above sea level at the point where the Rhine flows out of Lake Constance. Pop. (1959 est.) 51,666. Of the fortifications of the medieval town, on the left bank of the Rhine, only the Schnetz gate, two towers and a part of the town wall remain. The modern residential and industrial areas, recreation grounds and barracks are all north of the river in the district of Petershausen and the adjacent suburbs.

By the harbour of the old town is the Kaufhaus (warehouse) built in 1388 and, across the wide market place, stands the Renaissance-style town hall (1585). Near the Upper market is the Gothic Rosgarten museum, once the guild house of the butchers, and between these and the Rhine stands the 11th-century minster which was the cathedral until 1821, the diocese of Constance having once been the greatest in Germany. Among medieval houses are the city library and picture gallery and a house with frescoes (*c.* 1300) showing the history of linen weaving. In Niederburg is the unchanged medieval Dominican monastery of Zoffingen. The modern state technical college stands on the banks of the Rhine.

Constance is about 40 mi. from the Black Forest and at the end of the Black Forest and upper Rhine railways and is connected to the Swiss railway network. The shipping routes of the lake converge on Constance harbour and the airfield is used by small aircraft. There are textile concerns, engineering works and electrical and chemical works. Because of its beautiful setting Constance is the most popular tourist resort on the lake.

A Roman fort, established there in the reign of Claudius (A.D. 41–54), was invaded in the 3rd century by the Alamanni who, in about 600, founded a bishop's see. The emperor Frederick I Barbarossa made peace there with the Lombard states in 1183. In the 13th century the export of linen brought great prosperity and in the 14th century the townspeople freed themselves from episcopal rule. Constance, then a cultural centre, became an imperial city and head of a powerful confederacy of towns. The

14th-century mystic Heinrich Suso entered a monastery there. During the council of Constance (*see* CONSTANCE, COUNCIL OF) John Huss was tried and burned. In 1417 at Constance Frederick I of Hohenzollern was enfeoffed with the electorate of Brandenburg (*q.v.*) by King Sigismund. During the Reformation Constance became Protestant under the influence of Zwingli and the bishop transferred his see to Meersburg on the north coast of the lake. After the defeat of the Protestants in 1547 Constance lost its rights as an imperial city, became Catholic again and fell under Austrian rule, until it became part of the then newly formed grand duchy of Baden in 1805. In 1633 the Swedes laid siege to the city. During the 19th century many collections and archives were removed, churches and monasteries suppressed and most of the city fortifications pulled down. Nevertheless, Constance remains the cultural and economic centre of the district. (O. F.)

CONSTANCE, COUNCIL OF, a church council convoked, under pressure from the emperor Sigismund, by John XXIII (1410–15), one of the three popes who divided the allegiance of Christendom at the time and generally considered to have been an antipope (an opinion shared by the pope who ascended the throne in 1958, also as John XXIII). The two other papal claimants were Gregory XII, third successor of Urban VI and now commonly considered the legitimate pope, and Benedict XIII, successor of the schismatic Clement VII, also generally regarded as an antipope. The principal task of the council, which opened on Nov. 5, 1414, at Constance in Baden, and closed on April 22, 1418, was to put an end to the great schism of the west. In this task it was successful. Other objects were the reform of the church and the examination of the teachings of John Wycliffe and John Huss.

Sigismund had persuaded John XXIII to call the council in a German city and had won for it the support of central Europe, England and most of Italy. The majority of the French episcopate and the University of Paris also favoured the council but the French government stood aloof. Scotland and the parts of Spain that remained true to Benedict XIII at first took no part in it.

The Council of Constance was a brilliant gathering. Thousands of persons, representing the intellect, learning and power of the age, thronged the streets of the little city on the Lake of Constance. At the time of its greatest numbers, it counted three patriarchs, 29 cardinals, 33 archbishops, 150 bishops, 100 abbots and 300 doctors of theology and canon law. If the staffs of the emperor and nobles, the retinues of the prelates and the merchants whom the council attracted are included, about 70,000 people attended, among them a large number who did not contribute to the council's good name.

The majority of the council's members acknowledged the Council of Pisa (1409) as ecumenical and considered John XXIII to be the legitimate pope. But when it was proposed that the decrees of Pisa, and implicitly the validity of John XXIII's election, be approved, the French cardinal Pierre d'Ailly intervened and maintained that all three contestants were obliged to obey the Council of Constance, which would decide who was the legitimate pope. The thesis that all three rivals should abdicate gained steadily. John XXIII hoped to maintain himself because he could count on the votes of the Italian bishops and prelates, who formed the majority of those with the traditional right of suffrage in ecclesiastical assemblies. The German members, however, were able to win the right of voting for the representatives of absent prelates, for doctors of theology and canon law and even for ambassadors of princes. This measure, which was against conciliar usage, broke the power of John XXIII. To decrease still further the influence of the Italians, it was decided that differences were to be settled not by the majority of those having right to vote but by nations, of which there were at first four: English, French, German and Italian. Later, the cardinals present were given a vote as a group, and still later, after the deposition of Benedict XIII, the Spanish nation was empowered to vote. This division according to nations, copied from the organization of the University of Paris, gave England, with a handful of representatives, as much power as Italy, with its great numbers.

John XXIII at first would not hear of abdicating, but under threat of an investigation of his life, he promised on oath (March 2, 1415) to resign if his rivals would do the same. Three weeks later, however, he fled in disguise from Constance, hoping that this act would deprive the council of its authority and lead to its dissolution. The emperor, however, insisted that the council continue. D'Ailly and other leaders maintained that the popes were subject to the council. The consequence was that in the third session (March 29, 1415) and the fifth (April 6) the famous decrees on the church were passed. It was asserted that the council had its authority immediately from God and could not be dissolved or transferred by the pope without its consent; that everyone including the pope must obey the council in matters concerning the faith; the ending of the schism and the reformation of the church in head and members; and that the council had power to coerce and punish all the recalcitrants, even the head of the church.

It appears that these decrees, in the minds of those who voted them, applied not only to the Council of Constance, held in exceptional circumstances, but to all future councils. No pope and relatively few cardinals or bishops accepted this revolutionary interpretation of the church's fundamental law.

Four sessions of the council were devoted to an examination of the life of John XXIII, who had been brought back as a prisoner to Constance and who was deposed. Although he accepted the sentence, he was kept in captivity till 1418 by Sigismund and released only on the payment of a heavy ransom. He died in 1419.

In the 14th session (July 4, 1415), through a cardinal legate, Gregory XII convoked the council and ordered his adherents to join it. Then his free and unconditional abdication was announced. The council acknowledged this convocation and accepted the resignation. In gratitude for his resignation the council conferred on him the bishopric of Porto, the legation of Ancona and rank second only to that of the pope. He died in 1417. The council, after the convocation by Gregory XII, is regarded as a true general council by Roman Catholic theologians.

Benedict XIII refused to resign, although Sigismund went personally to his residence at Perpignan in France to persuade him. Sigismund, however, was able to induce the Spanish princes to abandon Benedict, who on July 26, 1417, was deposed by the council. He still refused to submit and remained in the castle of Peñíscola near Valencia till his death.

After the deposition of Benedict, the council decided that general councils were to be held frequently. One was to be held five years after the end of Constance, a second seven years later, and thereafter one was to be held every ten years. A disagreement about the order of procedure led to debate. Sigismund and the German nation wanted to proceed to a reform of the church before the new pope was elected. On Oct. 30, 1417, a decree was published binding the future pope to a reform.

In electing the new pope, the council decided that for this time 30 other prelates representing the different nations should be associated with the cardinals present at Constance. This conclave on Nov. 11, 1417, elected Oddone Colonna, who became pope as Martin V.

The council also dealt with the teachings of John Wycliffe, John Huss and Jerome of Prague. Forty-five propositions of Wycliffe and 30 of Huss were condemned. Huss and Jerome were declared obstinate heretics, delivered to the secular arm and burned at the stake. (*See* further HUSS, JOHN; JEROME OF PRAGUE.)

The council had also been summoned to bring about a reform of the church in head and members. Seven reform decrees were adopted and Martin V concluded concordats on other points, chiefly methods of taxation, with the various nations. To the council's failure to effect any real reform the Reformation may in large part be attributed.

The Holy See never approved of the decrees of the council as a whole, and specifically reprobated those on the supremacy of the council. Others—*e.g.*, the condemnations of Wycliffite and Hussite doctrines—were accepted.

See PAPACY: *The Great Schism, 1378–1417: The Council of Constance;* COUNCIL. *See* also references under "Constance, Council of" in the Index volume.

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CONSTANCE, LAKE OF (BODENSEE), after the lake of Geneva, the largest lake in the region of the Alps, lies along the northeast frontier of Switzerland with Germany and Austria. It is entered by the Rhine near Bregenz and the river leaves the lake at Stein am Rhein. The lower end of the lake is divided into two arms, the Untersee, below Constance, and the Überlingersee, extending to Ludwigshafen am Rhein. Lake Constance has an extent of 46½ mi. from southeast to northwest. Glacial in origin and hemmed in by moraines at its lower end, the lake lies 1,299 ft. above sea level, with a maximum width of 10½ mi. and a maximum depth of 827 ft. The area of the lake is 207 sq.mi., divided between Switzerland (cantons Thurgau and Sankt Gallen), Austria (Vorarlberg) and the Federal Republic of Germany. Bronze Age pile dwellings have been found and reconstructed at Meersburg, Ger. The island of Reichenau is the site of the medieval monastery of Zell.

See J. Früh, *Geographie der Schweiz*, 3 vol. (1930–45). (A. F. A. M.)

CONSTANS, FLAVIUS JULIUS (CONSTANS I) (*c.* A.D. 323–350), Roman emperor, was the fourth or fifth son of Constantine the Great. Proclaimed *Caesar* in 333, he became ruler of Italy, Africa and Illyricum on the death of his father (337). His brother Constantine II (*q.v.*) invaded northern Italy in 340, but was defeated and killed at Aquileia by the troops of Constans, who then became ruler of the western empire, Italy, Spain, Gaul and Britain. He defended his realm successfully against the Franks in 341, and in 343 visited Britain. He was an ardent Catholic, vigorously opposing Arianism (*q.v.*) and paganism. He was overthrown and killed in Gaul in 350 by Magnentius. (E. A. T.)

CONSTANS II POGONATUS (630–668), Byzantine emperor from 641 to 668, became sole ruler in 641 after the death of his father, Constantine III, and the downfall of his uncle Heracleonas. He had to face the early onslaughts of Islam. Alexandria was finally lost in 646, and Egypt fell into Muslim hands. The Arabs, becoming powerful at sea, attacked Cyprus (649) and Rhodes (654). In 655 Constans was defeated at sea, and only internal dissensions prevented the Arabs from attacking Constantinople. They continually harried Asia Minor and gained a footing in Armenia. Constans ensured the defense of the eastern provinces by strengthening their military organization and was thus free to turn to the Balkans and the west. In 658 he campaigned against the Slavs who were settling in the Balkans. In 662 he took an army to Italy, visited Rome briefly in 663, and finally settled at Syracuse, intending to make it his capital. He evidently hoped to drive out the Lombards and had some success against them, but he then concentrated on consolidating the southern imperial provinces as a bulwark for protecting North Africa and Sicily against the Arabs. His heavy exactions led to an African revolt, but at least he contributed to the long persistence of Byzantine power in southern Italy and Sicily. He was assassinated at Syracuse on Sept. 15, 668.

Constans tried to impose unity on the church by an edict, the *Typus*, forbidding discussion of the monothelite question (648) and by the arrest, trial and exile of Pope Martin I (653). Both his foreign and his ecclesiastical policy show Constans to have been dominated by the old conception of a single universal empire comprising both east and west.

See G. Ostrogorsky, *History of the Byzantine State* (1956); E. W. Brooks in *Cambridge Medieval History*, vol. ii, ch. 13 (1913). (J. M. Hv.)

CONSTANT, BENJAMIN JEAN JOSEPH (1845–1902), French painter and etcher who gained particular fame for his portraits of the English aristocracy, was born in Paris on June 10, 1845. He studied under Alexandre Cabanel and greatly admired the work of Eugène Delacroix. In 1871 Constant traveled through Spain and Morocco, and the oriental subjects which this trip inspired established his reputation as a painter. Later he turned toward more decorative painting for public buildings, and portraiture. He exhibited frequently in the Paris salons. As an occasional etcher, he is accredited with three plates.

CONSTANT, a quantity which does not vary. In mathematics and physics a quantity may be constant with respect to one variable but not with respect to another. Many so-called physical constants are constant under certain conditions only; *e.g.*, the boiling point of a pure substance is constant only if the atmospheric pressure is constant (*see* VAPORIZATION). On the other hand there are constants which express invariable ratios, such as the gas constant R (*see* THERMODYNAMICS), the gravitational constant G (*see* GRAVITATION) and Avogadro's constant (*q.v.*) N. The elementary electric charge e (*see* ELECTRON) is an example of the invariable measure of a physical property. Planck's constant h, the elementary quantum of action, is probably the most important constant in quantum theory (*see* QUANTUM MECHANICS). Another famous physical constant is the velocity of light, approximately 3×10^{10} cm. per second (*see* LIGHT, VELOCITY OF; *see* also PHYSICAL UNITS).

See also references under "Constant" in the Index.

CONSTANŢA, a town of Rumania and administrative centre of the Dobrůja region, is located on the Black sea, 201 km. (about 125 mi.) E. of Bucharest. It is the principal seaport of Rumania and, like Bucharest, has the status of a *reguinea* (region). Pop. (1960 est.) 112,993. The first settlement on the site was the ancient city of Tomis, founded in the 6th century B.C. by Greek colonists. It was the place of exile of the Roman poet Ovid, and numerous remains testify to the existence of a flourishing Greco-Roman settlement of considerable military importance. In the 4th century the town was largely rebuilt by Constantine the Great and renamed Constantiana. Its modern development dates from the late 19th century.

The port and dockyards, rebuilt and modernized, are connected by oil pipeline to Ploeşti. Air service is from Hellenie. There are brick, textile and edible-oil factories, slaughterhouses, flour mills and rice-husking plants. Constanţa contains several theatres and a regional archaeological museum. The marine zoological station, directed by Iaşi university, carries on research on the marine biology of the Black sea. An aquarium is connected with it. Constanţa is a popular seaside resort.

DOBRUJA (formerly Constanţa) ADMINISTRATIVE AND ECONOMIC REGION is situated in the southeastern part of Rumania between the Danube and the Black sea, covering part of the historic territory of Dobruja (*q.v.*). Area 15,460 sq.km. (5,969 sq.mi.). Pop. (1960 est.) 502,674. It is divided into nine districts.

The relief of the region is formed of the Danube delta, the Măcin mountains, the Babadag and Dobruja plateaus and the Black sea coast. The climate is continental-temperate. The hydrographic network consists of lakes and rivers with a small and variable flow. A steppe vegetation prevails.

Minerals include copper, barite, iron ores, marble, limestone and chalk. Industry is concentrated in Constanţa, Medgidia, Cernavodă, Năvodari and Tulcea and includes metallurgical, chemical, food-processing and thermal power plants. Agriculture, which is important in the region's economy, is completely collectivized. Wheat, maize, barley, oats and fruits are grown, and Constanţa is the home of the Murfatlar wine. Merino sheep are bred on the Dobruja plateau. The region produces 70% of Rumania's fish catch, including both fresh- and salt-water varieties. There are a number of resort towns on the shore of the Black sea.

CONSTANT DE REBECQUE, HENRI BENJAMIN (BENJAMIN CONSTANT) (1767–1830), Franco-Swiss novelist and political writer, the author of *Adolphe* (1816), a forerunner of the modern psychological novel, was born at Lausanne, Switz., on Oct. 25, 1767, the son of a Swiss officer in the Dutch service, whose family was of French origin. The very type of the cosmopolitan European of the Napoleonic generation, he studied at Erlangen, Ger., briefly at Oxford, and at Edinburgh. In 1787 he formed, in Paris, his first liaison, with Madame de Charrière (*q.v.*), 27 years his senior. His republican opinions in no way suited him to the office of chamberlain to the duke of Brunswick, which he held for several years, marrying in 1789 a lady of the court, Baroness

Chramm. In 1794 he chose the side of the French Revolution in a divided Europe, abandoning both his office and his wife, whom he divorced. The influence of Madame de Staël (*q.v.*) had a good deal to do with his decision. He had met her at Lausanne earlier in 1794 and he accompanied her on her return to Paris in 1795 after the Terror. Their tumultuous and passionate relationship was to last until 1806. It corresponds with the first part of the political life of Constant who, throughout the period of the Directory, remained a faithful supporter of Barras. After the *coup d'état* of 18 Brumaire (1799) he was nominated a member of the tribunate, but he quickly became, like Madame de Staël, an opponent of the Bonapartist regime and, expelled from the tribunate in 1802, followed her into exile the year after. During the succeeding years he spent his time either at Madame de Staël's *salon* at Coppet, near Geneva, or in Germany, chiefly at Weimar, where he met Goethe and Schiller. Constant, among the most talented of those who transmitted German literary influence to France, was the associate, both at Coppet and in Germany, of the brothers Friedrich and August Wilhelm von Schlegel, the pioneers of the romantic idea, and with them he inspired Madame de Staël's book, *De l'Allemagne*.

This period of exile was the most productive in Constant's life. For many years he had been collecting material for the book on which he was now engaged, which was to be his life's work, *De la religion considérée dans sa source, ses formes et ses développements* (5 vol., 1824–31). It is a historical analysis of religious feeling in all its varied forms and also the argument of a positive, even a skeptical, nature confronting the threat of death. In it he revealed his inner self, as he also did in his intimate diaries, which for long remained unknown, in his correspondence—particularly with his cousin Rosalie—and not least in *Adolphe*, the barely disguised account of his break with Madame de Staël in 1806.

Nearly a century and a half after the appearance of *Adolphe*, another novel, *Cécile*, dealing with events between 1793 and 1808, was discovered. Constant has been compared as a novelist with Stendhal, and, in fact, beneath the romantic trappings and rapturous emotion, there is to be found the sure and easy artistry of a masterly prose writer, and the objective observation which belongs to a true storyteller and which makes him a pioneer of the psychological novel.

In 1808 Constant secretly married Charlotte von Hardenberg, whom he had known at Brunswick. But his intellectual relationship with Madame de Staël and the group at Coppet remained unbroken. This is confirmed in the preface (1809) to his mediocre adaptation—greatly admired by Madame de Staël—of Schiller's *Wallenstein*.

Nevertheless, Constant's principal ambitions were political. He published in 1813, in Hanover, *De l'esprit de conquête et de l'usurpation dans leurs rapports avec la civilisation européenne*, in which he surveyed the decadence of the Napoleonic regime. As a liberal he was, like Madame de Staël, disappointed by the Restoration, and he reconciled himself with the Empire of the Hundred Days under the influence of Madame Récamier, the other great love of his life. On his return to Paris after a short exile, Constant, through the *Minerve française* (1818) and *La Renommée* (1820), became one of the leaders of liberal journalism. He was elected a deputy in 1819 and advocated the liberty of the press. He collected his articles and speeches and published them as a sort of political testament. He died in Paris on Dec. 8, 1830, having seen the realization of the Staëlian political ideal: the monarchy of Louis Philippe brought about by the revolution of July 1830. On Aug. 27 of the same year he had been appointed president of the council of state.

Constant's complete works were published in 1957, edited by A. Roulin, who also edited the first edition of *Cécile* (1951; Eng. trans. by N. Cameron, 1952). There are numerous translations of *Adolphe* and of *Le Cahier rouge*, Constant's autobiography until 1787, which describes his travels in Britain.

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CONSTANTIA, a valley and residential town on the Cape peninsula, Republic of South Africa, lies about 10 mi. S. of Cape Town by road. Pop. (1960) 15,556. The valley is famous for its wines, the finest of which are produced by the government wine farm of Groot Constantia and the adjacent farm of High Constantia. It produces especially the best light-bodied red table wines. The district is also renowned for its excellent fruits. Groot Constantia house, a fine example of a Dutch colonial manor house, has been restored and turned into a museum containing antique Cape furniture of stinkwood. It was built (*c.* 1685) by the governor Simon Van der Stel and named after his wife, Constance. Van der Stel also laid out the vineyard. In earlier times shipmasters and others visiting Cape Town would visit Groot Constantia where, after lavish entertainment by the proprietor, they frequently placed orders for wine.

CONSTANTINE (Constantinus), the name of a pope and an antipope.

Constantine (d. 715), pope from 708 to 715, upheld Roman supremacy against Ravenna's claim to independence. Summoned to Constantinople, probably to obtain his ratification of the Trullan council of 692, he was flatteringly received by Justinian II, who "renewed all the privileges of his church." After Justinian's murder (711), Constantine's conflict with the usurper Philippicus, a monothelite heretic, foreshadowed the iconoclast controversy. He died April 9, 715.

Constantine II, antipope from 767 to 768, was a soldier and brother of Toto, duke of Nepi, through whom, on the death of Paul I, he was elected pope on July 5, 767. His opponents, led by the powerful *primicerius* Christopher, fled to the Lombards. Constantine failed to win support from Pepin and the Franks. His deposition in 768 by a Lombard army was canonically ratified by a council of Italian and Frankish bishops; after 769 no more is heard of him.

See, for Constantine I, E. Caspar, *Geschichte des Papsttums*, vol. ii, pp. 637–642 (1933); for Constantine II, L. Duchesne, *Les Premiers Temps de l'état pontifical*, new ed. (1912). (Hy. C.)

CONSTANTINE, the name of a number of Roman and Byzantine emperors.

Constantine I, called the Great (Flavius Valerius Constantinus) (d. A.D. 337), was the first Roman emperor attested to have become a Christian. He was born at Naissus (Nis) in Moesia, south of the lower Danube, on Feb. 17 of an unknown year, probably in the 280s, the eldest son of Constantius I (*q.v.*) by his first wife, Helena. When his father was given the title of Caesar in 293 Constantine was attached to the court of the emperor Diocletian, where he became tribune. He was present when Diocletian received an oracular response about the Christians, and must have witnessed the great persecution of 303. When his father received the title of Augustus for the western provinces of the Roman empire in 305, Constantine sought leave to join him, but Galerius, the eastern Augustus, would not let him go. He succeeded however in making his way to Gaul, and accompanied his father to Britain. When Constantius died at Eboracum (York), the troops proclaimed Constantine as Augustus on July 25, 306. Galerius grudgingly acknowledged him as Caesar, but when Maxentius, son of Maximian (*qq.v.*), revolted in Italy (306), Constantine accepted his overtures, and Maximian, who had resumed the throne, granted him the title of Augustus and gave him his daughter Fausta in marriage on March 31, 307. Maximian soon quarreled with his son and sought refuge with his son-in-law: in 310, however, while Constantine was away on the Rhine, Maximian revolted at Arelate (Arles) but was quickly defeated and compelled to commit suicide. Constantine, whose claim to legitimate rule had been based on Maximian's recognition, now announced

that he was descended from the emperor Claudius II Gothicus and therefore claimed to rule by hereditary right, a claim going back beyond the emperor Diocletian and the rulers appointed by him.

Constantine's ambition was not satisfied with being emperor of Gaul, and in 312 he invaded Italy, defeated Maxentius' generals near Augusta Taurinorum (Turin) and at Verona, and moving southward won the final victory over Maxentius in the battle of the Milvian bridge, where Maxentius was killed during the rout. Before this battle Constantine had a device representing the chi-rho monogram of Christ painted on his soldiers' shields, the first of his actions indicating conversion to Christianity. This monogram was later incorporated in the imperial standard, called the labarum.

Constantine was acknowledged by the senate as senior Augustus and accepted by all the western provinces. Next spring Licinius (*q.v.*), who ruled the dioceses of Moesia, Pannonia and Thrace, visited Constantine at Milan and married his sister Constantia. During the meeting Galerius Valerius Maximinus (*q.v.*), who ruled Asia Minor, Syria and Egypt, invaded Thrace, but Licinius hastened back and completely defeated him, thus becoming the sole ruler of the eastern provinces. On June 15, 313, he issued at Nicomedia (Izmit) an edict (often misleadingly called the edict of Milan) proclaiming the common policy, agreed between the two emperors at Milan, of full toleration for all religions and restitution of wrongs done to the Christians. Constantine himself went further, making lavish donations to the churches and granting immunities to the clergy.

Conversion.—The reasons for Constantine's conversion to Christianity have been much debated. Some believe that it was an astute stroke of policy, designed to win the support of the Christians, or a wise act of statesmanship aimed at buttressing the decaying fabric of the empire with the strength of the Christian church. Neither view is very likely, for the Christians, especially in the west, were a small and unimportant minority and the churches weak and divided.

Constantine's motives can be best divined from his voluminous letters and edicts on religion, whose authenticity has been proved. From these it appears that from 313 he regarded himself as the chosen servant of the "Highest Divinity" (whom he identified with the God of the Christians), who had given him victory over his enemies and raised him to supreme power, and believed that the prosperity of the empire and of himself, to whose care it had been committed, would be increased by God if his worship were properly conducted, and would be endangered if God were moved to wrath by its neglect.

This belief is most simply explained by the story Constantine himself many years later told his biographer Eusebius of Caesarea and confirmed upon oath. When he was contemplating his attack on Maxentius and considering whence he should obtain divine aid, he saw a cross of light superimposed upon the sun. This vision, whatever its nature, was decisive in his conversion, evinced in the favours he henceforth showered on the Christian church.

During the decade following his conversion Constantine's legislation shows many signs of Christian influence. For example, he repealed the legislation of Augustus that penalized celibates, legalized bequests to the church and gave full validity to manumission performed in a church. He even gave powers of jurisdiction to bishops, allowing either party to transfer a suit to the cognizance of a bishop, whose verdict should be final and executed by the civil authority. He also made Sunday a public holiday according to Christian practice, although he emphasized its sacredness to the sun. It was probably at this period that he built and lavishly endowed the Basilica Constantiniana and its baptistery, the Fons Constantini, in the palace of the Laterani in Rome.

Religious Policy.—Constantine was soon involved in ecclesiastical controversy, in particular that associated with Donatus (*see* DONATISTS). In 313 a group of African bishops led by Majorinus, who claimed to be bishop of Carthage, submitted to him charges against Caecilian, the rival bishop of Carthage, and asked him to appoint judges to decide the dispute. Constantine was already aware of the schism and on the suggestion of his ecclesiastical adviser, Ossius, bishop of Córdoba, he had confined his benefactions to Caecilian's party, but he accepted the petition of the other group and appointed as judges the bishops of Rome, Arelate (Arles), Augustodunum (Autun) and Colonia (Cologne). The bishop of Rome, having called in 15 Italian bishops in addition, pronounced in favour of Caecilian, but the defeated party, now led by Donatus, Majorinus' successor, appealed. Constantine summoned a larger council of bishops at Arles (314), and they again decided in Caecilian's favour. The Donatist party now appealed to Constantine himself. He eventually agreed to hear the case, and again condemned the Donatists. When they remained recalcitrant he endeavoured to suppress them by force, but they welcomed martyrdom. In 321 he ended the persecution, announcing that he would leave the dissidents to the judgment of God.

Constantine was convinced, doubtless by Ossius, that dissension in his church was deeply displeasing to God. It was the traditional duty of the emperor to maintain the *pax deorum*, and Constantine assumed that he had to win and retain for the empire the favour of God. He used the bishops as experts to pronounce on the religious issue, as his pagan predecessors had used the *pontifices* or the augurs, but he himself selected and summoned the bishops, received appeals on their decision and took what executive action he thought fit.

Victory over Licinius and Foundation of Constantinople.—Constantine and Licinius were soon at variance. In 314–315 there was a war in Pannonia in which Constantine on the whole gained the upper hand: Licinius had to cede to him the two dioceses of Pannonia and Moesia as the price of peace. In 317 Constantine's two elder sons, Crispus and Constantine, were jointly given the title of Caesar with Licinius' son Licinius, but relations gradually deteriorated. Licinius, uncertain of the loyalty of his Christian subjects, began to persecute them, and Constantine in a war against the Goths violated Licinius' territory in Thrace. In 324 Constantine attacked, and, fighting under the protection of the labarum, his armies were victorious at Adrianople (modern Edirne) in Thrace (July 3) and on Sept. 18 at Chrysopolis (Üsküdar), situated opposite Byzantium across the Bosporus. Licinius surrendered and in 325 he was executed for an alleged attempt at revolt.

Soon after his victory Constantine began to rebuild Byzantium on a magnificent scale, renaming it Constantinople (*q.v.*). He spent great wealth on his new foundation, and to adorn it robbed many pagan shrines of their statues and columns; the city was formally dedicated on May 11, 330. It symbolized a break with the pagan past which was identified with Rome, and heralded the beginning of a new Christian empire. Constantine states in one of his laws that he founded the new city "by the command of God," and he doubtless conceived it as a memorial and thank offering for the final victory whereby God had granted him rule over the whole empire. As such it was from the start a Christian city, unsullied by pagan sacrifice and amply endowed with magnificent churches. Coin types suggest that it was regarded as a sister to Rome, and it may have been called New Rome from the beginning. But it did not share Rome's constitutional privileges under Constantine. It had no prefect of the city until 359 and no senate, but was primarily an imperial residence.

Arianism: Council of Nicaea and its Consequences.—Immediately after his victory over Licinius Constantine had redressed the wrongs inflicted on the Christians during the recent persecutions and supplied funds for enlarging and rebuilding the churches in all the eastern provinces. He remembered from his youth that the church was far larger and more flourishing in the east than in the west, and he had hopes that the eastern bishops would be able to resolve the intractable Donatist problem. It was therefore with dismay that he discovered that the eastern churches were divided by a much more widespread dispute, the doctrinal controversy between Alexander, bishop of Alexandria, and one of his priests, Arius (*see* ARIUS; ARIANISM). Not understanding the theological points at issue Constantine first sent a letter to the two parties rebuking them for quarreling about minute distinctions, as he believed them to be, about the nature of Christ, and urging them to agree to differ, as did pagan philoso-

phers. Ossius, who carried this letter to Alexandria, soon discovered that the dispute was too serious to be thus resolved, and summoned a large council of Syrian bishops at Antioch (325). They condemned Arius, but before they had concluded their deliberations, Constantine decided to convoke a still larger council at Ancyra (Ankara) in Galatia. Shortly afterward he resolved to hold a universal (ecumenical) council of all the churches at Nicaea in Bithynia; this city was chosen as being more convenient for the bishops of Italy and the west who had been summoned, and for the emperor himself, who intended to be present. The Council of Nicaea met on May 20, 325. Constantine himself presided, actively guiding the discussions, and personally proposed (no doubt on Ossius' prompting) the crucial formula expressing the relation of Christ to God in the creed issued by the council, "of one substance with the Father" (*see* CREED). Overawed by the emperor, the bishops, with two exceptions only, signed the creed, many of them much against their inclination. The council also dealt with a number of lesser schisms and heresies, laying down the conditions on which their adherents might be readmitted to the church; endeavoured to settle the date of Easter; and regulated various questions of ecclesiastical precedence and organization. Constantine banished Arius and his partisans, confiscated the Arian churches and banned the cult of recusant schismatics and heretics.

Constantine regarded the decisions of Nicaea as divinely inspired. As long as he lived no one dared openly to challenge the creed of Nicaea, but the expected concord did not follow. Those who disliked the Nicene formula took every opportunity of attacking its principal adherents and succeeded in condemning several of them on charges of doctrinal error or uncanonical conduct. Their chief victim was Athanasius, who became bishop of Alexandria in 328 (*see* ATHANASIUS, SAINT). At first Constantine supported him, acquitting him of several charges, but he eventually lost patience. The emperor's cherished aim was to reconcile Arius with the church, but Athanasius stubbornly refused to accept Arius' vaguely worded submission. At last, in 335, Constantine summoned a council of bishops at Tyre to investigate various charges against Athanasius and ordered him to appear. The council condemned him; he appealed to Constantine himself, who banished him to Gaul. In the same year at a council at Jerusalem Arius was readmitted to communion.

During the last decade of his reign Constantine became increasingly pious. He devoted more and more of his time to completing his religious education, reading the scriptures and theological works supplied by Eusebius of Caesarea, listening to sermons and himself delivering homilies to his court. He continued to spend lavishly on building churches, at Rome, Constantinople, Antioch and the holy places in Palestine. He showed marked favour to Christians, thereby causing a flood of interested conversions. At the same time his attitude to his pagan subjects became more severe. Shortly after his victory over Licinius he issued an edict urging all his subjects to adopt the Christian faith, but at the same time he confirmed his policy of toleration to paganism (although in contemptuous language) and forbade overzealous Christians to disturb the pagan cult. He nevertheless destroyed three famous temples, at Aegae in Cilicia and at Apheca and Heliopolis in Phoenicia, and in 331 confiscated all the temple treasures, even stripping the cult statues of their gold; he probably also seized the temple endowments. Before the end of his reign he may even have banned sacrifice.

Secular Policy.—Much less is known of Constantine's secular than of his religious policy. He made an important change in the military organization of the empire, building up the *comitatus* (the imperial escort) into a large field army, partly by raising new regiments and partly by transferring to it the best units of the frontier armies. The *comitatenses* were accorded a privileged status and henceforth received the best recruits, and the frontier armies (*limitanei* or *ripenses*) thus sank in efficiency and morale. To command the *comitatenses* Constantine appointed two new officers, one in charge of infantry (*magister peditum*) and the other of cavalry (*magister equitum*). The praetorian prefects lost their military functions, and the separation of the military command from the civil administration, which the emperor Diocletian had begun, was thus completed. Unlike Diocletian, Constantine favoured the senate, appointing senators freely to provincial governorships and other administrative posts. He was also lavish in grants of senatorial rank, and initiated a great expansion of the senatorial order. He had a taste for pomp and ceremony, and revived or created many titles: he revived the ancient patriciate in a new form as a very select personal honour (*see* PATRICIANS), and in the order of the imperial "companions" (*see* COUNT) he created a new aristocracy of service, open to senators and non-senators alike. Constantine was of a lavish disposition, distributing gold and land on a vast scale to his favourites, and spending huge sums on his new capital and on benefactions to the churches. As a result of his extravagance he had to institute new taxes, the *collatio glebalis* or *follis*, a surtax on senators, and the oppressive *collatio lustralis*, a levy of gold and silver on traders and craftsmen. The confiscation of the temples eased the financial strain at the end of his reign, enabling him to mint large quantities of gold and silver coins. His gold coin, the solidus, which he minted from the beginning of his reign at 72 to the pound, was maintained for many centuries at its original weight and purity.

Constantine was a firm believer in the principle of hereditary succession, and gave his sons the title of Caesar (Crispus and Constantine in 317, Constantius in 324 and Constans in 333, as well as a nephew, Dalmatius, in 335) and allotted them parts of the empire to govern. Crispus (*see* CRISPUS CAESAR) was executed in mysterious circumstances in 326. The others at the end of the reign shared the government of the whole empire between them, the young Constantine ruling Britain, Gaul and Spain, Constans Italy, Africa and western Illyricum, Dalmatius Thrace, Dacia and Macedonia, and Constantius the eastern provinces (Asia and Egypt). Constantine could thus concentrate on his religious duties. In the spring of 337 he fell seriously ill at Nicomedia and received baptism from Eusebius, bishop of Nicomedia, an Arian. A few days later, on May 22, he died at Ancyrona, near Nicomedia.

Constantine hardly deserves the title of "the Great": he was an able general but lacked other qualities of a good emperor. He was extravagant, susceptible to flattery, and capricious. His temper was violent, but he was easily mollified and he lacked firmness and steadiness of purpose. Still less does he deserve the title of saint, which he holds in the Orthodox Church. His dominating passion was ambition, and he was unscrupulous and ruthless to his rivals. His religious beliefs, though sincere, were perhaps vague. For instance, for some years after his conversion he continued to issue coins in honour of "the Unconquered Sun." He may at first have believed, as his vision might suggest, that Christ and the sun were both aspects of "the Highest Divinity." Nevertheless his reign was of immense importance for the future of the empire, of the church and of Europe. Constantinople, which he probably founded as a memorial of his final victory, sustained and inspired the empire for more than a millennium. The manner of his conversion influenced the relations of church and state for centuries to come. Believing that he was God's chosen servant he regarded himself as responsible to God for the good government of his church. Above all his conversion assured the future of Christianity. From a minority sect Christianity became the official religion of the empire and was stimulated by the imperial patronage of Constantine and his sons. The church so grew in wealth and numbers that its position could not be shaken by the apostate emperor Julian. (*See* also references under "Constantine I [the Great]" in the Index volume.) (A. H. M. J.)

CONSTANTINE II (317–340), Roman emperor, second son of Constantine the Great, was born at Arelate (Arles) in Feb. 317 and on March 1, 317, was given the title of Caesar. After the death of his father in 337 he became ruler of Britain, Gaul and Spain. At first he tried to control his brother Constans (*q.v.*), who soon objected. Constantine claimed Italy and Africa from him, and early in 340 unexpectedly attacked Italy and penetrated to Aquileia. There he was met by the vanguard of the army of Constans, who was then at Naissus (Nis) in Moesia, and was killed. (E. A. T.)

Constantine III (612–641), Byzantine emperor in 641, son of he emperor Heraclius by his first wife, Fabia-Eudocia, succeeded is joint emperor with Heracleonas, the son of Heraclius by his econd wife, Martina. Court intrigues nearly led to a civil war, which was prevented by the death of Constantine (May 641). It was rumoured that he was poisoned by order of his stepmother, but he probably died of tuberculosis.

Constantine IV, Byzantine emperor from 668 to 685, was the eldest son of Constans II. He took a decisive stand against the Arabs under the caliph Mu'awiya. From 674 onward they besieged Constantinople until their decisive defeat in 678, which greatly enhanced Byzantine prestige and indeed marked a turning point in European history. In the Balkans Constantine campaigned against the Slavs and Avars and repulsed their attack on Thessalonica, but he could not prevent the Bulgars from crossing he Danube and establishing their kingdom in the district where heir name still survives. He had to recognize them and pay anual tribute. Constantine summoned the sixth ecumenical Council of Constantinople (680–681), which condemned monotheletism and recognized the orthodox christological doctrine as laid down by the Council of Chalcedon (451).

Constantine V Copronymus (718–775), son of Leo III the conoclast, of the "Isaurian" or North Syrian dynasty, was Byzantine emperor from 741 to 775. Soon after his accession, while he was fighting against the Arabs, his brother-in-law Artabasdus, the count of the Opsikion theme, who opposed iconoclasm, set up as rival emperor. It was not till toward the end of 743 that Constantine finally defeated Artabasdus and re-entered Constantinople. When he felt his position secure, he determined to settle he religious controversy. In 754 he called a synod of 338 bishops at the palace of Hieria across the Bosporus from Constantinople, and the veneration of icons was forbidden. But resistance to conoclasm continued, partly owing to the influence of the monks, against whom a vigorous campaign was undertaken. Constantine was an able military commander. He invaded northern Syria, and won a naval victory against the Arabs (747). He then advanced into Armenia and Mesopotamia. He did not succeed in holding hese areas, but he had checked the Arabs and prepared the way for the Byzantine offensive in the following century. In the Balkans he warred continually against the powerful Bulgarian kingdom, finally dying on campaign, Sept. 14, 775.

These life and death problems had given Constantine little time for Italy, where the Byzantine position was being undermined by the Lombards; the pope (who had hitherto maintained his loyalty to Constantinople while protesting vigorously against iconoclasm) turned to the Frankish rulers for help. Henceforth he links between Italy and Constantinople were weakened and Byzantine authority confined to its provinces in south Italy. Constantine was blackened by the Orthodox historians of his time, but modern scholars have recognized that he was one of the most capable of the Byzantine rulers.

Constantine VI (770–after 797), grandson of Constantine V, was Byzantine emperor from 780 to 797. At ten years of age he succeeded his father, Leo IV, under the guardianship of his mother, Irene (*q.v.*). It was during her regency that the seventh ecumenical Council of Nicaea (787) re-established the veneration of icons. When Constantine came of age Irene attempted to retain supreme power, but in 790 the army proclaimed Constantine VI as sole ruler and she was arrested. Constantine foolishly pardoned her in 792. In 796 Constantine roused public opinion by divorcing his wife in order to marry his mistress, Theodote. Irene cleverly utilized this situation and in Aug. 797 had Constantine blinded. He was the last of the "Isaurian," or North Syrian, dynasty.

Constantine VII Porphyrogenitus ("born in the purple") (905–959), Byzantine emperor, author and patron of literature, was the son of Leo VI the Wise. Though nominally emperor from 913 to 959, he was in practice excluded from all real share in the government until 945, after his father-in-law, Romanus I Lecapenus, had been exiled in 944. He continued the latter's policy of supporting the small farmer and safeguarding the soldiers' holdings, and of waging war against the Arabs in the east Mediterranean. He also maintained diplomatic relations with foreign countries, and in 957 received a state visit from the Russian princess Olga who had recently been converted to Christianity.

Constantine is best known for his patronage of art and literature, and he was well versed in the traditions of classical antiquity. Valuable information about the Byzantine empire is supplied by the works written by him or directly inspired by him. His own works are: *De thematibus,* a geographical and historical account of the Byzantine provinces; *De administrando imperio,* a handbook for the foreign office, written for his son, Romanus II; *De cerimoniis aulae byzantinae,* on customs and ceremonial of the Byzantine church and court with much historical and archaeological material; a life of Basil I, his grandfather, forming book v of the history known as *Theophanes Continatus.* Under his auspices a number of works of an encyclopaedic nature were compiled, consisting of excerpts from classical and later authors. A number of manuscripts of the more complete works of classical authors date from this period.

Constantine VIII (958–1028), Byzantine emperor, the younger brother of Basil II and coemperor 976–1025, sole ruler 1025–28. He was a pleasure-loving man who allowed the administration to fall into the hands of others. He had no male heir and on his deathbed he arranged that his second daughter, Zoe, should succeed him and marry the eparch of Constantinople, Romanus III Argyrus.

Constantine IX Monomachus (*c.* 980–1055), Byzantine emperor from 1042 to 1055, owed his elevation to Zoe, the empress of the Macedonian dynasty who took him as her third husband. Constantine belonged to the civil party, the opponents of the military magnates, and he neglected the defenses of the empire and reduced the army. He spent extravagant sums on luxuries and magnificent buildings and seriously debased the coinage. Rebellions broke out at home and abroad; the Normans were overrunning the Byzantine possessions in south Italy; the Pechenegs (Patzinaks) crossed the Danube and attacked Thrace and Macedonia; and the Seljuk Turks made their appearance on the Armenian frontier which was directly exposed to attack, as the Armenian kingdom of Ani lapsed to Constantinople during this reign. Constantine attempted to ally with the papacy against the Normans, but relations between the churches of Rome and Constantinople deteriorated, and in 1054 the visit of the papal legates resulted in schism. Though he was not outstanding for his statesmanship, it was under his auspices that the university of Constantinople was reorganized, and there was a marked efflorescence of learning and letters.

Constantine X Ducas, Byzantine emperor from 1059 to 1067, succeeded Isaac I Comnenus. His accession was a triumph for the civil aristocracy but was unfortunate in that he proved an incapable emperor. He reduced the army and neglected the frontier defenses at a time when the Seljuk Turks were pressing into the eastern provinces; and the sultan Alp Arslan overran Armenia (1064–65) and attacked Caesarea (1067). In 1064 the Hungarians occupied Belgrade, and the Pechenegs (Patzinaks) and Uzes (Kumans) crossed the Danube and ravaged the Balkan provinces, penetrating into Greece. In Italy the Normans were rapidly conquering the last remnants of the Byzantine possessions.

(J. M. Hy.)

Constantine XI (Constantine Dragases Palaeologus) (1404–1453), the last Byzantine emperor (1449–53), was the fourth son of the emperor Manuel II and his Serbian wife, Helen, of the dynasty of Dragas in Macedonia. He spent his early career with his brothers Theodore and Thomas governing the Byzantine despotate of the Morea (Peloponnese) and completing its recovery from the Franks; and when his brother John VIII died childless in 1448 he was proclaimed emperor at Mistra (Jan. 1449). He was a man of courage and energy, but he succeeded to a *damnosa hereditas.* Mohammed II, who became Ottoman sultan in 1451, directed all his resources to the capture of Constantinople. Constantine did everything within his power to organize the defense of the city and to enlist the support of the west by acknowledging the obedience of the Greek church to Rome, but in vain. He was killed fighting at the walls when the Turks finally broke through on May 29, 1453.

(D. M. N.)

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Constantine XI: E. Pears, *The Destruction of the Greek Empire and the Story of the Capture of Constantinople by the Turks* (1903). (D. M. N.)

CONSTANTINE (FLAVIUS CLAUDIUS CONSTANTINUS) (d. A.D. 411), usurper of the title of Roman emperor A.D. 407–411, was recognized as emperor by Flavius Honorius (*q.v.*) in 409. A private soldier elevated by the army in Britain in 407, he immediately crossed to the continent with a force of British troops, who feared that the invasion of Gaul by the Vandals and other barbarians, which had begun in 406, would lead to an attack on Britain. By the end of 407 he possessed eastern Gaul and defeated the invaders. The central government sent a force against him commanded by a Goth called Sarus, who defeated Constantine's generals and besieged the usurper in Valentia (Valence). But Sarus had to retire (408), and Constantine established himself at Arelate (Arles). The Roman troops in Spain joined him, and Constantine, appointing his son Constans as Caesar, sent him with Gerontius as master of the soldiers to suppress a revolt organized there by relatives of Honorius. After the fall of Stilicho (*q.v.*) in 408 Constantine threatened Italy, and Honorius was obliged to recognize him as joint emperor (409). Constans, successful in Spain, returned to Gaul; but Gerontius and the troops in Spain set up one Maximus as a rival emperor, which seriously weakened Constantine and later led to the defeat and death of Constans at Vienne (*c.* 411). Constantine entered Italy, but he had to retreat to Arelate, where he was besieged by Honorius' generals; he capitulated and was killed in Sept. 411. (E. A. T.)

CONSTANTINE (1868–1923), king of the Hellenes from 1913 to 1917 and from 1920 to 1922, was born in Athens on Aug. 2, 1868, the son of George I and his consort the Russian grand duchess Olga Konstantinovna. Educated in Germany at Leipzig university and at the Prussian staff college, he was married in 1889 to Sophia Dorothea of Hohenzollern, sister of the German emperor William II. His command of the Greek army in Thessaly in 1897 led to his being widely blamed for its defeat, and in 1909 the Military league made him and his brothers the scapegoats for the failure to achieve union between Greece and Crete, whereupon they had to resign their commissions in the army. Subsequently restored to his position, thanks to Eleutherios Venizelos (*q.v.*), Constantine then co-operated with the French military mission to reform the Greek army, whose successes in the Balkan Wars of 1912–13 re-established his prestige. He became king of the Hellenes on George I's death (March 18, 1913).

On Aug. 7, 1914, at the outbreak of World War I, Constantine expressed sympathy for the German emperor and advocated neutrality for Greece. After Turkey's entry into the war, the king, advised by his chief of staff, Ioannis Metaxas, vetoed Venizelos' proposal to co-operate with the Allies in the Dardanelles in return for promises of concessions in Asia Minor. Venizelos resigned in March 1915, but won a large majority at the election in June.

The struggle between the king and Venizelos continued, and from Oct. 1915 the rupture was complete. Then, in May 1916, Ft. Rupel, which commanded the Struma (Strymon) pass into eastern Macedonia, was surrendered to the Bulgars, and the Allies demanded the demobilization of the Greek army, which menaced them in Macedonia. In October the Greek fleet was taken over by the Allies and in November a demand was made for the cession of war material. Next, though the king seems to have given personal assurances to the French admiral, an Allied landing at Piraeus was opposed and the naval contingents, disembarked there on Dec. 1, had to be withdrawn. A month later a further blockade was declared and the removal of the whole Greek army to the Peloponnese took place. A formal apology was made of the events of Dec. 1, but it soon became obvious that the king's attitude endangered the Allied position in Salonika.

In June 1917 Célestin Jonnart, the French high commissioner representing the Allies, arrived in Athens, where, backed by strong forces, he demanded better guarantees for the safety of the Allied army in Macedonia and the abdication of the king. Constantine left Greece for Switzerland on June 12, leaving his second son, Alexander, on the throne, but made no final renunciation of his own rights.

As a result of the election of Nov. 1920 and of the subsequent plebiscite, Constantine returned to Athens on Dec. 20. Never recognized by Great Britain and France, he was compelled either to pursue his predecessors' anti-Turkish policy for Asia Minor or to make himself unpopular by sacrificing gains promised to Greece under the treaty of Sèvres (*q.v.*). He chose the former alternative and made no use of offers by the western powers to mediate between Greece and Turkey. After the disastrous defeat of the Greeks in Aug.–Sept. 1922 an insurrection broke out in the army, and the king abdicated in favour of his eldest son, George II. On Sept. 30 Constantine left Athens for Palermo, where he died on Jan. 11, 1923.

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CONSTANTINE (KONSTANTIN PAVLOVICH) (1779–1831), Russian grand duke, was born at Tsarskoe Selo (Pushkin) on May 8 (new style; April 27, old style), 1779. He was the second son of the emperor Paul I and his wife Maria Fedorovna, and the brother of Alexander I and Nicholas I. His grandmother, Catherine the Great, directed his education; the only person who really took him in hand was his tutor in chief, Frédéric César de La Harpe. Like Alexander, Constantine was married by Catherine when still in his teens, and he made his wife, Juliana of Coburg, intensely miserable. After a first separation in 1799, she went back permanently to her German home in 1801.

Constantine's first military campaign took place in Italy in 1799 under the leadership of A. V. Suvorov during the war of the second coalition against France. The battle of Bassignano was lost by Constantine's fault, but at Novi he distinguished himself by such personal bravery that Paul I bestowed on him the title of tsesarevich (which properly belonged only to the heir to the throne). During the campaign of 1805 Constantine was in command of the guards and shared responsibility for the defeat in the battle of Austerlitz. In these and subsequent campaigns (1807, 1812, 1813 and 1814) he showed courage but no military competence.

The congress of Vienna made Poland a constitutional monarchy (known as Congress Poland) with the Russian emperor as king. Constantine's importance in political history dates from Nov. 1815, when Alexander I made him commander in chief of the Polish armed forces with powers so wide that he was in fact a viceroy. Constantine organized the Polish army and felt himself

nore a Pole than a Russian, especially after his morganatic marriage to a Polish lady, Joanna Grudzinska, on May 24 (N.S.; 12, O.S.), 1820. He himself renounced any claim to the Russian imperial succession (Aug. 28 [N.S.; 16, O.S.], 1823), but this was only revealed to three or four persons and his brother Nicholas was left in ignorance of it. As a result, on the death of Alexander (Dec. 1 [N.S.; Nov. 19, O.S.], 1825), there was some uncertainty. Since the second half of the 18th century a revolutionary movement seeking some degree of self-government had been developing. The confusion surrounding the succession provided the revolutionaries with an opportunity for action, and on Dec. 26 N.S.; 14, O.S.), the Decembrists (*see* DEKABRISTS) mutinied, demanding "Constantine and Constitution." The rising was easily suppressed, and Constantine had had no part in the plot, but differences soon arose between him and Nicholas I in consequence of the share taken by the Poles in the conspiracy. Constantine held obstinately to the belief that the Polish army and bureaucracy were loyally devoted to the Russian empire. Nicholas I's eastern policy and the Turkish War of 1828–29 caused a fresh breach between the brothers. It was due to Constantine's opposition that the Polish army took no part in the war.

Although Constantine had built up the army of Poland, he had failed to win its loyalty, and his harsh rule, in spite of his sympathy for Polish autonomy, had alienated the parliament and the people. The insurrection in Warsaw in Nov. 1830 took Constantine completely by surprise. Because of his utter failure to grasp the situation the Polish regiments passed over to the revolutionaries; and as the revolution wore on, he showed himself as incompetent as he was lacking in judgment. He did not live to see the rising suppressed, for he died of cholera at Vitebsk on June 7 (N.S.; 15, O.S.), 1831. (G. A. LN.)

CONSTANTINE THE AFRICAN (*c.* 1020–1087), an important medieval medical figure who initiated the translating of important writings from Arabic into Latin. His name is surrounded by legends and his early career is still obscure.

Although it is said that he was born at Carthage, his actual birthplace seems to have been Sicily, whose residents then spoke many tongues. It is certain that he was a Christian, knew Arabic as well as some Latin and Greek and led a wandering life. About 1071 he was in the service of the Norman duke Robert Guiscard, whom he probably followed to Salerno, the city with which Constantine's name is most closely linked. There he became a monk and ended his days at the Benedictine house of Monte Cassino, where he translated a number of Arabic works into Latin. His labours are exceedingly important for the history of culture. They represent the first inflow of a group of new ideas, and their appearance marks the end of the "dark ages" and the dawn of the scholastic period.

Among the works that Constantine thus conveyed were two philosophical treatises by Isaac Israeli (855–955) of Kairouan, known to the west as Isaac the Jew. The most important medical work that he translated into Latin he called *Pantechne*, an abbreviated version of the *Liber Regius* of the Persian Ali ibn al-Abbas (died 994), also known as Haly Abbas. This was extremely important as the first work that gave the western world a view of Greek medicine as a whole.

Constantine's translations spread through Europe with extraordinary rapidity and it is difficult to overestimate their influence on the ages that followed. They continued to be read until the sixteenth century and were particularly influential at the important medical school at Salerno.

See C. and D. Singer, "The Origin of the Medical School of Salerno" in *Essays on the History of Medicine Presented to K. Sudhoff* (1924); C. Sudhoff in *Kurzes Handbuch der Geschichte der Medizin*, 4th ed. (1922). (C. SI.; I. V.)

CONSTANTINE (anc. CIRTA), a city of Algeria, Africa, and capital of the prefecture of the same name, is 54 mi. S.S.W. of the port of Philippeville by rail. It is the seat of a bishop and a military station. Pop. (1960) 217,000 (metropolitan). The city occupies a rocky, diamond-shaped plateau, surrounded, except at the southwest, by a precipitous ravine through the eastern side of which flows the Rummel river. The plateau is 2,130 ft. above sea level and from 500 to nearly 1,000 ft. above the river bed. The cliffs of the ravine, at its narrowest, are 15 ft. apart and at its greatest width, about 400 yd. The gorge is crossed at the northeast angle of the city by the El Kantara bridge, a modern 420-ft. structure constructed on the site of earlier bridges, and north and south by a suspension bridge and a viaduct, built in 1912. On the northeastern side it is spanned by natural stone arches.

The City.—Constantine is walled, the existing medieval wall having been largely constructed out of Roman material. Through the centre from northeast to southwest runs the Rue de France-Rue Caraman, roughly dividing the city into two parts. To the west are the kasbah (citadel), cathedral, prefecture building, town hall, law courts and other administrative and commercial buildings, standing among straight streets and wide squares. The east and southeast part provides a striking contrast, with its tortuous lanes and oriental architecture. The Place de Nemours, at the southwest, is the commercial and social centre, and from it the Rue Georges Clemenceau, with some commercial offices, runs northeast to the El Kantara bridge, which leads to the railway station. The palace of Haji Ahmet, built in 1830–35 by the last bey of Constantine and subsequently in military use, stands on the Place Maréchal Foch, as does the cathedral, once the mosque of Souk el Ghezel. The massive kasbah, containing barracks and a hospital, occupies the northern apex of the city. It dates from Roman times and in its more modern portions preserves remains of other Roman structures. The mosque of Sidi el Kettani (or Salah Bey), on the Place Négrier southeast of the kasbah, and that of Sidi Lakhdar farther southeast date from the 18th century. The city has *lycées* for boys and girls, a technical college and a Franco-Muslim *lycée* (*medersa*). There are a museum and library, a theatre, a casino and sports stadiums. New quarters have been developed southwest of the town.

The industry of Constantine is chiefly confined to leather goods and woolen fabrics. A considerable trade is carried on over a large area through the town's railway connections with Algiers, Bône, Tunis, Biskra and Philippeville.

History.—Constantine or, as it was originally called, Cirta or Kirtha, from the Phoenician word for city, was one of the most important towns of Numidia (*q.v.*) and the residence of the kings of the Massyli. Under Micipsa (2nd century B.C.) it reached the height of its prosperity and was able to furnish an army of 10,000 cavalry and 20,000 infantry. Julius Caesar having bestowed a part of its territory on his supporter Sittius, the latter introduced a Roman settlement. In the war of Maxentius against Alexander, the Numidian usurper, it was laid in ruins, and on its restoration in A.D. 313 by Constantine it received its present name. It was not captured during the Vandal invasion of Africa but on the Arab conquest (7th century) it shared the fate of the surrounding country. Successive Arab dynasties looted it. During the 12th century it was still prosperous, however, and its commerce was extensive enough to attract the merchants of Pisa, Genoa and Venice. Frequently taken and retaken by the Turks, Constantine became the seat of a bey, subordinate to the dey of Algiers. Salah Bey, who ruled from 1770 to 1792, was responsible for most of the existing Muslim buildings. In 1826 Constantine asserted its independence of the dey of Algiers and was governed by Haji Ahmed, the choice of the Kabyles. In 1836 the French under Marshal Bertrand Clauzel made an unsuccessful attempt to storm the city, suffering heavy losses. In 1837 Marshal S. C. Valée took it by assault from the southwest isthmus. In World War II, during the 1942–43 Allied campaign against the Axis, Constantine and nearby Sétif were important bases and centres of command. (X.)

CONSTANTINE TERRITORY, formerly the eastern of the three *départements* of northern Algeria, and from 1956 to 1958 a regional prefecture, comprises the four *départements* of Constantine, Bône, Sétif and Batna. It covers the whole of eastern Algeria, a countryside of mountains and plateaus, culminating in the Aurès mountains (7,638 ft.) in the south. Despite unpropitious terrain the population is dense and includes considerable elements retaining the Berber language and customs. Pop. (1960) 3,815,000, including

about 175,000 Europeans. Area 39,060 sq.mi. The territory has a territorial assembly, with prefects in charge of each *département*.

See E. Mercier, *Histoire de Constantine* (1905). (A. B. M.)

CONSTANTINOPLE, the capital of the Byzantine empire (*q.v.*) until its fall to the Turks in 1453 and then of the Ottoman empire (*see* TURKEY), is now called Istanbul (*q.v.*) and was originally Byzantium (*q.v.*). When Byzantium, on the European shore of the Bosporus, was officially inaugurated as the new capital in 330 by the emperor Constantine I (*q.v.*), it bore the names of New Rome and of Constantinopolis, after its founder. When the new Turkish republic succeeded the Ottoman empire in 1923, Constantinople ceased to be the capital city. In 1930 it was officially renamed Istanbul, as it had long been popularly called. The old name survives, however, in the title of the ecumenical patriarch of Constantinople, who still has his seat in Istanbul (*see* CONSTANTINOPLE, ECUMENICAL PATRIARCHATE OF). For the church councils held in Constantinople, *see* COUNCIL.

CONSTANTINOPLE, ECUMENICAL PATRIARCHATE OF, one of the four ancient autocephalous patriarchates of the Greek Orthodox Church federation (the others being Antioch, Alexandria and Jerusalem) and during the great period of the Byzantine empire the most powerful of all; before the division of the church the ecumenical patriarch ranked second only to the bishop of Rome among all the bishops. He retains his spiritual authority over the other Orthodox churches, though his actual jurisdiction has been much curtailed since Turkey became almost entirely Muslim and the national churches of many regions formerly subject to him gradually have become autocephalous.

History.—According to a legend of the late 4th century, the bishopric of Byzantium was founded by St. Andrew, whose disciple Stachys, mentioned in the New Testament as a friend of St. Paul (Rom. xvi, 9), was traditionally the first bishop (38–54). Soon after Constantine the Great in 330 transferred the capital of the Roman empire from Rome to Byzantium, renamed Constantinople and New Rome, its bishopric was elevated to an archbishopric. The metropolitan of Heraclea, to whom Byzantium had formerly been subject, now came under the jurisdiction of Constantinople, with the privilege of handing the bishop his crosier at his enthronement. The third canon of the second ecumenical Council of Constantinople (381) recognized that the bishop of Constantinople, "being now the New Rome," had rights equal to those of the bishop of Rome. This position was ratified by the 28th canon of the fourth ecumenical Council of Chalcedon (451), which assigned to his jurisdiction a large area in both eastern Europe and Asia Minor. In the 6th century the official title of the bishop became "archbishop of Constantinople, New Rome, and ecumenical patriarch"; the exact significance of "ecumenical patriarch" has never been officially defined. The successful territorial conquests of the Muslims, beginning in the 7th century, helped to augment the spiritual power of the ecumenical patriarchate. The patriarchs of the conquered sees were often forced into exile and became residents of the capital, where their successors over a long period were selected by the ecumenical patriarch.

The exaltation of Constantinople was not agreeable to Rome, yet the ecumenical patriarch never claimed to be a rival of the bishop of Rome. In the 9th century the two great sees were divided by the schism over the patriarch Photius (*q.v.*). Although this was temporarily healed, theological and political differences continued until in 1054 the final break was made under the patriarch Michael Cerularius.

After the capture of Constantinople by the Latins in the fourth crusade (1204), the ecumenical patriarchate was transferred to Nicaea (1206). It was restored to Constantinople when the emperor Michael VIII Palaeologus retook the city in 1261. In 1453 Constantinople fell to the Turks and the city became the capital of the Muslim Ottoman empire.

Constantinople has played an important role in church history. As the see of the capital of the Byzantine empire it was the centre of the theological controversies in which, from the 4th century on, the doctrines of the Holy Trinity and of the Person of Christ were finally formulated. Three of the ecumenical councils recognized by both Eastern and Western churches were held in Constantinople (*see* COUNCIL), and the first of these (381) promulgated the Niceno-Constantinopolitan Creed, commonly known as the Nicene Creed (*see* CREED). Constantinople was a great centre for monasticism, one of its chief houses being that of Studios, whose monks were fierce opponents of iconoclasm (*see* ICONOCLASTIC CONTROVERSY). The profoundly religious art of the Byzantine empire was largely produced in Constantinople under the inspiration of the church (*see* BYZANTINE ART).

A list of the patriarchs of Constantinople includes a number of famous names. The great theologian Gregory of Nazianzus (*q.v.*), one of the three Cappadocian Fathers, was bishop of Constantinople briefly in 381. John Chrysostom (*q.v.*), the most famous preacher among the Greek Fathers, was bishop from 398 to 404. Nestorius (*q.v.*) was bishop for three years before being deposed at the Council of Ephesus (431) for his christological teaching. The 6th-century patriarch John III Scholasticus was learned in canon law. Photius, one of the most distinguished Byzantine scholars of any period, was primarily responsible for the mission of SS. Cyril and Methodius to the Slavs. Jeremy II corresponded with Pope Gregory XIII about calendrical reform and held discussions with the Protestant theologians of Tübingen. In the 17th century Cyril Lucaris (*q.v.*) became involved in Calvinistic disputes. Gregory V was martyred by the sultan during the Greek War of Independence (1821).

Jurisdiction.—After the fall of Constantinople the ecumenical patriarch (Gennadius II) was recognized as the ethnarch of the conquered Orthodox peoples, with increased authority over the territories of the eastern patriarchates and over the Balkan countries as well as farther afield. This power began its decline when Jeremy II declared the patriarchate of Moscow autocephalous (1593), and was continued in the 19th and 20th centuries when various other national churches in Orthodox territories became in their turn autocephalous. A further reduction in the number of dioceses subject to the patriarch was caused by the exchange of populations in 1922, when about 1,500,000 Greek inhabitants of Asia Minor and Thrace were transferred to Greece, whose church had been autocephalous since 1833. This meant that there were practically no Christians left in Asia Minor.

The territory directly subject to the patriarch in Turkey is confined to the archdiocese of Constantinople itself, together with the four suburban dioceses of Chalcedon, Derkon, Pringiponisson and the islands of Imroz (Imbros) and Tenedos. In Greece the patriarch still has jurisdiction over the monastic state of Mt. Athos, the monastery of St. John the Divine on Patmos, four bishoprics in the Dodecanese headed by the metropolitan of Rhodes and the autonomous church of Crete under the archbishop of Herakleion. Other dioceses dependent on the patriarch of Constantinople include the archbishopric of Thyateira for western Europe, the archbishopric of North and South America and Canada, the archbishopric of Australia and New Zealand, the Russian exarchate in Paris and some dioceses in eastern Europe.

Under the patriarch Meletius IV (d. 1923) all civil powers were removed from the patriarch by the Turkish government. Although his jurisdictional powers are relatively small, his great spiritual authority is of special value in the efforts of the ecumenical movement and of movements toward Roman Catholic and Orthodox reunion. A great step in the latter direction was taken when in Jan. 1964 the ecumenical patriarch Athenagoras and Pope Paul VI met and embraced in a historic meeting at Jerusalem. In the words of the patriarch, "What is happening here opens the door wide to further meetings. From this moment on there is co-operation." *See* also BYZANTINE EMPIRE; ORTHODOX EASTERN CHURCH.

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(H. S. AL.)

CONSTANTIUS I CHLORUS, properly AURELIUS VALERIUS CONSTANTIUS (d. A.D. 306), Roman emperor, whose nickname *Chlorus* means "the Pale." A Dardanian, probably of humble origin (his alleged descent from Claudius II Gothicus is a later fiction), he served in the army as *protector* and tribune and be-

came governor of Dalmatia. On March 1, 293, he was given the title of *Caesar* by the emperor Maximian (*q.v.*), who adopted him and married him to his daughter Theodora. Constantius already had one son (later the emperor Constantine I) by Helena, whom he now divorced. By Theodora he had three sons, Flavius Dalmatius, Julius Constantius and Hannibalianus, and three daughters, Constantia, Anastasia and Eutropia. As *Caesar* he was assigned the government of Gaul with the task of subduing M. Aurelius Carausius (*q.v.*), the usurper in Britain. In 293 he captured Carausius' mainland base Gessoriacum (Boulogne), and in 296, after careful preparations, he invaded Britain and conquered Allectus, Carausius' successor. He won a notable victory over the Alamanni in Gaul (298) and restored cities of Britain and Gaul. He was deliberately lax in enforcing Diocletian's edicts against the Christians in 303, only demolishing the churches; there were no martyrdoms in his dominions. When Diocletian and Maximian abdicated on May 1, 305, he became the senior *Augustus*, but died at Eboracum (York) in the summer of 306. (A. H. M. J.)

CONSTANTIUS II (Flavius Julius Constantius) (A.D. 317–361), Roman emperor, third son of Constantine the Great and Fausta, was born in Illyricum on Aug. 7, 317, and was proclaimed *Caesar* on Nov. 8, 324. When his father died on May 22, 337, the troops massacred many of his relatives, allegedly at Constantius' instigation. Constantius then divided the empire with his brothers Constantine II and Constans (*qq.v.*), taking the eastern provinces (Thrace, Macedonia, Greece, Asia and Egypt) for himself. Much of his reign was occupied with repelling Persian attacks on the eastern frontier and with suppressing usurpers. The Persian king Shapur II (*q.v.*) directed several unsuccessful attacks between 338 and 350 at the important city of Nisibis (Nusaybin) in Mesopotamia, nevertheless inflicting heavy losses on the Romans. Recalled to Europe in 350 by the usurpations of Vetranio, commander of the Danube forces, whose troops he won over at Naissus (Nis) in Moesia without fighting, and of Magnentius, whom he crushed only after fighting the battle of Mursa (*q.v.*) in Pannonia (351), Constantius appointed his cousin Gallus Caesar to administer the east as *Caesar*, but recalled him and put him to death in 354. In 355 he brought about the murder of Silvanus, a Frank who had usurped the title of emperor at Colonia (Cologne), and in the same year appointed Julian (*q.v.*), Gallus' half brother, as *Caesar* to govern Gaul. He visited Rome in the spring of 357, and attacked the Sarmatae, Suevi and Quadi on the Danube (357–358). In the meantime Shapur had renewed his attacks on the eastern frontier (359) and captured Amida (Diyarbakir), Singara and Bezabde in Mesopotamia. In 361 Constantius was recalled to the west by the revolt of Julian, but he became ill at Tarsus and died at Mopsucrenae in Cilicia on Nov. 3, 361.

Constantius was deeply interested in theological matters: he was an Arianizer and an opponent of the Council of Nicaea (*see* Arius; Arianism) and of Athanasius, bishop of Alexandria. Numerous synods and councils were held during his reign, and many bishops were exiled, including Liberius, bishop of Rome. Although Constantius permitted the return of Athanasius to Alexandria in 346, he personally attacked him before the Council of Arles in 353, and the bishop went into hiding in 356. But at the end of the reign none of the questions which divided the supporters of Arius and of Athanasius had been resolved. Constantius opposed paganism, against which he passed several laws.

See also references under "Constantius II" in the Index volume.

See A. Piganiol, *L'Empire chrétien*, pp. 325–395 (1947). (E. A. T.)

CONSTANTIUS III (d. A.D. 421), Roman emperor in 421, was a native of Naissus (Nis) in Moesia. In 411 as *magister militum* (master of the soldiers) he helped to overthrow Constantine (Flavius Claudius Constantinus; *q.v.*) at Arelate (Arles). He drove the Visigoths from southern Gaul into Spain (415), where he forced them to fight the other barbarians already settled there. In 417 he married the emperor's sister Placidia, who bore him the future emperor Valentinian III. Recalling the Visigoths from Spain (418), he settled them in southwestern Gaul. Appointed emperor with the title of *Augustus* on Feb. 8, 421, he died on Sept. 2, 421, at Ravenna. (E. A. T.)

CONSTELLATION, in astronomy, the name given to certain groupings of stars that were imagined—at least by those who named them—to form conspicuous configurations in the sky (from the Lat. *constellatus*, "studded with stars"; *con*, "with," and *stella*, "a star"). Constellations are useful in tracking artificial satellites, and in assisting astronomers and navigators to locate certain stars. There are 88 constellations now universally recognized.

From the earliest times the star groups known as constellations, the smaller groups (parts of constellations) known as asterisms and, also, individual stars have received names connoting some meteorological phenomena, or symbolizing religious or mythological beliefs. At one time it was held that the constellation names and myths were of Greek origin; this view has now been disproved, and an examination of the Hellenic myths associated with the stars and star groups in the light of the records revealed by the deciphering of Euphratean cuneiforms leads to the conclusion that in many, if not all, cases the Greek myth has a Euphratean parallel, and so renders it probable that the Greek constellation system and the cognate legends are primarily of Semitic or even pre-Semitic origin.

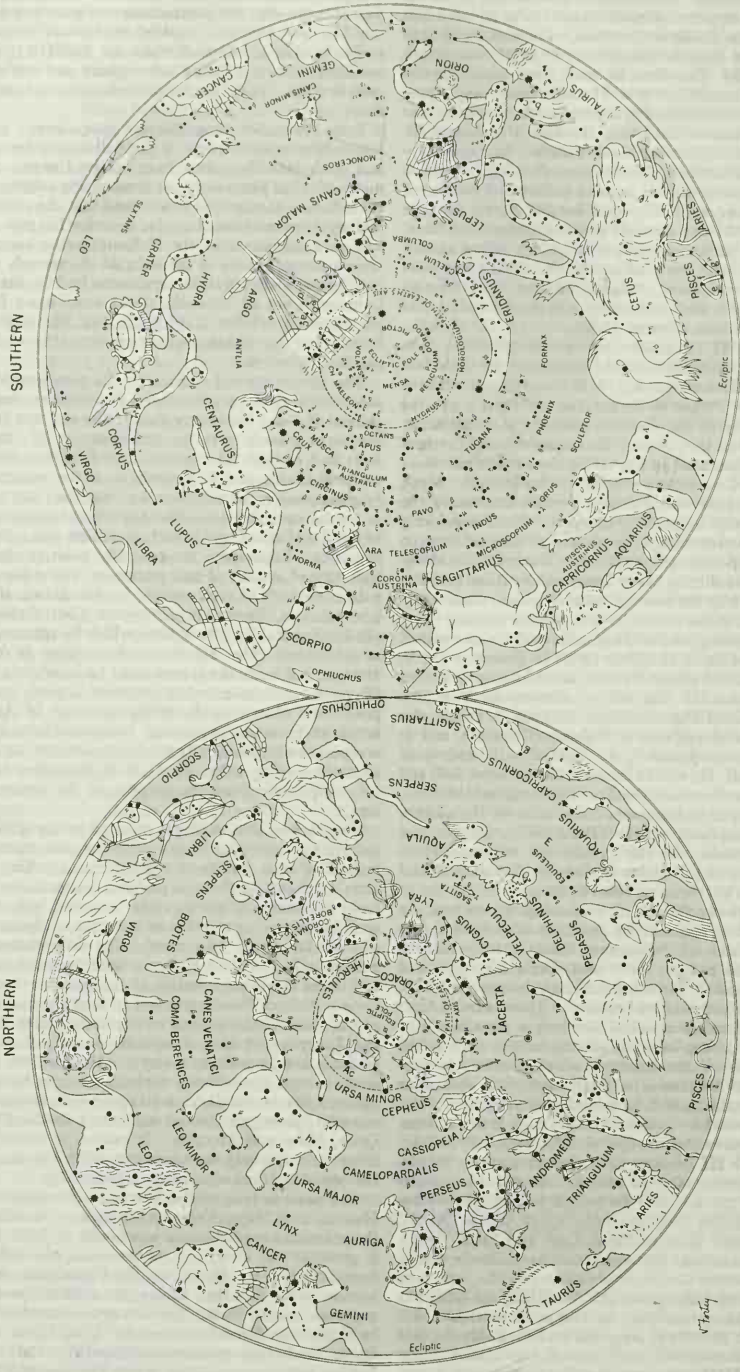
The Sumerians and Akkadians, the non-Semitic inhabitants of the Euphrates valley prior to the Babylonians, described the stars collectively as a "heavenly flock"; the sun was the "old sheep"; the seven planets were the "old-sheep stars"; the whole of the stars had certain "shepherds," and *Sibzianna* (which, according to A. H. Sayce and B. Bosanquet, is the modern Arcturus, the brightest star in the northern sky) was the "star of the shepherds of the heavenly herds." The Akkadians bequeathed their system to the Babylonians, and cuneiform tablets and cylinders, boundary stones and Euphratean art generally point to the existence of a well-defined system of star names in their early history. From a detailed study of such records, in their nature of rather speculative value, R. Brown, Jr. (*Primitive Constellations*, 1899) compiled a Euphratean planisphere, which he regarded as the mother of all others. The tablets examined range in date from 3000–500 B.C., and hence the system must be anterior to the earlier date. Of great importance is the *Creation Legend*, a cuneiform compiled from older records during the reign of Assur-bani-pal, in which there occurs a passage interpretable as pointing to the acceptance of 36 constellations: 12 northern, 12 zodiacal and 12 southern. (The zodiac [*q.v.*] is an imaginary band in the sky, 16° wide, centred on the ecliptic, or the apparent path of the sun.)

The Phoenicians—a race dominated by the spirit of commercial enterprise—appear to have studied the stars more especially with respect to their service to navigators; according to Homer "the stars were sent by Zeus as portents for mariners." But all their truly astronomical writings are lost, and only by a somewhat speculative piecing together of scattered evidence can an estimate of their knowledge be formed. The interrelations of the Phoenicians with the early Hellenes were frequent and far-reaching, and in the Greek presentation of the legends concerning constellations a distinct Phoenician, and in turn Euphratean, element appears. One of the earliest examples of Greek literature extant, the *Theogony* of Hesiod, appears to be a curious blending of Hellenic and Phoenician thought. Although not an astronomical work, several constellation subjects are introduced. In the same author's *Works and Days*, a treatise which is a sort of shepherd's calendar, there are distinct references to the Pleiades, Hyades, Orion, Sirius and Arcturus. It cannot be argued, however, that these were the only stars and constellations named in his time; the omission of other names proves nothing.

The same is true of the Homeric epics wherein the Pleiades, Hyades, Ursa Major, Orion and Boötes are mentioned, and also of the stars and constellations mentioned in Job. Further support is given to the view that, in the main, the constellations were transmitted to the Greeks by the Phoenicians from Euphratean sources in the fact that Thales, the earliest Greek astronomer of any note, was of Phoenician descent. According to Callimachus he taught the Greeks to steer by Ursa Minor instead of Ursa Major; and other astronomical observations are assigned to him. But his writings are lost, as is also the case with those of Phocus

THE OLD CONSTELLATION FIGURES

Projected on the Plane of the Ecliptic



the Samian and the history of astronomy by Eudemos of Rhodes, the pupil of Aristotle; hence the paucity of present-day knowledge of Thales' astronomical learning.

From the 6th century B.C. onward, legends concerning the constellation subjects were frequently treated by the historians and poets. Aglaosthenes or Agaosthenes, an early writer, knew Ursa Minor as Cynosura and recorded the translation of Aquila; Epimenides the Cretan recorded the translation of Capricornus and the star Capella; Pherecydes of Syros recorded the legend of Orion and stated the astronomical fact that when Orion sets Scorpio rises; Aeschylus and Hellanicus of Mytilene narrated the legend of the seven Pleiades. In the 5th century B.C. the Athenian astronomer Euctemon, according to Geminus of Rhodes, compiled a weather calendar in which Aquarius, Aquila, Canis Major, Corona, Cygnus, Delphinus, Lyra, Orion, Pegasus, Sagitta, and the asterisms Hyades and Pleiades are mentioned, always, however, in relation to weather changes. The earliest Greek work which purported to treat the constellations as constellations, of which there is certain knowledge, is the *Phainomena* of Eudoxus of Cnidus. The original is lost, but a versification by Aratus, a poet at the court of Antigonus II Gonatas, king of Macedonia, and a commentary by Hipparchus are extant.

In the work of Aratus 44 constellations are enumerated, viz., 19 northern: Ursa Major, Ursa Minor, Boötes, Draco, Cepheus, Cassiopeia, Andromeda, Perseus, Triangulum, Pegasus, Delphinus, Auriga, Hercules, Lyra, Cygnus, Aquila, Sagitta, Corona and Serpentarius; 13 central or zodiacal: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces and the Pleiades; and 12 southern: Orion, Canis, Lepus, Argo, Cetus, Eridanus, Piscis Australis, Ara, Centaurus, Hydra, Crater and Corvus. In this enumeration Serpens is included in Serpentarius and Lupus in Centaurus; these two constellations were separated by Hipparchus and, later, by Ptolemy. On the other hand, Aratus kept the Pleiades distinct from Taurus, but Hipparchus reduced these stars to an asterism. Aratus was no astronomer, while Hipparchus was; and from the fact that the latter adopted, with but trifling exceptions, the constellation system portrayed by Aratus, it may be concluded that the system was already familiar in Greek thought.

Three hundred years after Hipparchus, the Alexandrian astronomer Ptolemy adopted a very similar scheme in his uranometria, which appears in the seventh and eighth books of his *Almagest*, the catalogue being styled the "accepted version." The names and orientation of the 48 constellations therein adopted are, with but few exceptions, identical with those used at the present time; and as it cannot be doubted that Ptolemy made only very few modifications in the system of Hipparchus, the names were adopted at least three centuries before the *Almagest* was compiled.

A later innovator of importance was Johann Bayer, a German astronomer, who published a *Uranometria* in 1603 in which 12 constellations, all in the southern hemisphere, were added to Ptolemy's 48, viz., Apis or Musca (bee), Avis Indica (bird of paradise), Chamaeleon, Dorado (swordfish), Grus (crane), Hydrus (water-snake), Indus (Indian), Pavo (peacock), Phoenix, Piscis Volans (flying fish), Tucana and Triangulum Australe. According to W. Lynn (*Observatory*, 1886, p. 255), Bayer adapted this part of his catalogue from the observations of the Dutch navigator Petrus Theodori (or Pieter Dirchsz Keyser; d. 1596).

The *Coelum stellatum Christianum* of Julius Schiller (1627) is noteworthy for the attempt made to replace the names connoting mythological and pagan ideas by the names of apostles, saints, popes, bishops, and other dignitaries and objects of the church. Aries became St. Peter; Taurus, St. Andrew; Andromeda, the Holy Sepulchre; Lyra, the Manger; Canis Major, David; and so on. This innovation (with which the introduction of the 12 apostles into the solar zodiac by the Venerable Bede may be compared) was short-lived. A similar confusion was attempted by E. Weigelius, who sought to introduce a *Coelum heraldicum*, in which the constellations were figured as the arms or insignia of European dynasties, and by symbols of commerce.

In Edmund Halley's southern catalogue (*Catalogus stellarum australium*), published in 1679 and incorporated in John Flamsteed's *Historia coelestis Britannica* (1725), the following constellations are named: Piscis Australis, Columba Noachi, Argo Navis, Robur Caroli, Ara, Corona Australis, Grus, Phoenix, Pavo, Apus or Avis Indica, Musca Apis, Chamaeleon, Triangulum Australe, Piscis Volans, Dorado or Xiphias, Tucana or Anser Americanus, and Hydrus. Flamsteed's maps also contained Mons Menelai. This list contains nothing new except Robur Caroli, since Columba Noachi (Noah's dove) had been placed in the skies by Jacobus Bartschius in 1624.

In 1690 two posthumous works of Johannes Hevelius (1611–87), the *Firmamentum sobiescianum* and *Prodromus astronomiae*, added several new constellations to the list, viz., Canes Venatici (the greyhounds), Lacerta (the lizard), Leo Minor (little lion), Lynx, Sextans Uraniae, Scutum Sobieskii (the shield of Sobieski), Vulpecula et Anser (fox and goose), Cerberus, Camelopardalis (giraffe) and Monoceros (unicorn); the last two were originally named by Bartschius. In 1679 Augustine Royer introduced the most famous of the constellations of the southern hemisphere, the Crux Australis or Southern Cross.

Nicolas Louis de Lacaille, who made extended observations of the southern stars in 1751 and in the following years, and whose results were embodied in his posthumous *Caelum australe stelliferum* (1763), introduced the following new constellations: Apparatus Sculptoris (sculptor's workshop), Fornax Chemica (chemical furnace), Horologium (clock), Reticulus Rhomboidalis (rhomboidal net), Caela Sculptoris (sculptor's chisels), Equuleus Pictoris (painter's easel), Pyxis Nautica (mariner's compass), Antlia Pneumatica (air pump), Octans (octant), Circinus (compasses), Norma *alias* Quadra Euclidis (square), Telescopium (telescope), Microscopium (microscope) and Mons Mensae (Table mountain).

Attempts have been made to introduce new constellations since that date, but none of these is now accepted. The large Ptolemaic constellation of Argo is, however, subdivided into Vela (sails), Puppis (stern) and Carina (keel).

The delimitation of precise boundaries for the constellations was undertaken by a committee of the International Astronomical union. By 1945 it was possible to assign any star to its proper constellation without ambiguity.

The following list contains the constellations now used. The Ptolemaic constellations are printed in small capitals. Many are the subject of separate articles.

Northern

ANDROMEDA	CYGNUS	OPHIUCHUS
AQUILA	DELPHINUS	PEGASUS
AURIGA	DRACO	PERSEUS
BOÖTES	EQUULEUS	SAGITTA
Camelopardalis	HERCULES	SERPENS
Canes Venatici	Lacerta	TRIANGULUM
CASSIOPEIA	Leo Minor	URSA MAJOR
CEPHEUS	Lynx	URSA MINOR
Coma Berenices	LYRA	VULPECULA
CORONA BOREALIS		

Central (Zodiacal)

AQUARIUS	GEMINI	SAGITTARIUS
ARIES	LEO	SCORPIO
CANCER	LIBRA	TAURUS
CAPRICORNUS	PISCES	VIRGO

Southern

Antlia	Dorado	ORION
Apus	ERIDANUS	Pavo
ARA	Fornax	Phoenix
Caelum	Grus	Pictor
CANIS MAJOR	Horologium	Piscis Austrinus
CANIS MINOR	HYDRA	Puppis
Carina	Hydrus	Pyxis
CENTAURUS	Indus	Reticulum
CETUS	LEPUS	Sculptor
Chamaeleon	LUPUS	Scutum
Circinus	Mensa	Sextans
Columba	Microscopium	Telescopium
CORONA AUSTRINA	Monoceros	Triangulum Australe
CORVUS	Musca	Tucana
CRATER	Norma	Vela
Crux	Octans	Volans

BIBLIOGRAPHY.—S. G. Barton, *A Guide to the Constellations* (1935); D. H. Menzel, *A Field Guide to the Stars* (1959); W. T. Olcott, *Field Book of the Skies* (1954). (C. E.; A. S. E.; X.)

CONSTIPATION, a faulty functioning of the lower bowel resulting in undue retention of fecal material, which usually becomes dried and often hardened. It results from bad habits of personal hygiene, improper diet or disease of the lower bowel. Proper treatment is based upon the recognition and correction of the cause. The habitual use of laxatives and enemas may cause ultimate aggravation of this condition and the production of other disturbances. *See* DIGESTION; GASTROINTESTINAL TRACT, DISEASES OF. (F. L. A.)

"CONSTITUTION," a United States frigate familiarly known as "Old Ironsides," is the most famous ship in the annals of American history. She was one of the first three frigates built for the United States navy; designed by Joshua Humphreys of Philadelphia, her keel was laid at Hartt's shipyard, Boston, in 1794. Construction was temporarily suspended in 1795, when a tenuous peace was reached with Algiers. Work on the "Constitution" was undertaken again when the need arose to resist the deprivations of French privateers then infesting American waters. She was launched in 1797 and, under Capt. Samuel Nicholson, saw her first service in the quasi war with France.

The over-all length of the "Constitution" was 204 ft., breadth of beam 43 ft. 6 in., depth of hold 14 ft. 3 in., displacement 2,200 tons, gun range 1,200 yd. She was originally built of well-seasoned live oak, red cedar and hard pine. Bolts which fastened her timbers and the copper sheathing on the bottom were made by Paul Revere. Rated as a 44-gun frigate, she, however, generally carried more than 50 guns and a crew of over 450. Original cost of the vessel was $302,718.84, including guns and equipment.

In the successful war against the Tripolitan pirates (1801–05) the "Constitution" was Commodore E Preble's flagship, and peace was signed aboard her. During the War of 1812 she achieved an enduring place in the American tradition. On one occasion when there was no wind her crew took to small boats and towed her out of reach of the guns of the British fleet. On Aug. 19, 1812, when morale in the United States was at a low ebb, the "Constitution," commanded by Capt. Isaac Hull, won a brilliant victory over the British frigate "Guerrière." Tradition has it that during this engagement the American sailors, on seeing British shot failing to penetrate the staunch oak sides of their ship, dubbed her "Old Ironsides." This frigate duel was followed by numerous other victories hardly less notable, including destruction of H.M.S. "Java" (Dec. 29, 1812), when the "Constitution" was commanded by Capt. William Bainbridge.

The historic old ship was condemned as unseaworthy and it was recommended that she be broken up in 1828. She was saved, however, when the poem "Old Ironsides" by Oliver Wendell Holmes aroused public sentiment. Through subsequent rebuildings the "Constitution" retained, insofar as possible, her original appearance and characteristics.

BY COURTESY OF U S DEPARTMENT OF THE NAVY

U.S.S. "CONSTITUTION" ESCAPING FROM THE BRITISH FLEET OFF THE COAST OF NEW JERSEY, JULY 18, 1812; PAINTING BY F. C. MULLER

After a restoration (1927–31) she called at 90 U.S. ports on both coasts and was visited by more than 4,500,000 people. Returning to Boston in 1934, she has been permanently berthed there and opened to the public. "Old Ironsides" remained on the list of commissioned vessels in the United States navy.

See F. A. Magoun, *The Frigate Constitution and Other Historic Ships* (1928); and H. I. Chapelle, *The History of the American Sailing Navy* (1949). (J. B. Hs.)

CONSTITUTIONAL ACT, CANADIAN (1791). The Constitutional act, otherwise known as the Canada bill, repealed certain parts of the Quebec act (*q.v.*) of 1774 under which the province of Quebec had previously been governed, and provided a new constitution for the two provinces called Lower Canada (the future Quebec) and Upper Canada (the future Ontario) into which the territory was divided. After the American Revolution Loyalist settlers entered Quebec, bringing with them a desire for democratic institutions and for English civil law; the British merchants in the cities of Quebec and Montreal were also clamouring for a legislative assembly. Change was necessary, and the act was passed by the British parliament on June 10, 1791, and proclaimed to take effect on Dec. 26, 1791. The new legislatures, the first in this part of Canada, met in each province in 1792.

The act aimed to reproduce the general principles of the British constitution. There was to be a governor or lieutenant governor in each province representing the crown, advised by an executive council; a legislative council appointed for life by the governor; and an elected legislative assembly. The legislative authority of governor, council and assembly was defined generously as a power to make laws "for the peace, welfare and good government" of the provinces, not repugnant to the act, but bills might be disallowed by the crown in England. To the parliament of Great Britain was reserved the right to control navigation and to regulate the external commerce of the provinces.

Two special provisions of the act showed the fear of egalitarian principles. One provided for the appropriation of crown lands (one-eighth of all future grants) "for the support and maintenance of a Protestant clergy" (*see* CLERGY RESERVES). This portion of the act went into effect, with unhappy consequences to Canadian politics. The other provision sought to establish a landed aristocracy with the hereditary right of being summoned to the legislative council of each province. This feudal idea remained a dead letter, being wholly unsuitable to local conditions.

The wisdom of the policy underlying the Constitutional act has been seriously questioned. D. Creighton, for example, in *The Empire of the St. Lawrence* (1956), observed that Canada was "partitioned by the Treaty of Paris (1783) and repartitioned by the Constitutional Act." Commercial conflict inevitably arose between the two provinces linked by geography and trade routes. Believing that the American Revolution was caused by too much democracy, the English statesmen sought through the act to bolster authority against the popular will. Representative government was, however, introduced, and this led eventually to responsible government. French Canadians found in the legislative assembly of Lower Canada, in which they formed a majority, their first opportunity to express a nascent nationalism.

See also CANADA: *History.*

BIBLIOGRAPHY.—The text of the act is in W. P. M. Kennedy (ed.), *Statutes, Treaties and Documents of the Canadian Constitution, 1713–1929*, 2nd ed. (1930). *See* also A. L. Burt, *The Old Province of Quebec* (1933); D. Creighton, *The Empire of the St. Lawrence* (1956); A. G. Bradley, *Lord Dorchester* (1926); *Cambridge History of the British Empire*, vol. vi, *Canada and Newfoundland* (1930). (F. R. S.)

CONSTITUTIONAL CONVENTION (U.S.), an assembly of delegates who met in the Pennsylvania statehouse in Philadelphia during the period May 25–Sept. 17, 1787, and drafted the constitution of the United States, which replaced the Articles of Confederation (*q.v.*). The convention was called as the result of a demand for a stronger central government. By 1787 it

had become extremely doubtful that the Articles of Confederation could be amended to create an effective central regime that would regulate interstate commerce and effectively handle foreign relations. An economic depression, which was at its worst in 1785–86, and a rebellion led by Daniel Shays (*q.v.*) stimulated action. In the fall of 1786 the Annapolis convention (*q.v.*) issued an invitation to the states to send delegates to Philadelphia "to take into consideration the situation of the United States, to devise such further provisions as shall appear to them necessary to render the constitution of the federal government adequate to the exigencies of the Union. . . ." The congress sent forth a similar request on Feb. 21, 1787, and 74 delegates were chosen by 12 states. Rhode Island failed to appoint deputies. Only 55 men actually took part in the proceedings at Philadelphia; of these, 39 signed the constitution.

The members of the convention were distinguished in ability, education and experience, though hardly more so than those of the second continental congress. They were also men of property, as would be expected. Especially valuable were the contributions of George Washington of Virginia, who played little part in the deliberations but gave the convention dignity and prestige as its presiding officer; James Madison, also of Virginia, statesmanlike and prolific in political devices, often called "Father of the Constitution"; James Wilson of Pennsylvania, a strong nationalist; John Rutledge and Charles Cotesworth Pinckney of South Carolina, able and responsible representatives of the deep south; Oliver Ellsworth of Connecticut, a thoughtful and sober man who helped to solve several difficult problems; and Gouverneur Morris of Pennsylvania, who was especially responsible for the clear language in which the constitution was cast.

The convention quickly decided to make a new constitution rather than try to amend the Articles of Confederation. Its basic elements were contained in the Virginia plan, prepared by the Virginia delegation before the opening of the convention and proposed by Edmund Randolph. This plan called for the creation of a powerful central government, including a bicameral congress with the representation of each state based on its population or wealth. Agreement was quickly reached (on May 30) that ample powers must be vested in the central regime, and also (on June 12) that the constitution when finished should be presented for ratification to specially elected conventions in the several states rather than to their legislatures. Later it was stipulated that the constitution should be put in motion when nine such conventions had voted approval. Thus it was arranged that the constitution should have as its basis the solemn will of the people. Accordingly, both the central and state governments came to rest upon them.

The bases for representation in congress proposed in the Virginia plan encountered, however, serious opposition. From the time of the first continental congress each colony-state had possessed (as in the convention itself) one vote; the use of a ratio of numbers or wealth would obviously destroy that system and would give the larger states, especially Massachusetts, Pennsylvania and Virginia, a heavy representation. Bitter protests came from delegates of the smaller states, who were moved not only by state pride but also, and especially, by fear that members of the congress from the large states would combine their votes to dominate it. Massachusetts, Pennsylvania and Virginia, with support from Connecticut, the Carolinas and Georgia, urged the proportional principle for both houses of the congress-to-be. Clinging to their belief that the votes of the large states would be cast in bloc—although Madison correctly declared that voting would be in accordance with sectional, economic and social beliefs rather than according to state size—the small states insisted upon equal representation of the states. They rallied behind William Paterson of New Jersey, who offered the New Jersey plan on June 15. This scheme would have created a one-house legislature in which all states had an equal vote, and would have materially increased the powers of the congress beyond those granted under the Articles of Confederation. Provision was also included for an executive and a judiciary. After some weeks of discussion it became evident that constitutional reform would fail unless concession was made to the small states. As a result the "Great Compromise," in which the Connecticut delegation played an important role, was arranged by votes taken on July 16 and 23. It called for a bicameral congress with proportional representation in the lower house and equal representation of the states in the upper house, or senate. Thus the convention solved its most difficult problem, and the advocates of a strong central government gained strength, for Paterson and other representatives of small states abandoned their fears of national tyranny.

Further awkward difficulties arose because of conflicting sectional interests, chiefly those of the south and the north. Northern delegates desired representation in the house of representatives in proportion to wealth or free population. Those from Maryland southward insisted that Negro slaves be taken into account either as persons or property. On the other hand, northern spokesmen wished to count the slaves in the apportionment of direct taxes, while southerners were not eager to do so. Ultimately it was agreed that representation should be in accordance with numbers, and that five slaves should be counted as three freemen for both representation and direct taxation. Other delicate problems between north and south arose from divergent opinions regarding export duties, regulation of the oceanic slave trade and navigation acts. The southern delegates desired prohibition of export duties and laws that might give northern merchants a monopoly of southern maritime trade. Men from the deep south also desired a bar against action by congress to destroy the slave trade. New Englanders sought to secure as much of the southern sea-borne traffic as could be gotten for Yankee merchants; and, along with delegates from the upper south, they desired to abolish the oceanic commerce in slaves. After sharp disputes a compromise was finally reached on Aug. 29. By its terms, export taxes were forbidden; the slave trade was exempted from federal interference for 20 years; and passage of navigation acts by simple majority was permitted. The Connecticut delegation, which had been instrumental in arranging the "Great Compromise," also helped materially in the making of this sectional bargain.

Meanwhile the convention reached agreement on various political devices. It enumerated the powers of the central government; provided for a single executive chosen by a complicated system in which the voters, the states and the congress were all to play parts; laid down an outline for a federal judiciary; and adopted a system of checks and balances designed to prevent domination of the federal government by the president, the congress or the judiciary. The delegates did not provide specifically for judicial review of legislation but they apparently expected it to take place. They declared the constitution to be "the supreme Law of the land." They also failed to insert a full federal bill of rights, in part at least because they thought one unnecessary.

Although several delegates, including George Mason and Edmund Randolph of Virginia and Elbridge Gerry of Massachusetts, refused to approve the constitution, it was referred to the states by the old congress, and was endorsed by 11 state conventions by July 1788. North Carolina and Rhode Island withheld their sanction until after the new federal government was put in motion in the spring of 1789.

There has been much dispute among scholars concerning the achievement, the intentions and the motivations of the men who made the constitution and secured its adoption. In the latter part of the 19th century and the early years of the 20th both popular and scholarly opinion held that the constitution was an almost perfect document made by wise and altruistic men. It was generally believed that its adoption rescued the United States from economic distress and near anarchy during the years following the Revolutionary War. But in 1913 Charles A. Beard in *An Economic Interpretation of the Constitution* stimulated more sophisticated analysis. Beard contended that the making and the ratification of the document were the work of men who were merchants, lawyers, manufacturers and capitalists, dominated by interests in personal property, especially national certificates of indebtedness. He also offered data tending to indicate that the constitution was opposed by a majority of the voters in several states and that it probably was not favoured by a majority of the

American people; hence that its adoption was "undemocratic." Other writers following in his wake claimed that the adoption was the equivalent of the Thermidorian reaction in the French Revolution.

It should be observed that the process of adoption was as "democratic" as the ones employed in the ratification of state constitutions at that time, and that the provisions of the document were approximately as "democratic" as those of the average contemporary state constitution. There was, accordingly, no remarkable conservative reaction in 1787–88. Moreover, scholars have properly pointed out that possession or nonpossession of certificates of indebtedness could not of themselves have determined attitudes toward the constitution. Indeed, as Robert E. Brown and Forrest McDonald have asserted in critiques of Beard's work, conclusive evidence is lacking that economic status in general dictated allegiance or opposition to the constitution. In the debates over the influence exerted by the economic situations of persons and classes, arguments in behalf of the constitution for the general good have received insufficient attention. Yet it is clear enough that it offered promise of a respectable and dignified central government in which the Americans could take pride, of economic benefits to the American people as a whole and of solid improvements in the management of foreign affairs, defense and Indian affairs. *See* also CONSTITUTION AND CONSTITUTIONAL LAW: *United States;* UNITED STATES (OF AMERICA): *History.*

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(J. R. AL.)

CONSTITUTION AND CONSTITUTIONAL LAW.

In its wider sense the term "constitution" means the whole scheme whereby a country is governed; and this includes much else besides law. The constitutional lawyer must constantly keep glancing backward into constitutional history; he must also keep his eye on current political practice and the day-to-day working of political institutions. In its narrower sense "constitution" means the leading legal rules, usually collected into some document which comes to be almost venerated as "The Constitution." But no country's constitution can ever be compressed within the compass of one document and even where the attempt has been made it is necessary to consider the extralegal rules, customs and conventions that grow up around the formal document. It is essential to note in this regard that constitutional government is limited government; it requires that public authority be exercised according to law. (For the relationships of the U.S. constitution to constitutional law, see *United States,* below.)

CONSTITUTIONS IN GENERAL

It is almost impossible to give a satisfactory or comprehensive definition of constitutional law in the United Kingdom, and it is discussed more fully below (see *The English Constitution*). There are good historical and political reasons for this difficulty of definition, and today it is perhaps permissible to say, quite baldly, that constitutional law is the law relating to the government of the country, to the state and its various organs and their relations among themselves and with the ordinary citizen. There is in English law no real distinction between public and private law just as, in the middle ages, there was no distinction between property and government; both then were different aspects of the same thing; today public and private law are often inextricably mingled. But the main essentials of constitutional law are clear: they include all the rules relating to the crown and its powers or prerogatives; the composition, functions and powers of parliament; the executive, by which is meant all the various organs of central government that are collectively known as "Whitehall"; the duties and powers of the courts; and, not least, the rights and duties of the citizens: "the liberty of the subject" in a time-honoured phrase.

Written Constitutions.—In most western countries the constitution, using the term in the narrower sense, is a scheme of government that has been deliberately adopted by the people; examples are the constitution of the United States, drawn up in 1787 and ratified in 1789 and still in essentials unchanged; the constitution of the Weimar republic or that of the Federal Republic of Germany brought into force in 1949; the constitutions that France has had since the Revolution. These are "written" constitutions in the sense that there is some document or series of documents setting out the fundamental principles and chief legal rules, and to this the student can point and say "this is the constitution." The constitution in these countries is the basis of public law; it is usually enacted or adopted with special formalities; special processes are devised for its amendment (and sometimes safeguards are inserted to ensure that certain provisions are unalterable); and constitutional law comes to enjoy a special pre-eminence. In this type of constitution the courts have a special function: if some act of the legislature exceeds the powers conferred by the constitution, the courts must declare it to be unconstitutional and so null and void. The supreme court of the United States, for example, has again and again declared whole acts or clauses of particular acts to be *ultra vires* ("outside the powers") or to contradict some fundamental rule of the U.S. constitution. Thus in countries with a written constitution the judges have the very important task of passing on the validity of legislation, and for this reason appointments to the bench are sometimes matters of more than purely legal interest. Pres. Franklin D. Roosevelt inherited a supreme court that was not sympathetic to his views; all his nominations were from those who favoured his New Deal, and there were at times complaints of packing the bench. Since World War II the decisions of the constitutional court in the Federal Republic of Germany have been issues of first-class political importance.

Switzerland, France, Italy and the U.S.S.R. have constitutions of this type; so have the self-governing members of the Commonwealth of Nations, though in none is the emphasis on the judicial review of legislation and governmental acts so great as in the United States.

Written constitutions are sometimes also described as "rigid," meaning that they can be altered only in special ways, usually designed to guard against hasty action by majorities. Thus in the United States to propose amendments requires two-thirds majorities of both houses of congress, or a convention called on application of two-thirds of the state legislatures, and any amendment made is not effective until ratified by three-fourths of the states of the union; sometimes the process of ratification takes years. In France an amendment of the constitution must be approved by both assemblies and then by a referendum or, if the president so decides, the proposal may be submitted to a joint session of both houses sitting as congress, in which event the amendment is accepted only if it obtains a majority of three-fifths of the votes cast. In Belgium and in South Africa there must be a prescribed majority; in Switzerland and Australia a referendum is necessary. Sometimes, too, certain religious or social ideas are written into the constitution as "fundamental rights," and provision is made to ensure that they, as the religious and social basis of the state, are not altered or abandoned. This has happened in countries as divergent as the Republic of Ireland, Israel, India and Pakistan. Finally, it must be noted that there is a further distinction between unitary and federal states. In a unitary state, power is, ultimately, concentrated in one centralized government. In a federation each of the constituent states joins with its fellows to form a new state, the federal government, but the member states retain their own organizations and individuality. The instrument creating the federation (the constitution) sets out the powers and duties of the federation and those of the member states and often contains an elaborate system of checks and balances to ensure that the states do not trespass on the federation nor it on them. The demarcation of respective spheres gives rise to some of the nicest questions of federal law, and the task of the supreme court in such a situation can be very delicate. The United States, Canada, Australia, Switzerland and, to some extent, the Federal Re-

public of Germany are examples of federation.

The "unwritten" (in the sense of not being contained in a formally enacted document) nature of the British constitution contrasts largely with every other country. In France the constitution adopted in 1946 was superseded on Oct. 5, 1958, by one containing 92 articles grouped under 15 titles. Art. i establishes the republic and the overseas French territories as a community. Art. ii reaffirms the traditional notions: France is "an indivisible, secular, democratic and social republic"; the Tricolour is the national emblem and the *Marseillaise* is the national anthem; its motto is "liberty, equality, fraternity"; its principle is government of the people, for the people, by the people. Art. v to xix define the powers and functions of the president; other articles create a parliament of two houses (the national assembly elected by universal suffrage, a senate elected indirectly). There is also provision for a constitutional council, the judicial authority, an economic and social council and the institutions of the overseas territories in the community. The general effect of the new constitution was the strengthening of the office of president and the rural, traditional elements in France and the weakening of parliament and the "popular" elements. Similarly, the constitution of the Federal Republic of Germany, promulgated on May 23, 1949, contains 146 articles. The first 19, dealing with fundamentals of state authority, cover the rights of the citizen, the economic order, family and motherhood, education and religion. The remainder deal briefly with relations between the federation and the *Länder;* with legislation; with the powers of the executive, the president and the courts. The final article provides for a constitution to be adopted later "by a free decision of the German people." India has gone to the other extreme, and its constitution runs to about 250 printed pages.

In every other European country and in the commonwealth the pattern is the same: a constitutional document, setting up a legislature, defining its composition and powers; constituting an executive and providing for the exercise of executive powers; creating courts and regulating the judicial function; establishing and often guaranteeing the rights of the individual citizen; and in some cases dealing with local government as well. In federal and quasi-federal countries the picture is more complicated as it is necessary to provide for the division of authority between the federation and its members and for deciding the disputes to which any such distribution must give rise. Usually some topics are assigned exclusively to the federation; others are reserved exclusively to the constituent states or provinces; and there is often a third list of subjects over which both federal and state authorities have concurrent jurisdiction. In such cases it is also necessary to decide which of the concurrent authorities is to prevail if there is a conflict. A method of constitutional amendment is also generally provided.

These countries, then, have constitutions that consist primarily of rules of law. But in addition many are prefaced by a preamble which sets out in general terms the fundamental moral and political principles of the state. This preamble often reads more like a manifesto than a legal document and the principles it sets forth are often incapable of direct legal enforcement. Thus the French constitution begins ". . . the French people solemnly proclaim their attachment to the Rights of Man and to the principles of national sovereignty as defined by the declaration of 1789, confirmed and completed by the preamble to the constitution of 1946" (which had included the words "every human being, without distinction of race, religion, or belief, possesses inalienable and sacred rights," the substance of which now appears in art. ii). The constitution of the Federal Republic of Germany achieves much the same result; art. i proclaims that the dignity of man is inviolable; art. iii that men and women have equal rights; art. v that art and science research and teaching are free; and so on. The preamble to the constitution of India proclaims justice, liberty, equality and fraternity as its objects. Modern constitutions generally proclaim the sovereignty of the people; some, as in Ireland, South Africa and Switzerland, invoke the sanction of God.

In general a written constitution sets out the principal legal rules for the distribution and exercise of state authority and provides a means of enforcing them. Sometimes, almost by accident, quite minor rules have been included. Sometimes, under the guise of legal rules, fundamental concepts are set out in such general terms that enforcement is not really possible. Thus the constitution of India sets out "Directive Principles of State Policy," which, although fundamental in the governance of the country, are recognized not to be legally enforceable. Pakistan has provided for certain Islamic principles, and the Republic of Ireland has written into its constitution Catholic social ideals. Ireland, Norway and Denmark have inserted guarantees for the right of private property in their constitutions.

Certain similarities may be noticed. Most constitutions have a bicameral legislature, though the powers of the two houses are not always identical. One house, usually the largest, is elected by universal suffrage; the other is often indirectly elected, as in France, or nominated, as in Canada. In federations the second chamber, as in Canada and Australia, is designed to preserve the equality of the member states and thus gives equal representation to each irrespective of its size, wealth or population; while the elective chamber is generally chosen on a population basis, so that regard can be had to the relative size and numbers of each state. In some there is provision for referendum; *i.e.,* for a proposed law to be directly submitted to the people; Australia, Ireland, Denmark and Switzerland all employ some form of referendum. Sometimes a constitutional amendment is binding only if ratified by a certain number of the member states: one-half of the member states in India; three-fourths in the United States.

In form a written constitution derives its authority from God, the people or a constituent authority. In those countries where constitutions are derived from the United Kingdom the authority of the British parliament as lawmaker for the empire (as it was in the days when the constitutions of the older commonwealth countries were formulated) is sufficient; the British North America acts, the Commonwealth of Australia act, 1900, and the South Africa act, 1909, were all enacted at Westminster. But what of the authority of a constitution once it has been enacted? In the United Kingdom this question does not really arise. Constitutional law is only one branch of the common law; it enjoys no special sanctity; it can be made, altered or repealed in just the same way as any other law. The constitution is the law, but parliament, the omnicompetent legislature, can make or unmake it. A parliament or its equivalent is, however, only one of a number of state institutions, and generally the constitution precedes the institutions it creates and, just as it precedes them, so it regulates them. In this view the constitution limits the powers of all the constituent organs, the legislative no less than the others. It is, therefore, fundamental, superior, paramount law; its authority and sanction are higher than those of ordinary laws, which are, on this theory, derived from it; hence the special modes of constitutional amendment when the legislature can amend ordinary laws by a simple majority.

It is this view that gives constitutional law a superior, moral, binding force, either because it is the will of the people or the product of a supreme lawmaking authority, such as a constituent assembly; and it is because of this view that once a constitution is accepted it receives the support, in society, of a whole series of forces working against change and in favour of existing institutions. It leads directly to the theory that "constitutionalism" is something sacred, if not an end in itself.

The Citizen and the State.—The citizen in a democratic country enjoys freedom of speech, the right to say or publish what he pleases, freedom from arbitrary arrest, freedom to practise his religion and freedom of association; *i.e.,* to form political parties, clubs, trade unions or any other organization he wishes. In most countries these rights are written into the constitution by being specifically enumerated and enacted as part of the constitutional document itself. In the United Kingdom these freedoms exist as fully and as extensively as anywhere else; but there are no constitutional guarantees of liberty, no safeguards in any enacted constitution. These rights are derived simply from the ordinary law of the land. For example, a discussion of freedom of speech

would involve questions of criminal law (sedition, obscenity and blasphemy) and of private law (libel and slander); the extent to which freedom from arrest is enjoyed can be found only by considering, in the criminal law, the instances in which a man can be apprehended and, in the civil law, the remedies available to one who is wrongfully arrested (damages for false imprisonment or malicious prosecution; habeas corpus; the use of reasonable force in self-defense). These traditional liberties have had to be fought for but today are taken very much for granted; the very fact that there is so little enacted law relating to them is evidence of public assurance of their safety and security. Carried to its logical conclusion this absence of precise definition means, for example, that technically no citizen is safe in criticizing another without first studying the law of defamation carefully or in attacking the government without first informing himself as to the law of sedition. But in practice there is a wide toleration of all utterances on matters of public concern, and the stricter view that is taken of utterances or writings relating to the reputation of private individuals generally meets with public approval.

Freedom of property, however, stands on a very different footing. The crown (on behalf of the central government), every local government authority and most public boards (such as those that run the nationalized industries) have powers to acquire the land of a private individual if it is required for a public purpose (such as building schools or roads or providing a police station or hospital). The citizen is always entitled to compensation; there is a form of public inquiry before the order authorizing the acquisition of his land is made; but there has been great disquiet over the arbitrary way in which these powers have on occasion appeared to be exercised.

Administrative Law.—The exercise of powers such as those just described leads naturally into the field of administrative law, by which is meant the law relating to public administration, a vast subject of which it is proposed to mention only two aspects: administrative tribunals and delegated legislation. This field has developed rapidly since World War I and is still developing at a great rate. It is a topic that causes anxiety wherever the traditional western views on constitutional propriety have prevailed and nowhere more than in the United Kingdom. The growing complexity of the state's functions, particularly in matters of economic regulation, currency control, social welfare, education and health, has led to a great increase in the powers of the executive to control business, commerce, manufacture and the private life of the citizen at many points. To carry out these functions almost every government department has wide compulsory powers; powers to order, direct, regulate, license, forbid, acquire property. The carrying out of these schemes invokes a mass of detailed rules and regulations; the typical statute is not suited to minutiae; parliament has neither the time nor the knowledge to discuss these problems adequately. Hence the modern practice is for a statute to lay down general principles and leave the details to be filled in by ministerial order; *i.e.*, by orders made by the government department concerned. These orders, of which until 1949 over 2,000 were made annually (since then the annual output has shown some decline), are known as "delegated legislation." They are legislative because they make new law or change existing law; they are delegated because parliament has delegated the power to legislate to a subordinate authority.

Thus a modern ministry is invested with: (1) a power to compel; (2) a power to decide disputes; (3) a power to legislate. This cuts across the traditional theory of the separation of powers in that it confers legislative and judicial authority on the executive. This field, as already pointed out, raises the most difficult constitutional issues. The older view is that the traditional liberties are in danger; the modern view is that without such power the welfare state could not operate and that parliament, which conferred them, can also control them. Perhaps the most urgent issue is to devise some efficient control by parliament over delegated legislation and by the courts (or by some other independent authority) over the exercise of administrative powers.

Delegated legislation in England is subject to safeguards to ensure publicity and availability to the public by prompt publication under rules enacted by the Statutory Instruments act, 1946. Each house of parliament also has a select committee to scrutinize rules made under delegated powers and to report any unusual or improper exercise of the power. But the complexity of the rules and the pressure on parliamentary time make these safeguards less effective than it was hoped that they would be.

The Franks committee on administrative tribunals and inquiries (1957) examined the whole field of administrative law, and many of its recommendations were carried out administratively and as a result of the Tribunals and Enquiries act, 1958. A common procedure for inquiries has been evolved; the objector is enabled to have notice of the public authority's proposals; the inspector's report is to be published and also the minister's reasons for not accepting it, if in fact its recommendations are rejected; the supervisory powers of the high court have been extended; and a standing council on tribunals (with another for Scotland) makes an annual review and reports on the constitution and working of tribunals. These measures have gone a long way toward meeting the disquiet felt by critics of the system.

In the United States similar problems have arisen, and American experience has prompted some of the English criticism and the expedients adopted to meet it. In the United States the "due process" rule is a far more potent curb on administrative actions than any rule or doctrines in England, though the idea of "natural justice" has had, on occasion, not dissimilar results. Delegated legislation in the United States is subject to greater safeguards, and the process by which it is made is more fully regulated. This, indeed, is inevitable under a written constitution. The technique of the "public hearing" has been more fully developed, and a complicated adjudicatory procedure, with guarantees of the right to be heard in public and minimum standards for proof and procedure for administrative agencies and commissions, has been evolved, much of it based on the Federal Administrative Procedure act, 1946. Judicial review and access to the courts are ensured by carefully drawn safeguards, and these forms of remedy are probably better provided for than in England.

Notwithstanding these elaborate codes, criticism of the administrative system continues in both countries. Much thinking and writing have been done on both sides of the Atlantic and much controversy evoked. If a satisfactory solution was not in sight by the 1960s, developments then in progress were a great advance, and it was not doubted that parliament, congress and the common law in the United States and in England, all hardy growths, would ultimately find a means of reconciling the need to control persons and property in the public interest with the right of the individual "not to be pushed around." (*See* also ADMINISTRATIVE LAW; REGULATORY AGENCIES.)

Constitutionalism.—This means that public authority is to be exercised according to law; that state and civic institutions, executive and legislative powers, have their source in a constitution, which is to be obeyed and not departed from at the whim of the government of the day: in short, a government of law and not of men. To a greater or lesser degree the idea implicit in the word is respected in every country with a written constitution and in none more than the United Kingdom with its unwritten constitution. It is latent in Lord Chesterfield's oft-quoted dictum in the 18th century: "England is the only Monarchy in the world that can properly be said to have a constitution." It is this idea, and the esteem in which it is held, that will ensure that administrative law and delegated legislation adapt themselves to the parliamentary sovereignty and the rule of law.

THE ENGLISH CONSTITUTION

In England there is no one document or fundamental body of law that can be described as a "constitution" in the sense that has been discussed above. The absence of any such document or of any distinction between public and private law has led to the suggestion (perhaps first made by A. C. de Tocqueville) that there is in England no constitution. Certainly the English constitution has no existence apart from the ordinary law; it is indeed part of that very law. Magna Carta, the Petition of Right act, the Habeas Corpus act, the Bill of Rights and the Act of Settlement

are the leading enactments, but they are in no sense a constitutional code, and without a host of judicial decisions, scores of other statutes of much less importance and a mass of custom and convention, these statutes would be unworkable. The sources of English constitutional law are diffuse—statutes, judicial precedent, textbooks, lawbooks, the writings of historians and political theorists, the biographies and autobiographies of statesmen, the columns of every serious newspaper, the volumes of *Hansard*, the minutiae of every type of government record and publication. This is what is meant by saying the English constitution is "unwritten"; it is not formally enacted; its rules have to be sought out in a dozen fields, not in any one code. Similarly, it is flexible, and here the contrast is with a rigid constitution. There are no special safeguards for constitutional rules; constitutional law can be changed, amended or abolished just like any rule of private law; there is no field in which parliament is forbidden to legislate; there are no fundamental or unalterable "norms" and no procedures to prescribe delay or extra processes for constitutional change. Thus an act passed through all its stages in both houses and received the royal assent all in one day (May 22, 1940); it is true that the nation was gravely menaced at the time, but the measure, the Emergency Powers (Defense) act, 1940, required persons to place "themselves, their services and their property at the disposal of His Majesty." Earlier, in Dec. 1936, the Abdication act had the same rapid passage into law; it is doubtful if the institutions of any written constitution would permit of such far-reaching changes with so little formality and fuss. Moreover, since parliament is fully sovereign, it is not open to the courts to declare that an act of parliament is unconstitutional or void; all the courts can do is to interpret acts and enforce them (though it must be added that the process of interpretation can produce results that have on occasion largely stultified the purpose of the act). In *Lee* v. *Bude and Torrington Junction Railway Co.* (1871), a great judge said: "I would observe, as to these Acts of Parliaments, that they are the law of the land, and we do not sit here as a court of appeal from Parliament." The function of the courts is much more limited than in a country where judicial review is a recognized check on legislative activity.

So much, then, for the unwritten, flexible English constitution; why it developed in this way can be answered only by dipping into constitutional history. In the middle ages a strong centralized monarchy slowly and painfully emerged from the remains of the feudal kingdom; it was not perhaps until the time of Henry VII that the monarchy really came into its own. But at the same time the kings had called for and fostered the institution now known as parliament—a development from the feudal great council reinforced by "popular" elements from the counties and boroughs—and the institution in its time was to challenge the crown. By the end of the Stuart period the victory of parliament was assured; the crown lost its more objectionable powers; parliament established its legislative and financial supremacy; and the houses of Orange and Hanover were called in to provide rulers who would accept the new situation. A logical people would have formally transferred the powers of the crown to parliament or to some new organ. In fact the crown was left with most of its prerogatives and was expected to carry on the routine of government; yet for money and legislation, without which it could not govern, it depended on parliament. To fill the gap between the legal "sovereignty" of the crown and the political fact of parliament's supremacy, a new institution, the cabinet (*q.v.*), was called into being. The cabinet consists of the leading members of the party that has a majority in the house of commons and thus can command the support of parliament for its policies. At first, attempts were made to control cabinets in the royal interest but soon the convention of ministerial responsibility grew; this means, in brief, that the sovereign never exercises any of his or her powers without the advice of a minister nor refuses to exercise these powers when a minister advises him to do so. This is well recognized, and thus responsibility for any royal act is always laid at the door of the minister who advised it, not that of the sovereign in whose name it was done. With the doctrine of ministerial responsibility there also developed the parallel doctrine of collective responsibility of the cabinet: it speaks with one voice; each member is fully responsible for the acts of all the others; any member who disagrees with the majority's policy must hold his peace or resign.

In the 19th century the franchise was gradually extended until, in 1928, every man and woman was potentially entitled to a vote at 21. At the same time each of the great political parties acquired an organization, a discipline and a policy that enabled its leaders to count on the unquestioned support of their followers in the house of commons. So long as the cabinet can command its own supporters it enjoys a virtual monopoly of legislative and executive powers, since the royal prerogatives and the parliamentary timetable are at its disposal. It is for this reason that the large legal powers of the crown are tolerable in a political democracy; they are in effect the sinews of party government; and it was this that A. V. Dicey had in mind when he said that the prerogatives of the crown had become the privileges of the people. Since, too, parliament has by and large controlled the crown for 150 years and, more recently, the party has controlled parliament, there has never been any urge to impose limitations or restrictions on the crown's powers. Naturally enough, parliament has not felt moved to put fetters on itself. Hence the absence of the limitation on these legally wide and discretionary powers; public opinion, party feeling, the ballot box are the real safeguards in modern Britain.

It remains to describe in outline the leading institutions of the British constitution and to show their relations one to another.

The Crown.—Title to the crown is now statutory; parliament has changed the succession from time to time, and the British royal house derives its title from the Act of Settlement which limited the crown to the descendants of Sophia, electress of Hanover, being Protestants. Coronation is a religious and civic ceremony but has no legal significance today. The new sovereign's reign begins from the death of his predecessor; in the words of the law "the king never dies." Similarly the king at law was never an infant, and where there was a minority *ad hoc* arrangements were made. Nowadays the minority, incapacity or absence from the country of the sovereign is provided for by the Regency acts of 1937–53, which allow for the appointment of a regent in the case of minority (which ends at 18) or of counselors of state if the sovereign is ill or abroad. The regent or the counselors exercise, with important limitations, the power of the crown.

In theory and in law the powers of the crown—called the prerogatives—are very wide. Walter Bagehot, writing in 1860, startled his contemporaries by enumerating the things that the queen could legally do of her own motion and without anybody's consent. In fact the prerogatives are the sinews of government and have been allowed to survive, substantially undiminished, because the doctrine of ministerial responsibility has made them available to the government of the day, and thus it was convenient, as well as acceptable to a conservatively minded people, to leave them where they were. (*See* PREROGATIVE.)

Socially and politically, however, the more important functions of the monarchy are those that have a popular appeal. The sovereign, and other members of the royal family, frequently pay visits, open hospitals, attend sporting and other entertainments and inaugurate or patronize with their presence a host of national, municipal and local activities. The royal family is the focus of good will in the community; every religious, social or charitable movement can count on its support. In no sphere is this more marked than in relations with countries of the commonwealth. Since the Statute of Westminster, 1931, the legal links between the United Kingdom and the self-governing members of the commonwealth have been practically nonexistent. Each self-governing member is independent of the United Kingdom both internally and internationally; yet all are united by a common allegiance to the crown, and it is the crown as a symbol of a common allegiance that binds the countries of the commonwealth together more closely and more effectively than any formal or legal ties. When India and Pakistan adopted republican forms of constitution, they continued to recognize the queen as head of the commonwealth, membership of which they retained.

The crown is the formal legal institution; in it and through it all the prerogatives are exercised; it is an essential part of parliament; it is the executive ("her majesty's ministers," "her majesty's civil service," "her majesty's prisons," "the Royal Navy" are not empty phrases but correctly describe the legal status of the bodies or institutions to which they refer); the courts are the sovereign's courts, and justice is administered in her name by her judges. Yet the monarchy is something real and personal to every citizen, and the activities of the royal family are followed with interest, affection and often enthusiasm throughout the English-speaking world and beyond.

The Legislature.—The legislature or, more properly, the king or queen in parliament consists of the sovereign, the house of lords and the house of commons. The sovereign's part is today largely formal and normally undertaken wholly on ministerial advice. The royal proclamation dissolves one parliament and summons another. The sovereign can, and often does, open the new session in person by reading the royal speech. This sets out the government's proposals and policy, but it is in the first person and reads as if the proposals and policies were the sovereign's. The royal assent is necessary to every bill before it becomes a statute and so achieves the force of law. This is usually given by commissioners specially appointed by the queen to assent in her name, but there is no reason why a sovereign should not assent in person, and George VI did give his assent personally to various Canadian statutes on the royal visit to Canada in 1939. (For the composition, general functions and privileges of the house of lords and of the house of commons, *see* PARLIAMENT; for the process of legislation, *see* GREAT BRITAIN: *Constitution.*)

Finally, in addition to legislation and finance, the commons, and to a lesser extent, the lords, are important because they provide means whereby public opinion can be focused and pressure brought to bear on the government. A debate in either house, a motion on the adjournment, a series of questions can have important results in modifying or even changing government policy. Members of parliament constantly visit their constituencies; their ears are to the ground; they are the targets of all sorts of "pressure groups" and organized interests. By these means they can and do reflect the state of feeling and opinion in the country, and they, in their turn, get this across to the government. A seemingly inconsequential debate, in which member after member said the same thing, or a question, ostensibly repeated in slightly different forms time and again, are far more important than the casual observer would suppose. It is in these ways that public opinion makes itself felt and the workings of government are kept, in some sort, in harmony with democratic processes.

The Executive.—The king or queen in council is the head of the executive. Some functions of the crown can be exercised orally; others require a formal legal document, such as an order in council, letters patent or the fixation of the great seal. These formal matters are considered in the privy council (*q.v.*), a body of great antiquity and descended, in some sense, from the witan of the Saxon kings. Historically it has always been the duty of the crown to seek counsel and of the great in church and state to tender it. Under the Normans the king's council consisted of the archbishops, bishops, abbots, earls and barons and also a number of officials, clerks and royal officers, all of whom owed their place to the king and who, following him on the various royal progresses through his possessions, constituted his household. Soon a struggle developed between the feudal element (the baronage) and the "familial" element or officials. While the claim of the baronage to attend the council was never formally abandoned (and today the house of lords has aspects that show its origin as a council), the kings soon established their right to summon whomever they pleased to the council, which became a small body of great officials and royal favourites in constant attendance on the king. When English terms came into use, this body became known as the privy (or private) council to distinguish it from the great council (now the house of lords), which met in public. It remains, legally, the source of all formal royal acts; but since the evolution of the cabinet, its political functions have declined, and it is no longer an advisory body. Policy decisions are taken in the cabinet; the formal steps necessary to carry such decisions into effect are taken in the privy council.

Today membership is regarded as a great honour and is conferred on statesmen (from the commonwealth as well as from the United Kingdom) and on judges and other high officials. The body consists of between 200 and 300 members, but in practice the full council never meets, and only the two or three members particularly concerned with the business to be transacted attend. The sovereign is always present and the lord president of the council; and if, for example, foreign and colonial affairs are in issue, the foreign secretary and the colonial secretary will also be there. All cabinet ministers are sworn members of the privy council.

From the council all the great historic offices of state are descended. The office of lord high chancellor, the treasury and the admiralty go back in an unbroken line to the middle ages. The secretaryship of state and the lord president of the council date from the Tudor period; they were the instruments through which the Tudor monarchs modernized the medieval system of government. The board of trade and the ministries of education and agriculture were originally committees of the privy council that grew in importance and became separate departments. Most of the other departments, now called ministries, are of more recent origin and depend for their creation and function on a statute. For an account of the central government departments, *see* GOVERNMENT DEPARTMENTS. For the list of officials who staff them, *see* CIVIL SERVICE. For the power and forms of governmental authority, *see* PRIVY COUNCIL; PREROGATIVE.

The cabinet, already briefly mentioned, is the mainspring of all governmental activity and is one of the great contributions of Great Britain to political institutions. It is presided over by the prime minister (*q.v.*), who is the head of the administration.

The Judiciary.—Constitutionally the importance of the judiciary lies in its independence so that it can act as an impartial mediator between the citizen and the state. Judges of the high court enjoy office during good behaviour and are only dismissible on an address voted by both houses of parliament; no judge has ever been removed under this procedure. Their salaries are paid out of the Consolidated fund and are not subject to ordinary executive control. They cannot be criticized in parliament unless a member is prepared to go to the length of putting down a substantive motion. They enjoy a wide immunity from actions in respect of words spoken by them or things done on their orders in the course of their duties. Similar, though not quite so extensive, immunities are enjoyed by the judges of the lesser courts.

All this has created a tradition and a climate of opinion in which the independence of the judges is regarded as almost a fundamental dogma. Any attempt to interfere with any judicial process or to hinder a judge in the execution of his duties would cause a tremendous outburst of popular indignation. Perhaps the most important aspect of this tradition today is that, taken by British judges to the overseas possessions of the crown, it has helped to implant high standards and to impart a feeling of confidence and impartiality in lands where British justice is an alien importation.

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UNITED STATES

Origins.—The constitution of the United States was written in Philadelphia during the summer of 1787 by a convention of 55 delegates and, after ratification by the necessary number of states, went into effect on March 4, 1789. (For the text *see* UNITED STATES (OF AMERICA): *Administration and Social Conditions.*) It was a product of historical experience. For one thing, its authors drew heavily upon the constitutions which the various individual states had adopted in the years immediately following the Declaration of Independence (*q.v.*). These important documents summarized in constitutional language the prevailing political philosophy of the age, and particularly the idea that governmental power must be limited if the liberty of the citizen is to be secure. The separation of the legislative, executive and judicial branches of the government (see *The Separation of Powers,* below), the checking and balancing of each against the others and the spelling out of guarantees of individual liberty in bills of rights were all designed to find a balance between authority and liberty. This remains the central purpose of American constitutional law.

Furthermore, the authors of the United States constitution were heavily influenced by the experience of the country under its first written national constitution, the Articles of Confederation (*q.v.*). Dating from 1781, this short-lived document attempted to retain intact as much of the independence and sovereignty of the states as possible and at the same time establish a central government to carry out functions of national importance which the states could not handle individually. Perhaps the greatest lesson of the period 1781–87 was that this could not be done, for it was clear that under this confederate arrangement the national government lacked many essential powers: it had no independent taxing power and was obliged to beg from the states by a system known as requisitions; it could not regulate interstate and foreign commerce and was thus unable to safeguard vital national interests; it could enact laws on a limited number of subjects but had no powers of direct enforcement, thus being required to rely upon the state governments. Being weak, the national government was ineffective in the important field of foreign affairs. At home it was unable to restrain various types of economic radicalism then rampant in many states. In addition, the national government lacked adequate institutions under the Articles of Confederation, since about all these created was a congress. There was no chief executive and no national judiciary. Finally, since the Articles of Confederation could be amended only by the unanimous vote of all the states, it quickly became apparent that the document was in fact unchangeable. This soon spelled its doom and invited the writing of an altogether new document.

In many ways the constitution was a product of compromise on the part of the hardheaded realists who wrote it. The heated quarrel over representation in the new congress, which brought the convention to the brink of failure, was compromised by giving the states equal voting power in the senate to satisfy the demands of the small states and representation in the house of representatives according to population to satisfy the large states. The dispute over the counting of slaves in computing population was resolved by the three-fifths clause (art. i, sec. 2, now obsolete), and that over the commerce power by the prohibition of export taxes. While the compromises of the convention are generally stressed, the area of agreement upon some of the central and immediate issues of the times was far more significant than the area of disagreement. The necessity of a strong national government endowed with adequate powers and institutions was recognized, and it was agreed that the rights of private property must be protected from the inroads of agrarian radicalism: hence the prohibition of state-issued paper money and the protection of contracts against impairment by local legislation (i, 10).

The Constitution as a Document.—Under the United States constitution, the oldest written national constitution in operation in the world, the country grew and prospered and remained united, and the basic rights of man proved to be secure, in spite of all the profound changes, economic, social, cultural and political, which occurred after 1789. Many factors explain the continuing vitality of this 18th-century document. In contrast with some prolix state constitutions which are loaded down with provisions designed to appease temporary sentiments or interests, it is a brief and well-written document of about 7,000 words, confined to the enunciation of basic, permanent principles in broad and generous terms. The U.S. constitution does no more than organize basic political institutions: it describes the framework of government concisely, leaving the details to legislative action, and the door is left open for change and adaptation through usage and interpretation. It also limits all government by guarantees of individual liberties and provides for a workable method of amendment, thus allowing for future alterations.

Another reason for the constitution's success is that it was rooted solidly in historical experience, containing little when written that was experimental or new. Its authors drew their ideas from English law and practice, from colonial experiences, from the state constitutions and the Articles of Confederation and did not borrow from sources unrelated to their experience. In a real sense, the constitution was an outgrowth, and indeed the climax, as man's most recent victory in the ancient struggle for liberty, of the great traditions of the English common law. It was not imposed by a foreign power or dictated from above by a ruler, nor was it, as with many later constitutions, the product of military defeat. It was an act of free will, a triumph of human reason, so it seemed, in an age of European turmoil, a symbol of good government in that great epoch of modern political reconstruction. The document also served as a powerful centre of loyalty, in a pluralistic nation of nations, for the diverse peoples who make up the U.S. population.

Judicial Review.—The constitution is, in the last analysis, interpreted by the courts, the United States supreme court acting as the final court of appeal from the state courts and the lower federal courts (*see* SUPREME COURT OF THE UNITED STATES, THE). Strictly speaking, the constitution means what the judges say it means, as Charles Evans Hughes once said, and U.S. constitutional law consists of a vast body of judicial rulings interpreting the constitution. But in a broader sense, the constitution acquires meaning at the hands of all who use it. Thus congress on innumerable occasions has given new scope to the document through the enactment of statutes, such as those creating the great executive departments, the federal courts, territories and states, or those controlling succession to the presidency or those setting up the executive budget system. The chief executive likewise has contributed to constitutional interpretation over the years, as in the development of the executive agreement as an instrument of foreign policy. Furthermore, many key elements of U.S. government which in fact rise to the dignity of constitutional arrangements

are mainly a matter of custom, existing outside the letter of the constitution altogether. The English call these customs and usages "conventions" of the constitution. Perhaps the best example of an American constitutional convention is the system of political parties, with their elaborate organization and procedures for the fighting of campaigns. The presidential cabinet is largely conventional, as is the actual operation of the electoral college system. Very little indeed would be learned from a mere reading of the document about how the president is actually nominated and elected.

The power of U.S. courts to rule on the constitutionality of legislation, and to refuse to enforce legislation which in their judgment violates the constitution, has come to be known as judicial review (*q.v.*). Few courts in the world have this extraordinary power. Thus a statute passed by parliament may indeed violate the constitution of the realm, *e.g.*, a gross statutory invasion of free speech, but no English court has the right to refuse to enforce it on constitutional grounds. Parliament is sovereign; but in the United States the constitution, as construed by the courts and as the embodiment of the will of the whole people, is sovereign. This great power is, however, not explicitly mentioned in the constitution and is itself a product of judicial construction. While prerevolutionary state appellate courts had occasionally exercised the power of judicial review, the definitive assertion regarding federal judicial review was made by the U.S. supreme court in 1803 in *Marbury* v. *Madison*. Here Chief Justice John Marshall reasoned that since the constitution is the supreme law of the land (it says as much in art. vi), and since it is the province of the court to uphold the law, it follows that when a statute is inconsistent with a provision of the constitution the latter must be preferred to the former because it declares the law of superior obligation. Without judicial review, he argued, a written constitution would be quite futile as a means of limiting the abuses of governmental power.

While the supreme court possesses the ultimate power of declaring federal and state legislation invalid on constitutional grounds, it has exercised it with great restraint. Only about 80 federal statutes had by the early 1960s been so declared, though the number of state statutes held invalid was much larger. The court will exercise this power only if necessary to decide cases and controversies and will not, as a few state courts will, give mere advice to congress or the executive in the form of advisory opinions. Judicial review, therefore, always grows out of concrete litigation where the rights of adversary parties are actually involved. Furthermore, the supreme court imposes a number of its own restraints upon the exercise of judicial review. It always begins with the assumption that the legislative body did not intend to violate the constitution when it adopted the challenged statute. Therefore the burden of proof rests upon the party who questions the validity of the statute. If the court can possibly decide the case without ruling on the constitutionality of the statute, it will prefer to do so; it comes to constitutional questions last, not first, and seeks to dispose of cases on minimal grounds. If a statute is susceptible of any reasonable interpretation which will save it, the court will adopt that interpretation. In cases of reasonable doubt, the constitutionality of legislation will be upheld. The court will not hold a statute invalid on such vague grounds as that it violates natural justice, or the spirit of the constitution or the principles of republicanism.

The court takes a strict view of the question of who is eligible to raise constitutional questions to litigation: to be able to sue in court, a party must have a direct and substantial interest at stake. Thus it was held that a mere citizen and lawyer has insufficient interest to question in court the qualifications of a particular justice for his office (*Ex parte Levitt,* 1937). A mere taxpayer qua taxpayer does not have sufficient interest in the United States treasury to attack in court the validity of a federal appropriation act (*Frothingham* v. *Mellon,* 1923). This rule, which bars federal taxpayer suits, closed the door to a possible flood of litigation which would have been most embarrassing to the government. Further, a statute may be assailed only by one who relies upon an alleged invasion of his own constitutional rights; one does not have standing to sue in behalf of others.

Finally, the thrust of judicial review is limited by the doctrine of the political, nonjusticiable question. Certain questions arising under the constitution are regarded by the court as being political in character and therefore outside the scope of judicial action. For example, the constitution (iv, 4) declares that "The United States shall guarantee to every State in this Union a Republican Form of Government." But it was early decided (*Luther* v. *Borden,* 1849) that whether a particular state government is republican in form is for the political branches of the government, *i.e.*, congress and the president, to decide, not the courts. Similarly, the president's duty to see to the faithful execution of the laws is political and therefore not subject to judicial process (*Mississippi* v. *Johnson,* 1867).

Many military questions, such as the necessity for calling out the militia, and foreign policy questions, *e.g.*, whether the government has recognized a particular foreign government or international boundary or treaty, are considered political in character and therefore nonjusticiable.

The Separation of Powers.—The framers of the constitution accepted it as an unchallengeable maxim that the only way to avoid governmental tyranny is to put the legislative, executive and judicial powers in separate departments. This the constitution does in the so-called distributive clauses, declaring that all legislative powers shall be vested in the congress (i), stating that the executive power shall be vested in a president (ii) and placing the judicial power in the hands of the courts (iii). The separation of powers is not only a political theory about the proper organization of government but also a doctrine of constitutional law. It is in accordance with this principle that the courts decline to perform nonjudicial functions and that the exercise by congress of nonlegislative functions in connection with legislative investigations tends to be judicially censured.

Since the legislative power is vested in congress, the lawmaking power as a whole cannot be delegated to the president. It was on this theory that the court in 1935 invalidated the National Industrial Recovery act (NIRA), holding that the code-making authority given the president vested in him a virtually unfettered discretion to make law (*Schechter Poultry Corp.* v. *United States*). This was an unusual holding, since government without large-scale delegations is quite impossible, and as Chief Justice Hughes said in the case, the court had "repeatedly recognized the necessity of adapting legislation to complex conditions involving a host of details with which the national legislature cannot deal directly." This is well illustrated in the great regulatory commissions, such as the Interstate Commerce commission (ICC) and the Federal Communications commission (FCC), established by congress to deal with exceedingly complex and rapidly changing sectors of the economy. All of these agencies operate under the authority of broad delegations of power by congress and necessarily exercise legislative and judicial, as well as administrative, functions (*see* COMMISSION; REGULATORY AGENCIES).

The steady growth in the power and prestige of the office of president (*q.v.*) became a leading feature of U.S. constitutional government in the 20th century. Contrary to 18th-century assumptions about the separation of powers, the president takes the initiative in proposing legislation, and, indeed, his record as chief executive is more likely to be judged by the success of his legislative program than by any other event. The president possesses vast delegated legislative powers given him in a multitude of statutes. Nevertheless, there are limits to what the president can do, dramatically illustrated in the 1952 holding of the supreme court that Pres. Harry S. Truman's seizure of the steel mills, without statutory authorization, to avoid a strike during the Korean War, was illegal (*Youngstown Sheet & Tube Co.* v. *Sawyer*). The court ruled that since congress could have authorized the seizure under its various powers, in acting without permission of a statute the president usurped legislative power in violation of the separation of powers principle. It rejected the contention that the president could seize private property under his authority as commander in chief and as chief executive (ii), his power being only to enforce the laws, not to make them. The

constitution clearly vests the lawmaking function in congress, and while congress undoubtedly has the authority to authorize the taking of private property for public use under its power of eminent domain, "the constitution did not subject this law-making power of congress to presidential or military supervision or control."

The Federal System: National and State Powers.—A central fact of the U.S. constitution is that it creates a federal system (*see* also FEDERAL GOVERNMENT), under which the powers of government are divided between the national government and the states. This constitutional arrangement is binding upon both parties and not subject to formal change by the national government acting alone. In a true federal system the powers of the local governments are not at the daily mercy of the central government but are derived from a constitution which is equally the source of national powers. The national government has those constitutional powers which are delegated to it; the states, unless they are otherwise restricted, possess all the remaining powers of government (10th amendment). Thus national powers are enumerated, whereas state powers, which are often referred to as the residual powers, are not. Both the national and state governments have a full array of executive and judicial agencies to enforce the laws of their respective legislative bodies. Each has the power to make and enforce its own laws in its own way, though by the second half of the 20th century there had developed a steady growth of co-operation between them in the accomplishment of common purposes, as in the case of the wide variety of social services covered by the grant-in-aid system. All citizens, under the 14th amendment, possess dual citizenship, being simultaneously citizens of both the nation and the state in which they reside. Each citizenship carries with it a bundle of rights and obligations.

While the national government is limited to its enumerated powers, several important facts about these powers must be noted: (1) The national constitution, and statutes and treaties adopted pursuant to it, constitute, in the language of art. vi, "the supreme Law of the Land; . . . any Thing in the Constitution or Laws of any State to the Contrary notwithstanding." This means that any state law, otherwise valid, must yield if contrary to a valid federal law, since the latter is the supreme law of the land. (2) While the national government is limited to the exercise of enumerated powers, these powers are spelled out in broad terms, and the "elastic" clause (i, 8) states that congress shall have the authority "To make all Laws which shall be necessary and proper for carrying into Execution" the various powers vested in the national government by the constitution. It follows that in addition to the specified powers, congress possesses implied powers, a proposition definitively established by Chief Justice John Marshall in the celebrated case of *McCulloch* v. *Maryland* (1819). Here the supreme court held that congress had the power to incorporate a national bank, in spite of the fact that the constitution is silent on both the creation of corporations and the chartering of banks. It was concluded that since a national bank would facilitate the accomplishment of purposes confided to the national government, such as the collection of taxes and the maintenance of armed forces, congress had a choice of means to achieve these proper ends. "Let the end be legitimate," said the chief justice, "let it be within the scope of the constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist with the letter and spirit of the constitution, are constitutional." This doctrine of implied powers became a powerful force in supplying the constitutional basis for the steady growth, over the years, of national power. (3) In the field of foreign affairs the doctrine of enumerated powers breaks down almost entirely, since the supreme court takes the view that whether enumerated or not, the national government, from the very nature of things, has full responsibility over foreign affairs and has the inherent power to do all things which sovereign nations customarily do in this area. Thus the court early took the position that the national government has unlimited power to exclude aliens from the country, and very wide authority to deport them, on any terms it desires, though the constitution says not a word on this subject (*see* ALIEN). In the *Chinese Exclusion* case (1889) the court said: "While under our constitution and form of government the great mass of local matters is controlled by local authorities, the United States, in their relation to foreign countries and their subjects or citizens, are one nation, invested with powers which belong to independent nations, the exercise of which can be invoked for the maintenance of its absolute independence and security throughout its entire territory." And Justice Stephen Field added: "For local interests the several states of the union exist, but for national purposes, embracing our relations with foreign nations, we are but one people, one nation, one power." In fact, in 1936, in a decision upholding an arms embargo, the court went so far as to say that in contrast with the enumerated powers exercised internally, the federal powers of external sovereignty do not even depend upon affirmative grants of the constitution, though of course some of these powers, but by no means all of them, are enumerated (*United States* v. *Curtiss-Wright Export Corp.*).

Whether the national government or the states have overstepped the boundaries of their constitutional authority is ultimately a legal question for the supreme court to decide, if the issues can be brought to it in proper litigation. In this sense the supreme court may be said to be the umpire of the federal system. It has on occasion declared acts of congress invalid as invading the reserved powers of the states, and it has often held state laws unconstitutional as being contrary to the supreme law of the land. Nevertheless, though the supreme court is the umpire of the federal system, it is chosen by only one side; it is a national, and in no sense at all a state, institution, and on the whole its leanings are toward the national position. While the court was states-minded during some periods, as during the chief justiceship of Roger B. Taney (1836–64) and in the period 1933–36, for the most part it was willing, in the course of U.S. history, to sanction an ever-expanding conception of national power. This was especially true after 1937, when the court began to uphold leading New Deal reform and regulatory measures. Thus, while the constitution cannot be formally changed without the concurrence of the states, if congress passes a law, and the president signs it and the supreme court holds it constitutional, there is, as a matter of law, no way of questioning the validity of the new enactment. As part of the supreme law of the land it is binding upon the states, whether or not they agree that it falls within the proper scope of the national government.

In still another sense the supreme court is the umpire of the federal system, for it is given original jurisdiction by the constitution (iii, 2) over disputes between the states. The last recourse a state has in such circumstances is to sue in the supreme court, and by the late 1950s every state in the union but one had been at least once a plaintiff or defendant in such lawsuits, involving such difficult questions as boundaries, debts, water rights and water pollution. The court performs an important function in successfully adjudicating disputes, which might lead to the use of force in the case of independent nations similarly involved.

Federalism and the Commerce Clause.—The competing concepts of federal supremacy and states' rights were brought early in U.S. history into sharp focus in the field of commercial regulation. The commerce clause (i, 8) of the constitution simply authorizes congress "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." In the formative years of the republic the supreme court took a broad view of national power under this clause, as in the seminal case of *Gibbons* v. *Ogden* (1824), which held that the power of congress over commerce includes navigation. As new methods of interstate transportation and communication came into use, ranging from the stagecoach, the railroad and the telegraph line to the ticker tape, trucking, radio, the airplane and television, the court interpreted the national power to keep pace with the times.

But on occasion the supreme court followed a theory of dual federalism, later abandoned, according to which the mere existence of states is regarded as interposing an independent limitation upon the exercise of the powers duly delegated to the national government; *i.e.*, the national government is supreme only to the point

where reserved state power might be invaded. To put it differently, the 10th amendment, in this view, was regarded as a judicially enforceable limitation on the supremacy clause. Perhaps the most famous examples of the use of the doctrine of dual federalism were two child labour cases, *Hammer* v. *Dagenhart* (1918) and *Bailey* v. *Drexel Furniture Co.* (1922), in which the supreme court invalidated acts of congress which barred the products of child labour from the channels of interstate commerce and which taxed the net profits of the employers of such labour. The dual federalism doctrine reached its high-water mark during the years 1933–36, when the court held unconstitutional a significant portion of the early New Deal legislation, as in the invalidation of the Guffey Coal act (*Carter* v. *Carter Coal Co.*, 1936) and the Railroad Retirement act of 1934 (*Railroad Retirement Board* v. *Alton Railroad Co.*, 1935). The theory of dual federalism was, however, abandoned by the court in 1937, when it upheld the National Labor Relations act, the amended Railway Labor act and other New Deal statutes. The court began to hold, in effect, that in the exercise of its delegated powers the national government is supreme, as the supremacy clause says, so that as far as these powers go there are no states' rights. Perhaps the best example of this reassertion of the national supremacy doctrine was the case (*United States* v. *Darby Lumber Co.*, 1941) upholding the Fair Labor Standards act of 1938, which statute fixed minimum wages and maximum hours for all employees engaged in the production of goods for interstate commerce. The commerce clause, the court said a few years later, was not designed "to render the nation powerless to defend itself against economic forces that congress decrees inimical or destructive of the national economy. Rather it is an affirmative power commensurate with the national needs. It is unrestricted by contrary state laws or private contracts." (*North American Co.* v. *S.E.C.*, 1946.)

Nevertheless, the court did not regard the commerce power as being exclusively national, the states being up to a point conceded the right also to regulate interstate commerce. The problem was to locate the point. After considerable fumbling the court hit upon a formula (*Cooley* v. *Board of Wardens of the Port of Philadelphia*, 1851). Upholding state regulation of pilotage, the court ruled that the states may regulate those aspects of interstate commerce which congress has not attempted to regulate and which do not "imperatively [demand] a single uniform rule" for the whole country. Where congress has been silent and diversity of treatment is desirable, the states enjoy the power of concurrent regulation; but where uniformity of treatment is imperative, the power of congress is "exclusive." The application of this formula was, following its enunciation, the subject of an immense number of decisions. Under it the court sustained a wide variety of state tax and regulatory measures as applied to interstate commerce. In the absence of federal legislation, for example, and in the interests of safety and economy, a state may go a long way in regulating interstate highway traffic, for this is of peculiarly local concern. The tax measures involving a wide variety of state imposts on the sale, use or storage of goods which were shipped interstate before or after the taxing event were similarly sustained.

But it is familiar doctrine that a state may not regulate an aspect of interstate commerce at all if congress has pre-empted the field. To the extent that congress has stated a policy, state legislation which is inconsistent with it is invalid. However, unless congress spells out its purpose of pre-empting a field by specific language, which it rarely does, whether or not federal legislation occupies a field to the point of excluding state legislation is a matter for the court to decide, and this question has accordingly come up many times, especially in cases involving labour relations. In balancing competing local and national needs in commerce, the supreme court exercises a wide discretion. The applicable legal formulas are broad and ill-defined, and the justices have ample scope for the consideration of the equities of the public policy questions which the cases present.

The Guarantee of Individual Rights.—The national government is obliged by many provisions of the constitution to respect the basic rights of man. (For a detailed discussion of these rights *see* CIVIL LIBERTIES; NATURAL RIGHTS.) Some civil rights limitations were imposed on this government in the original document, notably in the provisions guaranteeing the writ of habeas corpus and forbidding bills of attainder (legislative trials) and ex post facto laws, (i, 9) and guaranteeing trial by jury in criminal cases (iii, 2). But the most significant limitations of this character upon the national government were added in 1791 with the ratification of the first ten amendments, the Bill of Rights (*see* BILL OF RIGHTS, UNITED STATES). Here are guaranteed basic rights of conscience, such as freedom of religion, speech, press and petition; fundamental guarantees of fair procedure for persons accused of crime, such as protection against unreasonable searches and seizures, compulsory self-incrimination and excessive bail, a speedy and public trial by a local, impartial jury before an impartial judge and representation by counsel; and rights of private property, as in the provision that private property shall not be taken for public use without just compensation.

For the protection of such rights as these against state, as opposed to federal, action, the citizen originally had to look to the state constitution, each state constitution possessing a more or less elaborate bill of rights enforceable by the state courts. But an important new federal limitation on the states was added to the national constitution with the ratification, in 1868, of the 14th amendment, by which the states are forbidden to deny any person life, liberty or property without due process of law or to deny to any person the equal protection of the laws (*see* also DUE PROCESS). By a process of interpretation at the hands of the supreme court these two clauses took on increased meaning.

The liberty which the due process clause of the 14th amendment guarantees against state action has been held to include the liberties of religion, speech and press which the 1st amendment protects against violation by the national government. Similarly, some of the guarantees of a fair trial in other parts of the federal Bill of Rights, such as the defendant's right to an impartial judge and the assistance of counsel, have also been judicially absorbed into the 14th amendment. Indeed, a minority of supreme court justices argued that the 14th amendment was intended to incorporate as limitations upon the states all the provisions of the federal Bill of Rights. But a majority of the court clung to the position that not all of the guarantees of the federal Bill of Rights are so fundamental to justice that they are required by due process of law. Thus, to cite an early example, the 5th amendment guarantee of indictment by grand jury was held inapplicable to the states (*Hurtado* v. *California*, 1884), and in fact most states abandoned this type of indictment in favour of allowing the public prosecutor to bring criminal charges. A number of the purely procedural guarantees of the federal Bill of Rights have been held inapplicable to the states, although they of course bind the agencies of the national government.

The other great limitation on the states in the 14th amendment, that no state shall deny any person within its jurisdiction the equal protection of the laws, has a long and important history in U.S. constitutional law. Thus over the years the supreme court has set aside many criminal convictions of Negroes on the ground that the state courts which convicted them arbitrarily and systematically excluded Negroes from their juries, this being construed as a denial of equal justice to members of the excluded group. By all odds the most spectacular and controversial application of the equal protection clause came on May 17, 1954, when the court ruled that states which segregated white and Negro children in the public schools violated the constitution (*Brown* v. *Board of Education*). In so ruling the court set aside the 1896 ruling (*Plessy* v. *Ferguson*) that "separate but equal" facilities satisfied the command of the 14th amendment, holding by unanimous vote that separate educational facilities, by creating feelings of inferiority, are inherently unequal. After a year of further study the court fashioned a decree which ordered that racial integration in the public schools should be handled at the local level by the federal district courts, which were directed to take local conditions into account and to proceed, in the classical language of equity, with all deliberate speed.

It remains to be noted that none of the great constitutional rights of conscience, however vital to a free society, is absolute

in character. Thus, while the constitutional guarantee of freedom of religion goes a long way, it does not serve to protect acts judged to be morally licentious, such as polygamous marriages. Children cannot be required to execute a flag salute which is forbidden by religious belief (*West Virginia State Board of Education* v. *Barnette*, 1943), but parents are not free to ignore child labour laws on the ground of religious practice (*Prince* v. *Massachusetts*, 1944). Similarly, freedom of speech, often defended by the courts, does not extend to the seditious utterances of a conspiracy which, in the considered opinion of congress, poses a clear and present danger to the safety of the republic (*Dennis* v. *United States*, 1951). But the court has emphasized that the act of congress on this subject, the Smith act, does not forbid mere advocacy of abstract doctrine but only incitement to action designed to accomplish the illegal purpose of overthrowing the government (*Yates* v. *United States*, 1957). The state is not free to license the privilege of giving a speech (*Thomas* v. *Collins*, 1945), but it may punish utterance of "fighting words" which may lead to breaches of the peace (*Chaplinsky* v. *New Hampshire*, 1942) or the publication of obscene matter (*Roth* v. *United States*, 1957).

There was much concern at mid-20th century with the rights of persons accused of crime. The right of an indigent defendant to representation by counsel has been judicially underscored, and the courts appeared increasingly meticulous to safeguard the right to reasonable bail and the right to a fair trial, including a public, speedy trial before an unbiased judge and a jury free of mob domination. The uses of the writ of habeas corpus were steadily expanded. Some rights, such as the privilege against self-incrimination, came under heavy public fire, but the proposition that no one should be compelled to testify himself into jail retained its vitality in U.S. courts. Everywhere, in criminal cases, the burden of proof remained on the prosecution, and the accused carried with him the presumption of innocence.

Taxation.—The constitution delegates to congress an extremely broad power "To lay and collect Taxes, Duties, Imposts and Excises" (i, 8). It forbids congress to tax exports and requires that direct taxes must be apportioned among the states according to population (i, 9). When the supreme court ruled in 1895, contrary to a century of precedent, that taxes on incomes derived from property were in contemplation of law direct taxes, thus invalidating the federal income tax law of 1894 (*Pollock* v. *Farmers Loan & Trust Co.*), the decision was set aside by the ratification in 1913 of the 16th amendment. This relieves congress of the necessity of apportioning income taxes. Whether congress may use its taxing power for regulatory purposes has long been an issue, and occasionally a federal tax has been set aside on the ground that its purpose is not fiscal but is designed to accomplish a purpose which is within the range of state power, as previously noted in the child labour tax case. But such decisions were extremely rare, since almost all taxes have nonfiscal purposes, and accordingly a wide variety of federal taxes having regulatory purposes were approved by the court, such as taxes on narcotic drugs, gambling devices and firearms and the social security taxes. The classic example, of course, was the tariff, the primary historic purpose of which was to protect U.S. economic interests from foreign competition and not simply to raise revenue.

The principal federal constitutional limitation on the taxing power of the states is derived from interpretation of the due process clause of the 14th amendment, the court having ruled that the provision that no state shall deny to any person his property without due process of law means that a state may not levy taxes for nonpublic purposes. But the court is extremely reluctant to dispute with the states as to what constitutes a public purpose, and very few state taxes were ever invalidated on this vague ground. The due process clause was also construed to mean that the states are free to tax persons and property only when they are within the jurisdiction of the taxing authority. It is considered an unreasonable taking of property for a state to levy a tax upon property outside its jurisdiction, since the state does nothing for the protection of such property. Complicated jurisdictional issues tend to arise particularly in connection with the administration of income and estate taxes, and speaking generally, the court leans in the direction of giving the taxing power of the states the widest possible scope.

Constitutional Amendment.—The procedure for amending the United States constitution is outlined in art. v. Amendments may be proposed by a two-thirds vote of both houses of congress or by a convention called by congress on the application of the legislatures of two-thirds of the states. No such convention had by mid-20th century ever been convoked, all amendments having been initiated by congress. The amendment thus proposed must be then ratified either by three-fourths of the state legislatures or by conventions in as many states. It is for congress to decide which of the two methods of ratification shall be used. Only the 21st amendment (1933), repealing the 18th, or prohibition, amendment, was submitted, under the terms in which it was drafted, to the convention method of ratification.

Only 24 amendments had by the mid-1960s been added to the constitution since 1789, but since the first ten amendments, which constitute the Bill of Rights, were submitted and ratified (1791) at the same time, and were numbered separately only for purposes of electoral convenience, it could hardly be said that the constitution had in fact been amended 24 times. It would be more accurate to say that it was amended on only 15 occasions. Furthermore, the 11th amendment, which forbids suits against states in federal courts, and the 12th, which corrected an error in the original operation of the electoral college, were purely technical in character, and the 21st amendment merely canceled out the 18th. The most far-reaching were the 13th, 14th and 15th amendments, adopted as a direct consequence of the Northern military victory and occupation of the South in the American Civil War, which imposed important new restraints upon the states.

If a state legislature ratifies a proposed amendment, the supreme court ruled, it may not reconsider its vote later and vote against it; but if the legislature votes against the proposed amendment, it is free to reconsider and vote in favour of it (*Coleman* v. *Miller*, 1939). One reason given is that the constitution speaks only of ratification, but perhaps a better reason is that the court believes that such questions are political and therefore within the control of congress. If congress wishes to accept a ratification or chooses to ignore a legislature's change of mind, the court believes there is nothing that it can with propriety do about it. Furthermore, congress began the practice, when it submitted the 18th amendment, of stipulating that it must be ratified within seven years, and continued this practice subsequently, except in the 19th (or woman suffrage) amendment, the 23rd, which gives the District of Columbia presidential electoral votes, and the 24th (poll tax) amendment. While art. v is silent on this subject, the court ruled that the power to fix time limits is a fair inference from its language, since submission and ratification are successive stages of a single process (*Dillon* v. *Gloss*, 1921).

See also references under "Constitution and Constitutional Law" in the Index.

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(D. FE.)

CONSTITUTION OF ATHENS, a treatise by Aristotle (*q.v.*) or a member of his school, composed at some date be-

tween 329 and 322 B.C., being one of the 158 *Constitutions* collected by him in his later life. Though extant in late antiquity, it was then lost till 1890, when a papyrus copy, not quite complete, was acquired in Egypt for the British museum, and published by F. G. (later Sir Frederick) Kenyon.

Date and Authorship.—The British museum's text was composed after 329, since ch. 54, 7 dates a recent change to the archonship of Cephisophon (329–328); but before 322, since the democratic constitution, abolished after Athens' surrender to Antipater in that year, is throughout assumed to be in normal operation. It was thus written during Aristotle's second stay in Athens. It is certain, from quotations and references in extant authors, that this treatise is to be identified with the work known from at least the 3rd century B.C. as Aristotle's *Constitution of Athens;* there remains a possible doubt how far it is a work of his school or of Aristotle himself.

It differs in style from his other works, but these were not meant for general circulation, whereas the *Constitution,* for all its imperfections, seems to be written for a wider public. There are undeniable contradictions between it and the *Politics,* written some time earlier, and most historians think the *Constitution* wrong in fact in the most striking of these discrepancies; *i.e.,* between *Constitution of Athens* 8, 1 which states that Solon introduced the appointment of archons by lot, and *Politics* 1274a which says that Solon did not disturb the existing method of selection. But this is not decisive, and the two works are similar in their general outlook and in the topics they discuss: it may be noted that the statement in *Politics* 1304a, that the Areopagus tightened the constitution as a result of the prestige it had obtained during the Persian Wars, was hardly even intelligible till *Constitution of Athens,* 23, 1–2 was available to explain how the Areopagus saved the situation before the battle of Salamis, and so gained influence without any formal change in the constitution.

The serious doubts are based on the character of the work in general: the inadequacy of parts of it, the odd proportions of the narrative, the trivial anecdotes, and some undoubted errors of judgment have been thought unworthy of Aristotle. But there is serious matter in the *Constitution,* and anecdote enough in the *Politics* and elsewhere, and some inequalities could be due to Aristotle's special interests. The grounds for questioning his authorship are not compelling.

Contents and Sources.—The first part (ch. 1–41), a narrative of constitutional developments down to the democratic restoration of 403, ends with a summary list of 11 principal changes. This list, with the bald epitome of Heraclides (an author, otherwise unknown, who preserved excerpts from the *Constitutions*) and a few outside quotations, forms the evidence for the lost beginning. It described the original monarchy; the first change, connected with the legendary Ion, introduced the four old Attic tribes; in the next stage Theseus was dealt with in detail; but for the period from then to the late 7th century there is little indication of what Aristotle wrote. He described Cylon's attempted tyranny (*c.* 632), and the first surviving sentences deal, by anticipation, with the eventual trial of the descendants of those responsible for the death of Cylon's supporters (*see* ALCMAEONIDAE).

Ch. 2 analyzes the situation which faced Solon (*q.v.*) in 594, but this is interrupted by 3, devoted mainly to the development of the archonship, and 4, the "constitution of Draco." This last, reflecting much later conditions, is certainly an imaginary construction composed in the late 5th or early 4th century; the mention of it in 41, 2 disturbs the numeration of the list of changes, and it appears to be an addition to the original text, though perhaps one made by the author. In the resumed account of Solon (5–12) he cites, without names, authorities of different political views, basing many of his own judgments on Solon's poems, which are extensively quoted; it is hotly debated whether Solon's laws were also available to consult, or were consulted directly. Ch. 9 agrees with the *Politics* in regarding the popular law court as Solon's main contribution to the development of democracy.

Ch. 13, and other chapters, contain material in annalistic form likely to have derived from the local histories of Athens called *Atthides:* of these the fullest and latest would be that of Androtion (*c.* 340), whose fragments suggest that Aristotle used his work but sometimes disagreed with it. Six chapters (14–19) give disproportionate space to the Pisistratid tyranny (*see* PISISTRATUS), but Aristotle was interested in tyranny, and the analysis in 16 shows affinities with *Politics* 1314–15. The narrative is substantially that of Herodotus (cited by name in 14, 4), with annalistic additions; Thucydides' account of the murder of Hipparchus is mentioned and rejected, without his name, in 18, 4. The narrative in 20 of the activities of Cleisthenes (*q.v.*) is again Herodotean, with qualifications; the analysis of his reforms (21), from a different source, agrees with the *Politics* in attaching great importance to Cleisthenes' introduction of new citizens.

Aristotle's treatment of the 5th-century democracy, which he found unattractive, is partial and perfunctory. The reforms of Ephialtes (*q.v.*) are described in one unilluminating sentence, the rest of the chapter (25) being devoted to a worthless anecdote of Themistocles' participation; the sentence devoted to the trial of the generals after Arginusae in 406 says that all ten were condemned to death (34, 1) when eight were summoned home for trial and only six attended—a misstatement hard to excuse. But there is still valuable annalistic material, notably the early ostracisms (22) and the legislation of the 450s (26, 2–4). The oligarchic movements at the end of the century receive more serious attention. His account of the revolution of the Four Hundred in 411 (29), markedly sympathetic and exculpatory, diverges widely from that of Thucydides, but the latter is the basis for much of 32–33: the source and status of the constitutional drafts in 30–31 is an unsolved puzzle, but in general the revolution cannot have run the course here described. On the rise and fall of the Thirty Tyrants (34, 3–38) he differs from Xenophon in the order of events and other details and is not to be trusted, but his account of the settlement of 403 (39) appears to be based on a genuine document. It has been supposed that these later chapters are heavily influenced by a pamphlet written by some follower of Theramenes (*q.v.*), but the hypothesis is unnecessary: the sources seem to be as varied here as elsewhere, and the political colour of the account accords with Aristotle's known views.

The second part (42–69) analyzes the contemporary constitution. A full chapter (42) is devoted to the training of the youths of 18–20 years old (*epheboi*), probably because a recent change of system attracted interest. Ch. 43–59 deal with officials appointed by lot, first (43–54) the council (*boule; q.v.*) and the many administrative officials associated with it, whose activities are listed in detail. The council's conduct of public business gives him opportunity to describe (43–44) the procedure of the assembly (*ecclesia; q.v.*), but there is no full discussion of the process of legislation. Ch. 55–59 treat of the archons, first the procedure of their examination and installation, then successively the duties of archon, king, polemarch and *thesmothetae,* primarily the sacrifices they make and the classes of lawsuit over which they preside (*see* ARCHON). Ch. 61 lists more briefly the elected magistrates, almost all military; 62 deals with public pay; the remainder (63–69) describes the law courts, mainly the elaborate mechanisms for assigning jurors to particular courts, and for voting. Most of this detail could have been collected directly, and the hypothesis that Aristotle used some predecessor's work is not now favoured. Where he refers to changes in practice, this rather suggests consultation in the archives of the laws governing the magistrates' duties.

Value.—In spite of complaints leveled against the narrative, comparison of Greek histories written before and after the manuscript was discovered in 1890 shows very clearly how much has been gained. In particular, the annalistic items have solved some old problems and added new knowledge. The value of the rest varies not only with the source but with the degree of the author's interest in the period or problem: the discussion of Solon is on an altogether higher plane than that of Pericles. It seems likely that the author was deceived by the official appearance of some spurious or doubtful documents, the so-called constitution of Draco and the constitutional drafts connected with the revolution of the Four Hundred (4; 30–31); and the quality of his

arguments by inference (from later survivals, etc.) has been criticized, perhaps to excess. The importance of the analytic part is beyond question.

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The most important single book on the subject is still U. von Wilamowitz-Möllendorf's *Aristoteles und Athen* (1893), though he accepted too much as true; G. Busolt and H. Swoboda, *Griechische Staatskunde* (1920–1926), discuss Athenian problems very fully; C. Hignett, *A Constitutional History of Athens* (1952), gives the only good modern account, though perhaps excessively critical of the Aristotelian *Constitution.* (A. As.)

CONSTITUTIONS, APOSTOLIC, the largest collection of ecclesiastical law that has survived from early Christianity. The full title is *Ordinances of the Holy Apostles Through Clement,* claiming that these regulations were drawn up by the apostles and transmitted to the church by Clement of Rome. Sometimes the apostles are represented as speaking jointly, sometimes singly. In modern times it is generally admitted that the constitutions were in reality written in Syria about A.D. 380 and that they are the work of one and the same compiler, who seems to have been an Arian and most probably identical with the 4th-century interpolator of St. Ignatius' Epistles.

The first six of the eight books are merely an adaptation of the *Didascalia Apostolorum,* written in Syria about A.D. 250. They deal with Christian ethics, the duties of the clergy, penitential discipline and eucharistic liturgy, widows, deaconesses and orphans, martyrs, fasts and feasts, schism, heresy and Christian burial.

Book vii, 1–32 is nothing more than a paraphrase and enlargement of the *Didache* or *Teaching of the Twelve Apostles* (*see* APOSTOLIC FATHERS); vii, 33–38 contains a Jewish collection of prayers, 39–45 the rites of baptism and confirmation, and 46–49 other liturgical material, especially ch. 47, which gives the *Gloria in excelsis* as the liturgical morning prayer.

The most important book of the constitutions is book viii. The first two of its chapters seem to be based upon a lost work of Hippolytus of Rome, "Concerning Spiritual Gifts"; ch. 3–22 apparently are based upon the same author's *Apostolic Tradition,* formerly called *Egyptian Church Order.* Book viii, 3–27 provides an elaborate description of the Antiochene liturgy. This part contains (5–15) the so-called Clementine liturgy, which is directed to be used at the consecration of a bishop, a very valuable source for the history of the Mass because of its completeness. There follows a series of canons on various subjects and liturgical formulas in ch. 28–46.

Ch. 47 seems to have been added to the work later, but by the same redactor. It comprises the so-called *Apostolic Canons,* a collection of 85 canons, derived in part from the preceding constitutions, in part from the canons of the councils of Antioch (341) and Laodicaea (*c.* 360). The last of these 85 canons contains a list of biblical books which omits Revelation but places the Apostolic Constitutions and the two Epistles of Clement in the canon of Scripture.

The first edition was published at Venice, by F. Torres, in 1563. The best is that of F. X. Funk, *Didascalia et Constitutiones Apostolorum,* 2 vol. (1905). For a selection of liturgical texts, *see* J. Quasten, *Florilegium Patristicum,* vol. vii, 4 (1936); the liturgy of book viii is given also in F. E. Brightman, *Liturgies Eastern and Western,* pp. 3–30 (1896). English translations include J. Donaldson, *Ante-Nicene Christian Library,* vol. xvii, pt. 2 (1870), reprinted in *Ante-Nicene Fathers,* vol. vii, pp. 391–505; R. H. Cresswell, *The Liturgy of the Eighth Book of the "Apostolic Constitutions"* (1900).

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CONSTRUCTION BATTALIONS, NAVAL: *see* SEABEES.

CONSUL. The ancient and modern meanings of the word "consul" must not be confused: in the ancient Roman republic it was the title of the two highest of the ordinary magistrates; in modern times it survives to designate a public official charged with certain duties in a foreign country.

THE ROMAN CONSULS

The consulship in ancient Rome arose with the fall of the kings (*c.* 509 B.C.). It was the deep-seated Roman reverence for the abstract conception of the magistracy, as expressed in the *imperium* (supreme military power) and the *auspicia* (the power of divination), that led to the preservation of the regal power in a qualified form. The two new officials who replaced the king first bore the titles of leaders (*praetores*) and of judges (*iudices*), but soon the title of *consules* (partners) prevailed; and this first example of the collegiate principle assumed the form familiar in the Roman commonwealth. Each of the pair of magistrates could act up to the full powers of the *imperium,* but the dissent of his colleague rendered his decision or his action null and void. At the same time the principle of a merely annual tenure of office was insisted on.

The only body known to us as electing the consuls during the republican period was the *comitia centuriata,* or military assembly (*see* COMITIA). In the 5th century the consulate was confined to patricians; but after a struggle for office between patricians and plebeians the Licinio-Sextian laws of 367 B.C. enacted that one consul must be a plebeian (*see* PATRICIANS). In 172 B.C., two plebeian consuls took office for the first time.

In the late republic a man could not be elected consul until two years after he had served as praetor, and re-election was nominally allowed only after ten years' interval. If one consul died during his tenure, his successor was elected; if both died, the patrician senators appointed an *interrex.* The date on which consuls took up office varied from time to time, but after 153 B.C. it was Jan. 1; their names formed the official designation of the ensuing year. The consuls were entitled to an escort of 12 lictors, to the *sella curulis* (*see* CURULE) and to the *toga praetexta* (purple-bordered robe).

The executive power of the consuls was gradually limited: (1) in jurisdiction, by the grant of appeal (*provocatio*), by the growth of the praetorship and by the publication of law (*e.g.,* the Twelve Tables, 450 B.C.); (2) in administration, by the appointment of the tribunes of the *plebs* (the common people) and by the creation of new magistrates (*censor* [*q.v.*] in 443, *curule aediles* in 367 B.C.) to take over parts of their functions. The consuls, however, were in a very real sense the heads of the state: for centuries they commanded the Roman army; they governed together with the senate, whose chief executives they were; they were the most regular consultants of this council; they formulated its decrees as edicts; and they brought before the people legislative measures which the senate had approved. They also represented the state to the outer world and introduced foreign envoys to the senate. Moreover, they retained certain powers of jurisdiction, both administrative and criminal. Their administrative jurisdiction was concerned with financial matters such as claims made by the state and by individuals against one another, when the censors were not in office, and with disputes about property between the cities of Italy. Their criminal jurisdiction was of three kinds: (1) it was their duty to set in motion the criminal law for ordinary, as opposed to political crimes, the reference of such cases to the assembly of the people was effected through their quaestors (*see* QUAESTOR); (2) when the people and senate, or the senate alone, appointed a special commission (*see* SENATE), the commissioner named was often a consul; and (3) we find the consul conducting a criminal enquiry raised by a point of international law.

As the consuls were recognized as the heads of the administration abroad as well as at home, their separate departments of administration (*provinciae*) had to be determined and assigned. The method of assignment varied. Foreign wars often demanded the attention of both consuls. In this case the regular army of four legions was usually divided between them. When it was necessary that both armies should co-operate, the principle of rotation was adopted, each consul having the command for a single

day. During the great period of conquest from 264 to 146 B.C. Italy was generally one of the consular "provinces," some foreign country the other; and when at the close of this period Italy was at peace, this distinction approximated to one between civil and military command. The consuls settled their departments by agreement or, by lot (*comparatio, sortitio*); the power of declaring what should be the consular *provinciae* was usurped by the senate (*see* SENATE). But the home officials invested with the *imperium* proved insufficient for the military needs of the empire, and the system of prolonging the command (*prorogatio imperii*) grew up (*see* PROVINCE, ROMAN). The former magistrates after their year of office began to go abroad to undertake a year of provincial government and, in some special cases, appointments were made by law for longer periods. Technically the provinces might still be consular, actually they were proconsular. The separation of military from civil power became general after Sulla, and in 52 B.C. the Lex Pompeia established a five years' interval between home and foreign command.

Since the theory of the persistence of the republican constitution was of the essence of the principate, the consuls lost little of their outward position and dignity under the Caesars. In the interval between the death or deposition of one *princeps* ("emperor") and the appointment of another the consuls resumed their normal position as the heads of the state. As the presidents of the senate, who after A.D. 14 elected them *de facto* to their office, they directed that high criminal jurisdiction which the senate of this period assumed. A restored power of jurisdiction is indeed one of the features of their position during this time, and it is probable that the civil appeals which came to the senate were delegated to the consuls. They acted for a time as delegates to the *princeps* in such juridical matters as trusts and guardianship. The consulship was also a preparation for some of the most important governmental posts in the provinces, and for the prefecture of the city. The tenure of the office was progressively shortened. In the early principate the consuls held office for six months, later for four to two months. The consuls appointed for Jan. 1 were called *ordinarii* (chosen at the ordinary time), the others *suffecti* (chosen in the course of the year), and the whole year was dated by the names of the former. This distinction continued in the empire of Constantine and his successors. The *ordinarii* were nominated by the emperor or emperors, one for the west and one for the east; the *suffecti* by the senates of Rome or of Constantinople, their appointment being ratified by the emperor. The consulship was still the greatest dignity which the empire had to bestow, and the pomp and ceremony of the office increased in proportion to the decline in its actual power. The entry of the consuls into office was celebrated by a great procession, by games given to the people and by a distribution of gifts. But the senates over which they presided were little more than municipal councils, and the justice which they meted out had dwindled down to formal and uncontested acts. The last consul born in a private station was Basilius in the east in A.D. 541. But the emperors continued to bear the title for some time longer.

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(A. D. Mo.)

CONSULS IN MODERN TIMES

A consul in the 20th century is a public officer authorized by the state whose commission he bears to protect the interests and to foster the commercial affairs of its subjects in a foreign country, and formally permitted by the government of the country wherein he resides to perform the duties which are specified in his commission. A consul, as such, is not invested with any diplomatic character and cannot enter on his official duties until permission, usually in the form of an exequatur, has been granted to him by the authorities of the state to which his nomination has been communicated by his own government although he is often provisionally recognized pending its issue. The exequatur may be revoked at any time at the discretion of the government of the country in which he resides.

History.—The title of consul, in the sense in which it is used in international law, is derived from that of certain magistrates in the cities of medieval Italy, Provence and Languedoc, charged with the settlement of trade disputes whether by sea or land (*consules mercatorum* or mercantile consuls, *consules artis maris* or maritime consuls, etc.). With the growth of trade it early became convenient to appoint agents with similar powers in foreign parts, and these often, though not invariably, were styled consuls (*consules in partibus ultramarinis,* consuls in overseas parts).

It was not until the beginning of the 19th century that the system developed universally. Hitherto consuls had, for the most part, been businessmen with no special qualification in regard to training; but the French system, under which the consular service had been long established as part of the general civil service of the country, was gradually adopted by other nations; though, as in France, consuls not belonging to the regular service and having an inferior status continued to be appointed. In Great Britain the consular service was organized in 1825; in France the series of ordinances and laws by which its modern constitution was fixed began in 1833. In Germany a well-organized consular system followed the establishment of the united empire. The functions, duties and privileges of French and German consuls do not differ materially from those of British consuls; but there is a great difference in the organization and personnel of the various consular services. In the United Kingdom, France, Italy, the United States, Belgium and other countries, members of the consular and diplomatic services are interchangeable. In France the diplomatic and consular services were amalgamated by decrees of July 10, 1880, and April 27, 1883, and other countries gradually followed this example.

Few countries can afford the cost of career officers at every consular post and the corps of career officials is therefore supplemented by honorary officers, usually residents engaged in trade, who are citizens of the country which nominates them, or in which they reside.

Privilege.—Whereas diplomatic privileges and immunities are clearly defined, those to be enjoyed by consuls are not finally established in all their details, and some differences of opinion exist about some of these. At the end of the 18th century and the beginning of the 19th the question whether consuls were public ministers and thus entitled to all the privileges and immunities of diplomatic representatives was debated. After some divergence of opinion, the view prevailed generally that consuls had no representative character and could not, therefore, claim the general immunity and exterritoriality attaching to diplomatic representatives. From this it was concluded at one time, particularly in the United Kingdom, that consuls possessed no privileges or immunities at all. They are, however, charged by their governments with the carrying out of important duties and it became generally recognized that under international law consuls enjoy such protection and immunity as are required for performance of these duties. It is not, therefore, disputed that the archives and all other official documents and papers kept in a consulate and all correspondence between the consul and his government are inviolable. Consular officers and their employees are entitled to refuse production of such documents in the local courts or to give evidence relating to matters within the scope of their official duties. Furthermore, it is generally admitted that consular officers are not liable in criminal or civil proceedings for acts performed in their official capacity falling within the functions of consuls under international law. This protection does not cover the private activities of consuls, and numerous instances have been recorded where consuls were arrested for private debts. The status and privileges of consuls and the functions which they are entitled to perform are frequently specified in international agreements often called consular conventions. Consuls are, however, often exempt from all kinds of rates and taxes, and from personal taxes. They are exempt from billeting and military service and have the right to exhibit their national arms and flag over the door of their offices. (E. J. P.; X.)

UNITED STATES

The U.S. constitution provides (art. ii, sec. 2) that the president "shall nominate, and by and with the Advice and Consent of the Senate, shall appoint Ambassadors, other public Ministers, and Consuls. . . .". United States consuls served abroad from the foundation of the republic, and even before, but it was not until the early 20th century that a career, nonpolitical consular service was established. Prior thereto consular appointments were political favours, subject to patronage. The act of April 14, 1792, first defined the duties of consuls; these related primarily to the protection of U.S. citizens and property. An act of 1856 raised some consular salaries and defined powers and rights of consular officers in greater detail, but still no career service was provided. The act of April 5, 1906, classified officers in nine grades, provided for inspectors, required that fees be placed on a strict accounting basis, and made performance of notarial services obligatory. By executive order of June 27, 1906, Pres. Theodore Roosevelt placed the consular service under operation of the civil service law, thereby establishing a career service.

The Rogers act of 1924 merged the consular and diplomatic services into a single, unified professional U.S. foreign service under the direction and supervision of the secretary of state. This law established the principle of interchangeability of consular and diplomatic assignments for foreign service officers which was observed generally thereafter. Provision was made for the selection of new officers by competitive written and oral examinations.

The Foreign Service act of 1946 was designed to improve the organization and administration of the service. In addition, the 11 classes of officers under the 1924 act were reduced to 6, plus the new class of career minister. Officers' salaries included allowances for quarters, cost of living, representation and hardship conditions. The interchangeability principle for foreign service officers was preserved. The act also created a foreign service staff corps whose officers were intended to be technical specialists primarily throughout their careers. Consular officers serving permanently as such were to be staff corps officers. The number of classes was increased to ten in 1956, and the foreign service was integrated with the home service of the department of state. In the late 1950s salaries ranged from $4,730 for a foreign service officer 8th class to $19,250 for a career minister and $20,000 for the new rank of career ambassador. Staff salaries ranged up to $11,965.

Four consular titles are in use: consul general, consul, vice-consul and consular agent. Consuls general and consuls are commissioned by the president and approved by the senate, as are foreign service officer vice-consuls. Staff officer vice-consuls are commissioned by the secretary of state without senatorial approval. All must be U.S. citizens; consular agents, appointed by the secretary of state, need not be. Consular posts are designated as consulates general, consulates or consular agencies. Those located at diplomatic missions are referred to administratively as consular sections of the missions. Where several consular posts exist in a country (*e.g.*, Great Britain, France, Germany, Italy, Spain, Japan) the ranking consular officer therein is designated "supervising consul general," responsible for co-ordinating the entire consular program on a country-wide basis.

Technical consular functions are prescribed by law and regulation. These include issuance, extension, amendment and renewal of passports; original determination of validity of claims to citizenship; issuance and refusal of visas to aliens; performance of notarial services; protection of U.S. citizens and property; assistance to seamen and shipping; documentation of imports. Consular officers also engage in reporting, representation, negotiation, and promotion of commerce and perform services for many other government departments and agencies.

The bureau of security and consular affairs in the department of state supervises and co-ordinates the activities of three offices therein—passport office, visa office and office of protective services—which provide the requisite technical guidance and assistance to consular officers in the field.

The U.S. relinquished its former jurisdiction over civil and criminal cases in which a U.S. citizen was a defendant in China, Ethiopia, Japan, Iran, Thailand and Turkey. Its extraterritorial consular courts therein were closed accordingly. The last two such courts in Tangier and Casablanca were closed in 1956.

See the draft code on the legal functions of consuls, in *American Journal of International Law*, supplement, vol. 26, pp. 189–450 (1932); *Foreign Service Journal* (monthly), Washington, D.C.

(F. J. Mn.; X.)

UNITED KINGDOM

Until the year 1825 British consuls were usually merchants engaged in trade in the foreign countries in which they acted as consuls, and their remuneration consisted entirely of fees. An act of 1825 organized the consular service as a branch of the civil service with payment by a fixed salary instead of by fees; consuls were also forbidden to engage in trade, and the management of the service was put under the control of a separate department of the foreign office, created for the purpose. The restriction as to engaging in trade was withdrawn in 1832, except for salaried members of the British consular service.

Specialized consular services for China, Japan, Thailand (Siam) and the Levant were formed later. In 1903 the general consular service was organized as a self-contained career service. In 1919 the administrative control of the consular service was transferred from the consular department of the foreign office to the department of overseas trade (a joint department of the foreign office and the board of trade). The specialized regional consular services were merged with the general consular service into a single entity in 1934. By the reforms of 1943 the consular service and the commercial diplomatic service were amalgamated with the foreign office and diplomatic service to form a single foreign service. Consular ranks descend from consul general, consul and vice-consul, down to pro-consul. In some places honorary consuls are appointed. Under a system inaugurated in 1913 and subsequently developed, a corps of inspectors has the duty of visiting consular posts all over the world and reporting to the foreign office on personnel, work and conditions in them.

The many duties of British consuls are given in detail in the official *Instructions*. They may briefly be summarized as follows: To protect British subjects and to assist them in distress; to watch and, where necessary, to represent British interests; to act as notaries public and as registrars (*e.g.*, for births, deaths and marriages); to administer the Merchant Shipping acts with regard to British ships and seamen, wrecks and collisions; to report fully on the trade and commerce of the district; and generally to facilitate and to uphold the rightful interests of British traders. Under the Merchant Shipping acts of 1894 and 1906, British consuls have certain statutory duties and powers relating mainly to the welfare of the crew and to discipline on board. At a foreign port engagements and discharges of seamen must be sanctioned by the consul, who arranges suitable hospital treatment for sick seamen and takes charge of their wages. The consul also provides for the subsistence of seamen who are shipwrecked or left behind; they are generally sent home in the first British ship. Complaints by crews as to their treatment on board are investigated by the consul, who enters a statement in the log book and reports to the ministry of transport. When an offense has been committed on the high seas by British seamen, the consul may make inquiry on oath and send home the offender and the witnesses. In certain cases a consul can summon a naval court to deal with a grave offense or casualty, but the procedure is cumbersome, and effect cannot always be given to the findings. The master of every British ship not carrying passengers is obliged to deposit at the consular office at a port where there is a British consul the copy of the articles of agreement with the crew, if the ship remains 48 hours in port.

The board of trade is authorized to communicate with and give instructions to consuls on all questions relating to commercial intelligence and the development of British overseas trade. Consuls report direct to the board of trade on commercial matters, and they are also, for the commercial side of their work, under the general supervision of the senior commercial officer attached to the embassy or legation to the country in which they are

stationed. *See* also FOREIGN SERVICE; DIPLOMACY.

It is the duty of a consul to deal to the best of his ability with all questions on commercial subjects addressed to him not only by the departments at home but also by individual British traders. He is expected also to furnish on his own initiative reports on matters of commercial interest. In addition to such questions as tariffs, customs regulations, patents, regulations relating to commercial travelers and their samples, the formation of industrial syndicates, legislation regarding transport, the organization of international exhibitions and fairs, aerial navigation, labour legislation, crops and fishery matters, the consul is expected to report regularly on changes in the general financial and other conditions affecting local trade and industry; openings for the sale of British goods and effects of foreign competition; the development and organization of local industry, trade, finance, public utilities and means of transport; and the development of local export trade in raw materials.

As regards extraterritorial jurisdiction her majesty's courts have jurisdiction over certain classes of foreign nationals in Kuwait, Bahrain, Qatar, the Trucial states and Muscat and Oman.

Her majesty's government renounced as from Dec. 6, 1956, the jurisdiction possessed in the former Spanish zone of Morocco (see *The Morocco [Former Spanish Zone] Order, 1956*), which also brought to an end the functions for the court for Morocco.

(E. J. P.; X.)

"CONSULATE OF THE SEA," a celebrated collection of maritime customs and ordinances in the Catalan language, published at Barcelona, Spain, in the latter part of the 15th century. Its proper title is *The Book of the Consulate*, or in Catalan *Lo Libre de Consolat*, the name being derived from the fact that it embodied the rules of law followed in the maritime cities of the Mediterranean coast by the commercial judges known generally as consuls (*q.v.*).

The edition of 1494, which is justly regarded as the first edition of the *Book of the Consulate*, contains (1) a code of procedure issued by the kings of Aragon for the guidance of the courts of the consuls of the sea; (2) a collection of ancient customs of the sea; and (3) a body of ordinances for the government of cruisers of war. A colophon states that "the book commonly called the Book of the Consulate ends here"; after which there follows *The Acceptations*, which purports to record that the previous chapters and ordinances had been approved by the Roman people in the 11th century, and by various princes and peoples in the 12th and 13th centuries, but this document clearly has no proper reference to the Book of the Consulate, and is, in fact, of no historical value. *See* also MARITIME LAW.

CONSUMER'S SURPLUS, a term used by economists to denote the benefit to a consumer from being able to buy an item at the current price when it is actually worth much more than that price to him. A ten-cent telephone call, for example, may sometimes be worth many times its actual cost. In general, a consumer will buy only a specific amount of a given commodity because one more unit would not be worth the price, but most of the units that he does buy are actually worth more to him, and he would have bought them even at a higher price. The sum of the differences between what he would have paid and what he does pay is a measure of the consumer surplus.

This concept was used by A. J. E. J. Dupuit in 1844 and popularized by Alfred Marshall in 1890 as a means of measuring the degree to which an increase in price caused by a tax affects the consumer and thus to show the government how to minimize the tax burden on the consumer. In the same way one could measure the benefit to consumers from a subsidy to determine whether it was worth the cost.

Early in the 20th century the concept of consumer's surplus fell into disrepute among economists because of certain difficulties in measuring its amount and because of certain errors into which Marshall himself had fallen in adding up the consumer's surplus of different people and in adding the consumer's surpluses that an individual got from different items. This is troublesome because the consumer's surplus obtained from one item is not independent of the availability and price of other items. Furthermore, the measure of consumer's surplus by the amount of money a consumer would give rather than have a price increase is in general different from the amount of money he would have to be paid in lieu of price reduction, and these were both considered to be measures of the same thing. However, in the 1940s some of the difficulties were cleared up and consumer's surplus became a more respectable part of welfare economics, largely as a result of the initiative of John R. Hicks. (A. P. Lr.)

CONSUMPTION. By origin and usage the word consumption implies the destruction in use of goods and services normally produced by deliberate human effort. In modern economic writing it is synonymous with the final appropriation of goods and services for use or ownership by the general public. In this sense the general public may include persons who act either directly as private persons or indirectly as members of some corporate body, such as a division of local government, empowered to distribute the benefits of consumption according to agreed rules. In addition to items such as food and fuel, which are usually destroyed in use shortly after appropriation by final consumers, the act of consumption includes the acquisition of many others, such as furniture or vehicles, which may be extremely durable, and some, such as works of art, which may increase in value with the passage of time.

Final consumption may be contrasted with the physical disappearance or transformation of fuel, raw materials and other intermediate products of human industry when these are combined to produce further commodities. Final consumption is also to be distinguished from the purchase by industry of fixed assets, such as buildings and machinery. This last activity is known as capital formation, and the wearing out of the stock of capital during the process of commodity production is known as depreciation, again in distinction from the direct consumption of the final commodities themselves.

In the internationally agreed framework of modern national income accounting, the gross national expenditure (including depreciation) of an economy is made up as shown in Table I, which gives the relevant figures for the United Kingdom in 1960. These may be taken as fairly typical for a modern industrial economy, and they show that final consumption accounts for about 88% of the gross domestic product.

TABLE I.—*Consumption Expenditure in the United Kingdom National Accounts, 1960*

Expenditure	in £000,000	Per cent
Consumption expenditure		
Consumers' expenditure on goods and services	16,608	70
Government current expenditure on goods and services (including defense)	4,189	18
	20,797	88
Capital expenditure		
Net investment in fixed assets by government and industry	2,088	9
Depreciation of fixed assets	2,015	8
Accumulation of stocks	591	3
	4,694	20
External transactions		
Exports of goods and services	5,102	22
less Imports of goods and services	−6,983	−30
	−1,881	−8
Gross domestic product at current market prices	23,610	100

Source: *National Income and Expenditure*, 1961 (reprinted by permission of Her Majesty's Stationery Office, London).

As defined for the purposes of national accounting it should be stressed that the value of consumption excludes many items of private or potential exchange value produced by private individuals for their own use or for the use of members of their household. In an urban community perhaps the most important items are the domestic services of housewives; in rural communities, particularly in countries with poor communications and few developed markets, many items of food, clothing and domestic utensils are so produced and often evade evaluation. This limitation on the concept of consumption, enforced by the practical difficulties of objective measurement, is of no serious consequence in the comparison of consumption levels between two countries of similar social organization or over short periods of time in in-

dustrialized countries. But great difficulties arise when widely disparate economies are compared, or when a predominantly non-market economy embarks on a program of rapid industrialization. In such cases care must be taken to avoid too facile an identification of apparent consumption levels with the total enjoyment of goods and services, however produced, which might be taken as an indication of economic welfare.

Distribution of Consumption.—Table I shows that even in western countries a significant part of total consumption, and its allocation to particular goods and services, is determined directly by the expenditures of central and local governments. Some of the benefits of this part of consumption, such as defense expenditure or expenditure on public hygiene services, are widely diffused, but others are directed by common consent to the benefit of particular sections of the community. In part these provide specialized services, such as education or the medical care of the infirm or of expectant mothers; but others, such as the provision of assistance to the unemployed, of state pensions for old people and of assistance to children and wives deprived of the support of a family breadwinner, are designed to create greater equality in individual levels of consumption than would obtain under an unrestricted system of free enterprise. In normal times of peace the distribution of the nongovernmental share of consumption is almost entirely determined by the incomes of individual households and by the prices at which commodities are sold in the open markets. On the total level of demand for private consumption and on its allocation to particular goods and services, governments may and do operate in a number of ways in pursuance of a range of objectives. These objectives include the maintenance of a stable price level, the control of the demand for commodities imported from abroad, the avoidance of intolerable degrees of inequality and the discouragement of the excessive consumption of particular commodities that are considered harmful. The government's main instruments are the direct taxation of incomes and the indirect taxation of goods and services. Rationing of commodities is considered clumsy and inequitable in normal times, though necessary during periods of abnormal curtailment of supply when it is unreasonable to expect that the price mechanism alone will tend to bring production into line with the expressed preferences of the general public.

Many governments found it necessary after World War II to adopt various forms of control of consumer credit. An increasingly significant part of consumer demand has been directed since the war to the acquisition of large and more or less durable goods such as automobiles, refrigerators and other household appliances. Most consumers find it difficult to purchase such items at one stroke from current income or accumulated savings. Thus the provision of easy terms of purchase by which expenditure may be spread over one or two years into the future becomes of crucial importance in determining the level of current demand for these commodities. In some cases the imposition of restrictions on credit facilities is more effective in controlling consumption than the imposition of increased indirect taxes. (*See* also INSTALLMENT CREDIT.)

Consumption as a Branch of Economics.—The study of consumption as the final aim of economic activity has always been a major branch of economic science. In the 20th century three major developments have been added to it. First, the study of welfare economies, particularly by V. Pareto and A. C. Pigou, which attempts to construct criteria of an economy's progress based on consumption levels; second, the understanding of the importance of the desire for consumption in determining the short-run fluctuations and trend of a free-enterprise economy, so strongly associated with the name of J. M. (later Lord) Keynes; and third, the detailed study of the demand for particular commodities based on modern statistical techniques.

The beginning point in welfare economics has been the traditional assumption that the individual consumer uses his income to purchase commodities available to him at given market prices in such a way as to obtain the greatest possible satisfaction. This much is generally accepted by economic theorists and the refined expression of this theory is given by J. R. Hicks in *A Revision of Demand Theory* (1956). But most economists are skeptical with regard to the attempt to pass from a measure of satisfaction of the individual to that of a community. The essential obstacle is that, as the result of some event or act of policy, the consumption of some individuals in the community may be increased while that of others is decreased; and there exists no conceptual means of deciding whether one man's gain outweighs another's loss. The state of controversy is well summarized by E. J. Mishan in "A Survey of Welfare Economics," *Economic Journal* (1960). Nevertheless, most economists acting as advisers or policy makers rather than as theoreticians would act on a presumption that a movement toward greater equality in consumption levels per se increases total welfare and is to be recommended in the absence of unwelcome secondary effects. This principle, so important still in international as well as national economies, was based originally on the contention that as consumption increases the marginal satisfaction obtained from it declines. Hence a given extra amount of consumption means more to a poor man than to a rich one, or more to a poor community than to a rich one. This is now, regretfully perhaps, rejected as a *non sequitur* by the theoreticians, but retains a hold on the minds of men in the hope that one day its human appeal may be enhanced by theory.

The importance of consumption expenditure in the Keynesian theory of employment derives from the fact that income so spent forms the revenue of enterprises which in turn pay out their receipts in the form of wages and profits. Income saved, on the other hand, does not necessarily give rise to demand for commodity production, since intentions to save and intentions to incur investment expenditure are made by different social groups from different motives. If at a time when some productive capacity is idle through lack of demand a new project is undertaken which involves the payment of factor incomes, the total national income is increased by more than this direct payment. A proportion of these incomes may be saved but the larger part will be spent on consumption goods. The total increase in consumption demand so induced may be two or three times the size of the initial expenditure, and the ratio of the former to the latter is known as the multiplier. The value of the multiplier is a characteristic of the economic environment in which it operates and depends directly on the typical proportion in which incomes are divided between saving and current consumption expenditures. This division is controlled by what Keynes, in *The General Theory of Employment, Interest and Money* (1936), termed the "propensity to consume" or its complement, the "propensity to save." In a typical mature economy of the 1930s, an increase in the propensity to save was likely to be damaging since the process described would operate in reverse and would result in a higher level of unemployment and more productive capacity lying idle. In addition to this carefully worked out short-run analysis Keynes's thought was tinged by a long-run pessimism. It was probable, he thought, that as countries grew richer their desire to acquire consumption goods would not expand proportionately with the growth in their incomes. This would lead toward stagnation and a chronic problem of unemployment both of men and machines.

These pessimistic forecasts were challenged first by Simon Kuznets who examined a long record of data of consumption and national income in the United States and concluded that there was no evidence that the proportion of income spent on consumption had declined even though incomes had risen considerably. This conclusion was later confirmed for other countries and is now generally accepted. Later writers, notably M. Friedman, J. S. Duesenberry and Franco Modigliani, have given varying theoretical reasons for this stability. All such theories are based on a distinction between the effects on consumption of short-term and long-term changes in income. All suggest that though sudden changes in the income of an individual do not lead to equal proportionate changes in his consumption expenditure, in the long run human wants will continue to expand as quickly as does the ability to satisfy them. The economic environment after World War II, with its prolonged boom in the demand for durable consumer goods, was almost uniformly favourable to these optimistic critics of the original Keynesian thesis, though

later experience in the United States and western Europe created some grounds for renewed doubt.

The empirical study of the factors influencing demand for particular goods and services has itself a long history. The work of Gregory King in this area antedates the emergence of economics as a general field of human study in the work of Adam Smith. Although the systematic collection of data on consumption progressed during the 18th and 19th centuries, the foundation of modern demand analysis was laid by Ernst Engel in his studies of family budgets. In the 20th century H. L. Moore, E. J. Working and H. Schulz were the first to make extensive studies of the influence of income and price changes on the demand for agricultural products. For the first time systematic analysis was made of chronological series of consumption, price and income data and the concept of elasticity of demand set forth by Alfred Marshall was subjected to the process of measurement. The classical approach to the study of the demand for food reached a high level of statistical refinement in the works of J. R. N. Stone and of H. Wold, published in the mid-1950s, the emphasis of whose analysis is placed on the importance of income and price as consumption determinants. Modern work centres more on the other categories of consumption expenditure, and on the interrelation between economic and other social and cultural factors influencing consumption habits. In most industrialized countries analysis of the kind described is supported to a varying extent by empirical market research, carried out by private industry or government agencies. In the past, effort has been centred mainly on short-run forecasts of market conditions, but there is an increasing tendency in both commercial market research and academic studies to aim at longer-run predictions. The purpose of this work is to guide investment programs.

Data on Consumption Levels.—The two major types of published consumption data are: (1) national estimates based on production and imports, and (2) estimates based directly on enquiry from private individuals, households or local distribution points. In the former case the information, arising often as a by-product of administration, is based usually on a complete enumeration of sources of supply, and allowance has to be made for stock changes, wastage and other factors before an estimate of final consumption is arrived at. In the latter case, because of the large number of consumers and distributive outlets, the information is usually taken from representative samples covering a small proportion of the population involved. National estimates, of the type used in national income accounting, are usually compiled annually, but may also be available at quarterly or monthly intervals. For commodities which are largely imported, or whose production is concentrated in well-defined industrial undertakings, annual statistics are usually reliable and complete, especially if the commodities are taxed and hence are subject to statistical control by the central government. But the consumption of commodities whose production is small-scale, local and independent of any easily checked raw material is often underestimated and fluctuations therein pass unmeasured.

Modern sampling techniques have raised the level of family budget inquiries from that of individual case studies to that of a relatively reliable and inexpensive method of collecting continuous information. The method further permits analysis of the aggregate estimates derived from the survey, since the data can be tabulated separately for different social groups, for different regions or according to any other classifiable characteristics. Thus in the United Kingdom such budget inquiries are used to get behind, as it were, the national aggregates of consumption obtainable from supply sources, to study the distribution of consumption and to estimate the influence of changing social factors; while in India the survey method is used primarily because of the difficulty of obtaining national estimates from any other source.

After World War II great progress was made by international agencies, such as the department for economic and social affairs of the United Nations, the International Labour organization (ILO), the Food and Agriculture Organization of the UN (FAO), the Organization for European Economic Cooperation (after 1960, Organization for Economic Cooperation and Development [O.E.C.D.]) and the European Common Market (European Economic Community [E.E.C.]) in settling common definitions and methods of tabulation of consumption statistics. In particular the O.E.C.D. annually publishes comparable food consumption level estimates for its member countries. These are extended to most member countries of FAO, though the level of reliability varies considerably. Similarly, the O.E.C.D. publishes annual estimates of the national accounts of all its member countries corrected to a common basis of definition, in which consumption can be viewed against other relevant aggregates. The ILO has devoted a good deal of attention to international comparisons of consumption statistics. This work has aimed at achieving international agreement on a set of indexes covering the standard of nutrition, education (literacy) and medical care, as well as the more traditional indexes of consumption of commodities and services.

Major Surveys of Consumption.—The regular annual publication of comprehensive consumption statistics was begun in the United Kingdom during World War II. Since then the series has been extended back to 1920 by R. Stone, and the period from 1900 to 1919 has been covered by A. R. Prest. Similarly in the United States detailed estimates of consumption expenditures are available from 1909. In the United States the first extensive budget inquiry was carried out in 1935–36. From 1941 onward numerous budget surveys have been made by the National Resources Planning board, the federal reserve board, the bureau of labour statistics and the bureau of the census. In general, the emphasis of these inquiries has lain on the elucidation of factors influencing the total level of consumption, such as money income, liquid assets, savings, and plans and expectations concerning future incomes and expenditures.

In the United Kingdom the first large-scale household inquiry was conducted in 1937–38 in order to establish weights for the ministry of labour's cost of living index. Hence this survey was confined to the families of employed insured workers, which at that date comprised most manual workers and the lower grades of clerical workers. The technique was to collect records for expenditure covering four separate weeks (spaced at three-monthly intervals) from each household approached and willing to participate. In the successor to this survey after World War II, carried out in 1953–54 by the ministry of labour and published as *Report of an Enquiry into Household Expenditures, 1953–54*, each household kept a record for a continuous period of three weeks, and a moderate payment was made as an inducement to co-operate. This survey was repeated on a continuous basis after 1957, each household keeping a record for two consecutive weeks. (*See* also COST OF LIVING.)

The second major sampling inquiry carried out in the United Kingdom is known as the National Food survey and is carried out by the government's social survey organization on behalf of the ministry of agriculture, fisheries and food. The survey began as a continuous study of consumption by families of urban workers in 1942, and its primary objective was to watch the nation's nutrition for danger signs under wartime conditions. From 1951 it was reorganized to cover the whole population of Great Britain. Every year it samples about 10,000 households, each of which maintains a record of food purchased for a single week.

An inquiry on similar lines was carried out in France in 1956, covering the whole field of consumption expenditure. In a number of other continental European countries, notably the German Federal Republic, Poland and the U.S.S.R., the method preferred is to sample a smaller number of households who keep records for a longer period, namely a year or more. By these means it is hoped to avoid fluctuations in the estimates because of changes in composition of the sample. Against this view must be placed the disadvantage that the record-keeping households may become habituated, and their pattern of expenditure cease to be representative of the population at large.

Other major sampling inquiries are the National Sample survey of India, which has concentrated on differing objectives in a number of different phases, or rounds, and the continuous sample survey carried out by the office of the prime minister of Japan.

The Food and Agriculture organization had undertaken the collation of budget surveys covering the consumption of food, textiles and clothing carried out in member countries. Information and standardized tables relating to about 50 such surveys are given in its *Review of Food Consumption Surveys* (1959).

National Consumption Levels and Trends.—The distribution of private consumers' expenditure among the main categories of goods and services in the United Kingdom is shown in Table II for 1938, 1949 and 1959. The table shows that the distribution of consumption as well as the level of its total were similar in 1949 to those of the last year before World War II. In the ten years following 1949 there were substantial increases in most categories. By 1959, 54% of total consumption was accounted for by items of personal expenditure, namely food, drink, tobacco and clothing. A further 18% was spent on maintaining the household, not counting 3% spent on equipping it with radios and other electrical goods. Private and public transport and communications absorbed 10%, and the remaining 15% was divided roughly equally between other goods and services.

TABLE II.—*Private Consumers' Expenditure in the United Kingdom Valued at 1954 Market Prices*

Item	£000,000			Percentage increase of 1959 over 1949	Percentage distribution in 1959
	1938	1949	1959		
Food	3,264	3,464	4,180	21	30
Alcoholic drink and tobacco	1,569	1,555	1,881	21	14
Clothing and footwear	1,141	1,184	1,440	22	10
Housing services	832	935	1,080	15	8
Fuel and light	427	432	542	25	4
Furoiture and household goods	680	617	827	34	6
Radio and electrical goods	126	159	427	168	3
Motor vehicles and running costs	154	182	782	330	6
Public transport and communications	358	515	536	4	4
Recreational goods and services	302	489	489	0	4
Other goods	650	347	463	34	3
Other services	1,258	1,061	1,100	4	8
Total	10,761	10,940	13,747	26	100

Source: *National Income and Expenditure* publications for various years (reprinted by permission of Her Majesty's Stationery Office, London).

In the ten years preceding 1959 most of these categories had expanded in rough proportion to the total, though the rates of increase for food, clothing and household goods may be higher than for a normal peacetime period because these items were most affected by rationing in 1949. On the other hand notable increases occurred in expenditure on radio and electrical goods of all kinds and on the acquisition and use of automobiles. The very small increases in expenditure on recreation and other services conceal actual declines in motion picture expenditure and payments for domestic service, because of increased use in the home of television and labour-saving electrical equipment.

The extent to which these changes in consumption patterns in the United Kingdom are typical of a wider range of countries may be seen from Table III. Thus most industrialized countries have shown a compound rate of increase of 2% to 3% per year during the 1950s, the main exceptions being Canada, which experienced high rates of immigration and foreign investment, and Italy, which grew rapidly from a low base.

TABLE III.—*Percentage Increases in the Volume of Private Consumption Over Ten Years*

Country	Food	Clothing	Rent	Durables	Other	Total
Denmark*	20	15	19	112	24	28
Italy†	45	39	21	183	66	54
Netherlands†	34	28	37	137	23	36
Norway†	21	36	43	65	19	28
Sweden†	17	19	50	102	36	32
United Kingdom†	21	22	15	128	18	26
Canada*	45	29	67	146	54	58
U.S.*	23	25	63	43	38	36
All O.E.E.C. members except Spain	44	50	36	149	42	49

*1948–58, valued at 1953 prices. †1949–59, valued at 1953 prices.
Source: Organization for European Economic Cooperation, *Statistical Bulletin No. 4* 1960).

TABLE IV.—*Consumption Expenditures Shown by Family Budgets in the Mid-1950s*

Households surveyed	Total consumption expenditure (U.S. $)	Per cent			
		Food	Clothing	Housing	Other
U.S. urban	1,270	31	12	27	30
U.K. urban	620	33	10	21	36
North Italy urban	455	42	19	17	22
South Italy farm	235	52	18	11	19
Japan urban	160	45	11	11	33
Egypt rural	95	68	—	32	—
Ghana cocoa farm	65	66	17	9	8
Thailand farm	65	71	9	7	13
India urban	90	53	7	9	31
India rural	60	66	7	8	19

Source: Food and Agriculture Organization, *The State of Food and Agriculture* (1959).

But the pattern of change is similar in all countries. The volume of consumption of food and clothing has increased less than the total, and that of the consumption of durable goods by very much more, except in the United States, which experienced these changes at an earlier date. Changes in rent expenditure reflect to a large extent the varying use of rent control and building policies by governments rather than the free choices of consumers.

Comparable data for non-European countries are much harder to obtain and usually less reliable. But it is safe to suggest that, expressed as a proportion of total consumption expenditure, food expenditure is roughly twice as important over large areas of Asia and Africa as it is in western Europe and North America. Thus family budget inquiries show (*see* Table IV) that in many countries with a disposable income per head of about U.S. $100 per year, approximately two-thirds is spent on food, as compared with a proportion of about one-third spent for food by urban families in the United States and the United Kingdom.

The character of food consumption itself varies considerably from country to country. In part these variations are due to climatic factors and reflect long-established food habits. The Scandinavian diet is relatively poor in vegetables but contains a high proportion of milk, fats and sugar. On the other hand the consumption of vegetables and meat is high in France. In general fruit and vegetable consumption is high in southern Europe where milk consumption is low. In Italy, Greece and Turkey food grains are preferred to potatoes as sources of carbohydrates. But over and above these regional variations is evident the influence of variations in the living standards of the countries concerned.

TABLE V.—*The Income Elasticity of Food Expenditures in Rich and Poor Countries*

Food	U.S. 1955	U.K. 1958	Italy 1953	Japan 1955	India 1952
Bread and cereals	0.1	0.2	0.2	0.2	0.3
Sugar	0.3	0.1	0.9	—	1.1
Fruit and vegetables	0.4	0.7	0.8	0.6	—
Meat	0.3	0.3	1.1	—	1.3
Fish	0.2	0.4	0.9	—	1.1
Milk products	0.3	0.3	0.8	1.2	1.5
All food expenditure	0.3	0.3	0.7	0.6	0.8

Note: All elasticities are derived from analyses of the budgets of urban households.
Source: Food and Agriculture Organization, *The State of Food and Agriculture* (1959).

Thus the diet of the United States and Canada, with low levels of grain and potato consumption, and high levels of consumption of sugar, meat, eggs and fats, is indicative more of a high standard of living than of regional peculiarities of taste. These tendencies may be observed in the diets of the wealthier classes in most countries. (*See* FOOD SUPPLY OF THE WORLD.)

Trends in consumption induced by increases in income are generally measured by economic statisticians in the form of income elasticities, defined as the percentage increase in consumption divided by the percentage increase in income assumed to generate it. These elasticities may be obtained for a given country by comparing the household budgets of the rich with those of the poor in the same country.

Table V shows that the income elasticity of most items of food expenditure in the United States and the United Kingdom is of the order of 0.3, though the figures for fruit and vegetables are somewhat higher, especially in the United Kingdom. In Italy, Japan

and India, on the other hand, the figures for animal products and sugar are of the order of 1.0 or more, reflecting the fact that better nutrition ranks high in the scale of priorities for households in these countries.

Consumption levels in rural areas of underdeveloped countries are extremely difficult to measure with accuracy, especially where the illiteracy rate is high and the population is not accustomed to rendering regular returns on its activities. But a number of surveys collected by the FAO from Central America, Africa and southeast Asia show consumption levels of about 2,000 calories per person per day in rural areas and low levels of consumption of proteins and important vitamins. The difficulty of raising these to the level of 3,000 calories per person per day typical of North America and western Europe is enhanced by the rapid rate of growth of population in many of these areas.

See also references under "Consumption" in the Index volume.

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(J. A. C. B.)

CONSUMPTION: *see* TUBERCULOSIS.

CONSUS, an ancient Italian deity, cult partner of Ops. The time at which his festival was held (after harvest and seed sowing), the nature of its ceremonies and amusements, his altar at the end of the Circus Maximus always covered with earth except on such occasions, all point to his connection with agriculture. His name is clearly derived from *condere,* to store away, and he is in all probability god of the store bin.

Anciently, when the true meaning of his cult was forgotten, three explanations were rife: (1) he was a god of good counsel (according to Varro); (2) he was Neptunus Equester—*i.e.,* Poseidon Hippios (according to Livy); (3) he was god of hidden or secret policy (Dionysius of Halicarnassus, *Roman Antiquities*).

Among the ancient writers Consus was most commonly identified with Neptunus Equester, and in later Latin poets Consus is used for Neptunus, but this idea was due to the horse and chariot race that took place at his festival; otherwise, the two deities have nothing in common.

According to another view, he was the god of good counsel who was said to have "advised" Romulus to carry off the Sabine women when they visited Rome for the first celebration of his festival (Consualia). In later times, with the introduction of Greek gods into the Roman theological system, Consus, who had never been the object of special reverence, sank to the level of a secondary deity whose character was rather abstract and intellectual.

His festival was celebrated on Aug. 21 and Dec. 15. On the former date, the *flamen Quirinalis* (*see* FLAMEN), assisted by the vestals, offered sacrifice, and the pontifices presided at horse and chariot races in the circus. Horses and mules, crowned with garlands, were given rest from work. A special feature of the games in the circus was chariot racing, in which mules took the place of horses. The origin of these games was generally attributed to Romulus, sometimes to Evander.

There was a sanctuary of Consus on the Aventine, dedicated by L. Papirius Cursor in 272 B.C.

CONTANGO: *see* STOCK EXCHANGE.

CONTARINI, a distinguished Venetian family, one of the 12 that elected the first doge in 697 and later gave Venice eight doges and many other eminent citizens.

The first of the family to be invested doge was Domenico, during whose reign (1043–70) Dalmatia was subjugated and the rebuilding of St. Mark's church was begun. Andrea, doge from 1368 to 1382, ended the war with Genoa by defeating its fleet at Chioggia; he was the first to melt down his plate and mortgage his property for the benefit of the state. Gasparo (1483–1542) was a cardinal and diplomatist; as papal legate to the diet of Regensburg (1541) he favoured certain concessions to the Protestants.

Seven Contarini fought at Lepanto. Marco Contarini (1631–89) was a celebrated patron of music whose collection of musical manuscripts is now at the Marciana library in Venice.

CONTÉ, NICOLAS JACQUES (1755–1805), French mechanical genius who took an important part in Napoleon's expedition to Egypt in 1798, was born at Aunou-sur-Orne near Sées on Aug. 4, 1755. At the age of 14 he displayed precocious artistic talent and took up portrait painting, from which he derived a considerable income. He then gave free rein to his passion for the mechanical arts and scientific studies, and events of the French Revolution soon gave him an opportunity to display his inventive faculty. The war with England deprived France of its supply of native graphite, then known as plumbago, from Cumberland; he substituted for it a mixture of graphite and clay, the method on which the manufacture of all modern pencils is based. Summoned by Napoleon to take part as chief of the balloon corps in the expedition to Egypt, he considerably extended his field of activity. The disaster of Aboukir and the revolt of Cairo had caused the loss of the greater part of the instruments and munitions taken out by the French. Conté seemed to be everywhere at once and triumphed over apparently insurmountable difficulties. He made, in an almost uncivilized country, utensils, tools and machinery of every sort from simple windmills to stamps for minting coin. As a result of his activity and genius, the expedition was provided with bread, cloth, arms and munitions of war; the engineers with the exact tools of their trade; the surgeons with operating instruments. He made the designs, built the models, organized and supervised the manufacture, and seemed to be able to invent immediately anything required.

On his return to France in 1802 he was commissioned by the minister of the interior, Jean-Chaptal, to superintend the publication of the great work of the commission on Egypt. An engraving machine of his construction materially shortened this task, which, however, he did not live to see finished. He died at Paris on Dec. 6, 1805.

CONTEMPT (LEGAL). The concept of contempt in Anglo-American law goes back to the 12th century and is based on the notion that any insult to the crown or interference with or

violation of its orders is properly subject to punishment. In modern times the concept is utilized in two major areas, contempt of court and contempt of the legislature, each of which is characterized by sufficiently different processes and problems to warrant separate treatment. Though the procedure which governs and regulates judicial and legislative contempt proceedings differs from jurisdiction to jurisdiction in many particulars, the description which follows, based principally on U.S. law, is typical in its broader aspects. Additional points of English law are included in a special section at the end of the article.

Contempt of Court.—Any act of disobedience of a lawful order of a court, or any act which interferes with the administration of the law by a court, falls into the category of contempt of court. The primary importance of the notion of contempt is that it warrants judicial action in defense of the judicial power itself and without many of the safeguards that generally restrict the power of the state in the punishment of actions specifically categorized as civil or criminal wrongs. For purposes of noting which of these safeguards are present and which are absent in such proceedings, it is necessary to categorize contempt proceedings into civil and criminal, direct and indirect.

An act or language which consists solely of an affront to the court or interferes with the conduct of its business quite clearly falls in the category of criminal contempt. An act of disobedience to a court order, however, because of its multiple effects, may properly be treated either as civil or criminal contempt or both. Certainly such disobedience is an insult to the court as well as an interference with its judicial authority, and therefore constitutes criminal contempt. The same act of disobedience, however, may have the consequence of depriving a party to a lawsuit of the relief which the court order afforded him. Insofar as the sanction or penalty is imposed because of the interference with judicial authority, the wrongful act is a criminal contempt. Insofar as the sanction or penalty is utilized for the purpose of securing to the litigant that to which he was entitled under the court order, or for the purpose of compensating him for the loss resulting from the disobedient act, the contempt is civil in nature. The strange doctrine which results is that the categorization of the contempt as civil or criminal depends not on the act itself but rather on the purpose for which the sanction is imposed.

In both criminal and civil contempt proceedings, but more commonly in the former, a distinction is drawn between contumacious acts which take place in the presence of the court and are labeled direct contempts and those which are committed outside the geographical boundaries of the court and are called indirect or constructive contempts.

Civil Contempt.—Where the contempt is civil, the invocation of the contempt power is only at the instance of the injured party. In order to compel compliance with an order, the court is authorized in civil contempt proceedings either: (1) to order the defendant in the contempt proceedings to reimburse the injured party for his loss; (2) to threaten the wrongdoer with sanctions unless compliance is forthcoming; or (3) to impose a fine or imprisonment of fixed amount or duration, or of indefinite amount or duration, *i.e.*, a certain sum for each day of failure to comply or imprisonment until obedience to the order is forthcoming. It is possible to utilize a combination of these alternatives. It is commonly said that, under the last choice listed, the defendant "carries the keys to his own prison," since he can secure release by compliance. There is, indeed, no practical alternative limit on the term of imprisonment. In one Illinois case the contemner was kept in prison for nine years for failure to comply with a judicial order.

If the civil contempt is direct, the court is empowered to act summarily; *i.e.*, to impose a sanction without holding a trial or taking evidence. If, as is more usual in civil contempts, the contumacious action is labeled constructive, the question raised by the charge will be heard by the court sitting without a jury, and the proceedings will be governed by the ordinary rules of civil procedure. There is no right to a jury trial in civil contempt proceedings, and congress, at least, has not commanded jury trial in any such proceedings.

Where the contempt proceeding is civil and it is determined after the issuance of the contempt order that the order which was violated and which gave rise to the sanction was an erroneous one, the defendant is entitled to relief from the sanction to the extent that relief is available.

Criminal Contempt.—Where the proceedings are for criminal contempt, they are initiated at the instance of the court and not by a party who may have been injured by the act, although that party may call the wrongdoing to the court's attention. The available sanctions are imprisonment for a fixed term or a fine in a fixed amount, but not, under federal legislation, both. Except in a few special instances, there is no limit on the period of incarceration or the amount of the fine—which may be repeated each time the offense occurs—except for the power of an appellate court to limit the action of the trial judge as an abuse of discretion. Sentences for as long as four years have been imposed. In the case of *U.S.* v. *United Mine Workers*, 330 U.S. 258 (1947), the fine imposed by the district court was $3,500,000, which was reduced to $700,000 by the U.S. supreme court on condition of compliance with the order.

In the event of direct criminal contempt, as with direct civil contempt, the court may act summarily without taking evidence or providing for a trial. Where the contempt is indirect, a trial governed by the usual rules of criminal procedure, including the necessity for proof of guilt beyond a reasonable doubt, is utilized. There is, however, no constitutional right to a jury trial in criminal contempt proceedings whether direct or indirect contempt is involved. But congress has created a right to jury trial in three classes of cases: (1) where the contumacious act also constitutes a crime under state or federal law; (2) where the wrongful act consists of disobedience to an injunction issued in a case involving a labour dispute (an exception not applicable where the United States is the employer); and (3) where the contempt is a violation of an order issued pursuant to the Civil Rights act of 1957.

For many years it was believed that the contempt power was not subject to legislative control in any way and that it was, therefore, beyond the power of congress to authorize jury trials in contempt cases. This belief, however, was proved to be based on a historical error, and the congressional power, at least in the area of indirect criminal contempts, has been sustained.

Unlike the rule applicable to civil contempts, an erroneous order, unless palpably beyond the jurisdiction of the court, will not relieve the contemner of the obligation to obey it. Thus, a fine imposed for disobedience of an order will not be remitted even though the order was erroneously issued in the first place. This rule, established by the United Mine Workers case, has been the subject of much criticism.

Since the same act may constitute both civil and criminal contempt, a single proceeding may be used to resolve the questions raised by each, as long as the protections that are afforded a defendant in criminal contempt proceedings are observed. Under such circumstances, however, it is incumbent on the court to distinguish the sanctions imposed for criminal contempt from those imposed for civil contempt.

It is obvious that the power of punishment for contempt of court is subject to great abuses. The very judge whose order was disobeyed or whose authority is flouted is the judge who sits in judgment and imposes sanctions on the contemner. In cases of summary proceedings, there is not even the opportunity to present evidence. The U.S. supreme court has ruled, however, that at least in cases of criminal contempt, where it is not regarded as necessary to impose sanctions immediately, the offended judge should disqualify himself from presiding at the later contempt proceeding. The same considerations would seem to disqualify the judge in any case of nonsummary procedure. But the courts have not so ruled.

Contempt of Court by Publication.—One major difference between the U.S. and English doctrines of contempt of court is to be found in the treatment of newspaper and periodical comment on pending judicial proceedings. The English courts have been stringent in applying contempt sanctions against all commen-

tary on pending judicial business except for fair and accurate report of the proceedings themselves. The U.S. courts have resolved the conflict between the assurance of a fair and impartial trial and notions of freedom of the press in favour of the latter. According to U.S. doctrine, no publication can be restrained or serve as the basis for a charge of contempt unless it is clearly established that the newspaper comment presents the immediate danger of disorderly or grossly unfair administration of justice. The result in the United States has been unrestricted "trial by newspaper," a practice which has frequently deprived defendants of the right to a fair trial, particularly in notorious cases. There is developing, however, a doctrine calling for the reversal of a conviction where the abuse may be shown to have deprived the defendant of a fair trial.

Contempt of the Legislature.—The power of the houses of parliament, like that of the law courts, to protect the integrity of their own processes has a long history. Both houses have exerted the power summarily to punish such contumacious acts as infringement of parliamentary privilege, assumption of parliamentary functions such as the power to decide disputed elections, or insult to or libel of its members. The power to punish for contempt has involved the sanction of direct imprisonment of the offender by the offended house. The house of commons, however, can detain an offender only during its session, while the house of lords can detain for any fixed period, extending even beyond adjournment.

According to English doctrine, the legislative contempt power belonged solely to the "mother of parliaments" and did not extend to the legislatures of the colonies or commonwealth nations unless specifically granted by parliament. And the supreme court of the United States has announced, if on erroneous grounds, that congressional power in this area is not derived from the English precedents. Nonetheless, both the national and state legislatures have exercised these powers almost from the start. U.S. supreme court sanction of the power of congress in this regard was forthcoming as early as 1821, when the court sustained the warrant of arrest issued by the speaker of the house of representatives pursuant to the exercise of its contempt power. But the doctrine that incarceration for legislative contempt could not last beyond the end of the legislative session, among other problems, led congress to turn the courts into enforcement agencies. In 1857 the first of a series of statutes relating to contempt was passed. It authorized criminal prosecution for those who interfered with congress' investigatory powers and provided for a fine and a prison term of up to one year for those found guilty of such contempt. Congress, nevertheless, has also continued to exercise its own power to imprison for contempt.

As the 1857 statute would indicate, the most important use of the legislative contempt power has been, and continues to be, to compel testimony before its investigating committees. And it is in this area that the problems have been presented to the courts. In *Kilbourn* v. *Thompson,* 103 U.S. 168, 189 (1880), the supreme court held that the congressional investigating powers were subject to constitutional limitation and therefore to judicial review. It there sustained a witness' suit for false imprisonment against the sergeant at arms, on the ground that the inquiry directed to him was beyond the scope of congressional authority. And, in 1917, the supreme court held that it was beyond the contempt power to punish the writer of a defamatory and insulting letter about the activities of a congressional committee, because the object of the contempt power is "self-preservation" and not punishment, and its exercise, therefore, must be limited to "the least possible power adequate to the end proposed" (*Marshall* v. *Gordon,* 243 U.S. 521, 541 [1917]). The Kilbourn case and *Marshall* v. *Gordon* represented the high watermark of judicial limitation of the congressional investigating power. The tide began to recede in 1927, when the court held that the legislature had the power to compel the testimony of Atty. Gen. Harry M. Daugherty's brother in an investigation of the conduct of the department of justice. And the investigatory powers were again sustained in 1929 when a committee looking into the Teapot Dome scandal caused the indictment and successful prosecution of Harry Sinclair for violation of the 1857 statute for failure to testify.

Concurrent with the expansion of the power of the national government during the 1930s was the expansion of the congressional investigatory powers, since they could be used for any legitimate legislative inquiry. And the broad use of these powers by committee chairmen such as Senators Robert M. La Follette, Jr., and Hugo Black foreshadowed the even more controversial practices of the next decades.

The appropriate doctrines of limitation of the congressional investigative power on which the contempt power is based are easier to state than to apply. There is no doubt that a congressional committee can compel the attendance of witnesses. A witness who has refused to testify or to answer a question, however, cannot be held in contempt unless it has been made clear to him that his refusal will be treated as contumacious. The contempt must be deliberate and intentional, and the question addressed to the witness must be pertinent to the inquiry authorized by congress. Moreover, its pertinency must be made clear to the objecting witness. In order to accomplish the necessary showing of pertinency, the authorizing resolution must be sufficiently clear to inform the witness of the appropriate scope of the committee's authority. Also, the protection of the fifth amendment against compulsory self-incrimination applies to witnesses before congressional committees. (P. B. K.)

English Law.—Though the general principles underlying the law of contempt in England are the same as those outlined above in relation to the United States, it is important to bear in mind the distinction in English law between the superior and the inferior courts. The former have an inherent jurisdiction to protect their proceedings and to enforce their orders, as well as to protect inferior courts by the same means and subject to the same rules as they protect themselves. Inferior courts, it seems (although in relation to magistrates' courts it is not wholly free from doubt), have only such powers to protect themselves as are vested in them by statute. Thus, for example, by virtue of s. 157 of the County Courts act, 1959, a county court judge may order into custody and make an order either committing to prison for a specified period not exceeding one month, or imposing a fine of not more than £20 upon, any person who, for example, either willfully insults the judge or willfully interrupts the proceedings of a county court.

The Administration of Justice act, 1960, had an important effect upon the law of contempt. Section 11, altering the law as laid down in previous cases, made innocent publication or distribution of matter calculated to interfere with the course of justice a defense; s. 12 provided that publication or information relating to legal proceedings in private shall not of itself be contempt of court except in certain specified cases relating to such matters as infants, mental patients, national security and secret processes, and where the court expressly prohibits the publication of information. Section 13 provides, for the first time, for a right of appeal against orders or decisions of a court imposing penalties for contempt of court, such appeals lying to a divisional court of the high court, to the court of appeal or to the house of lords, according to the court that made the order from which the appeal is made.

There are, in English law, some questions of special difficulty in relation to the powers of each house of parliament to commit for contempt. In the somewhat unlikely event of a conflict between parliament and the courts on these matters, there would arise some fundamental difficulties of constitutional principle. (W. T. Ws.)

CONTI, PRINCES DE, a line of French princes belonging to the Condé branch of the house of Bourbon (*see* CONDÉ, PRINCES DE). The small property of Conty, in Picardy, passed to Louis I de Condé through his marriage with Éléonore de Roye.

The first prince to bear the name was FRANÇOIS DE BOURBON (1558–1614), a younger son of Louis I de Condé. He gave some valuable support to Henry of Navarre (Henry IV of France) in the civil wars, but was precluded from political distinction by a stammer which made him almost speechless. Married first, in 1582, to Jeanne de Coesme (d. 1601), then, in 1605, to Louise Marguerite de Lorraine (1574–1631), daughter of Henry, duc de

Guise, he died in Paris on Aug. 13, 1614. His widow had enjoyed court life under Henry IV. Her novel *Adventures de la cour de Perse* (1629) reflects her youthful memories. She is also commonly credited with the better-known *Histoire des amours du grand Alcandre*, a satire on Henry IV's love life. Later she was secretly married to François de Bassompierre (*q.v.*), on whose arrest she was exiled from court. She died at Eu on April 30, 1631.

The next prince de Conti was Armand de Bourbon (1629–1666), the second son of Henry II de Condé. Born in Paris on Oct. 11, 1629, the younger brother of the Great Condé and of the duchesse de Longueville (*q.v.*), he was despised by his brother because of his deformity and so fell entirely under his sister's influence. Destined for the church, he was the French crown's immediate nominee for a cardinal's hat; this gave rise to intrigues aimed at securing the nomination for another candidate if he should renounce it. On the outbreak of the Fronde (*q.v.*) in 1649, when his brother was supporting the government, his sister took Conti to join the Parisians, whereupon he was made generalissimo of the Fronde—to be the puppet of his supporters. Arrested with Condé and his sister's husband in 1650, he was released with them in 1651 as a result of the coalition between their faction and the Frondeurs, one of the terms of which was that he should marry Charlotte de Lorraine, daughter of the duchesse de Chevreuse (*q.v.*). He accordingly renounced his ecclesiastical prospects, but the bargain was set aside by Condé. In 1652 he was left by Condé in command in Bordeaux, whence government forces expelled him in July 1653. He then made his peace with Cardinal Mazarin, marrying his niece Anne-Marie Martinozzi (1637–72) in 1654 and being sent to command in Catalonia (1654) and in Italy (1657). After figuring as a patron of literature he fell like his sister under the influence of Jansenism. He died at Pézénas in Languedoc, of which he was governor, on Feb. 21, 1666. Some writings of his Jansenist period can be read in English translation, *The Works of Armand de Bourbon, Prince of Conti* (1711).

Louis Armand I de Bourbon (1661–1685), prince de Conti, was Armand's elder surviving son, born in Paris on April 4, 1661. His marriage (1680) to Marie Anne de Bourbon (1666–1739), daughter of Louis XIV and Louise de La Vallière, was the first union between a prince of the blood and one of the king's bastards. On his return from Hungary with his brother (1685; *see* below), he died of smallpox at Fontainebleau on Nov. 9, 1685.

François Louis de Bourbon (1664–1709), called *le Grand Conti*, was born in Paris on April 30, 1664. Before succeeding his brother Louis Armand I as prince de Conti he was known as prince de la Roche-sur-Yon. In 1685 he and his brother, with other nobles, went to Hungary to serve in the Holy Roman emperor's army against the Turks. Louis XIV had first granted permission for this, then withdrawn it. On returning to France, Conti secured the king's formal pardon in 1686 thanks to the intercession of the Great Condé, whose granddaughter Marie Thérèse (1666–1732) he was to marry in 1688. Louis XIV, however, never forgot Hungary and long refused to let Conti command an army, though he did well in every campaign from 1688 to 1695, especially those under his friend the marshal duc de Luxembourg (*q.v.*). The king's dislike, moreover, was exacerbated as the well-informed, deliberately charming and sexually ambivalent Conti won prestige at court and ingratiated himself with the dauphin. To get rid of him, the king sponsored his candidature for the Polish crown, and Conti was elected king of Poland on June 27, 1697. Escorted to Gdansk by Jean Bart in September, he found the Poles converted to his rival Augustus II and he sailed back to France. In 1698 he won a law suit over the inheritance of the house of Longueville, but in 1699 he failed to establish himself as prince of Neuchâtel, to which the inheritance gave him some claim. His avidity for Neuchâtel was contrasted with his lukewarmness about Poland, where he would have been far from his French amours. Promised (1708) the supreme command in Italy, he died in Paris on Feb. 22, 1709.

Louis Armand II de Bourbon (1695–1727), prince de Conti, was the only surviving son of François Louis. Born in Paris on Nov. 10, 1695, he was married in 1713 to Louise Elisabeth (1693–1775), daughter of the duc de Bourbon (Louis III de Condé). Her infidelities were excusable, his were accompanied by horrifying depravity. He died in Paris on May 4, 1727.

Louis François de Bourbon (1717–1776), prince de Conti, was born in Paris on Aug. 13, 1717, Louis Armand II's second son. Married in 1732 to Louise Diane d'Orléans (1716–36), he campaigned in Germany during the War of the Polish Succession (1733–38) and in Bohemia (1742), in Piedmont (where in joint command of the Franco-Spanish forces he took Villafranca and besieged Cuneo in 1744), on the Rhine (1745) and in the Netherlands (1746) during the War of the Austrian Succession. Leaving the army because of a quarrel with the marshal de Saxe, he became in 1747 a confidant of Louis XV's secret diplomacy, much of which was directed toward winning Conti's election as king of Poland. In 1757, however, his disrespect toward Mme de Pompadour lost him the king's favour, and he had to withdraw to his estate at L'Isle-Adam. When Louis XV and the chancellor Maupeou (*q.v.*) began their attack on the *parlement* of Paris (1770–71), the traditionalist Conti led the opposition, remaining irreconcilable with the court when the other princes made their peace. Hostile also to Turgot's innovations, he was suspected of having instigated the bread riots of 1775, which spread to Paris from Pontoise (near his estate). However, he was a patron of J. J. Rousseau and Beaumarchais. He died in Paris on Aug. 2, 1776, leaving several illegitimate children.

Louis François Joseph de Bourbon (1734–1814), prince de Conti, only legitimate son of Louis François, was born in Paris on Sept. 1, 1734, and married Maria Fortunata d'Este (1731–1803) in 1759. After some military experience in the Seven Years' War, he made his name as a timeserver. Subservient to Louis XV's mistresses, a supporter of Maupeou and an opponent of the reforms suggested in 1788, he emigrated at the outbreak of the Revolution but returned to France in 1790. Found guiltless by the Revolutionary tribunal in 1793 and pensioned by the Thermidorians, he was banished from France in 1797. He died in Barcelona on March 10, 1814. (J. G. R.-S.)

CONTI, NICCOLO DE' (*c.* 1395–1469), Venetian merchant and traveler in southern Asia, was born *c.* 1395, possibly at Chioggia. As a young man he lived in Damascus, where he learned Arabic, and whence, in 1414, he set out for Baghdad. He next visited Basra and Ormuz before sailing along the Persian coast to the great emporium of Calacatia, where he learned the language, adopted native dress and entered into partnership with some Persian merchants who accompanied him to India and the East Indies. He visited Cambay, Vijayanaga and Maliapur. He referred next to Ceylon. His travels then seem to have taken him to Sumatra and thence, by way of Tenasserim, to Bengal, visiting Burdwan and Aracan before crossing over into Burma. He sailed down the Irrawaddy and visited Ava and Pegu. He then set out for Java, his farthest point. In due course he returned to Coloen (Kulam or Quilon) in the extreme southwest of India by way of Ciampa (usually Cochin China in later medieval European literature but here perhaps Thailand). Thereafter he continued his way back to Europe, visiting Cochin, Calicut, Cambay, Sokotra, Aden and Jidda. He then traveled overland to Cairo and reached Venice in 1444, where he seems to have traded until his death in 1469.

As penance for his renunciation of the Christian faith during his travels, Pope Eugenius IV ordered him to tell his story to Poggio Bracciolini, the papal secretary. His narrative, as well as his answers to Poggio's questioning on Indian life, religion, customs and other matters, throws light on the human geography of southern Asia in the 15th century.

The original Latin text is in Poggio Bracciolini's *De Varietate fortunae, libri quatuor*, 1447 (ed. by Abbé Oliva, Paris, 1723); Eng. trans. by J. Winter Jones in R. H. Major (ed.), *India in the Fifteenth Century*, Hakluyt Society (1857).

See also C. Bullo, *La vera patria di N. de' Conti* (1880); V. Bellemo, *I viaggi di N. de' Conti* (1883); M. Longhena, *Viaggi in Persia, Indiae Giava di N. de' Conti* (1929). (E. M. J. C.)

CONTINENT, one of the larger continuous masses of land, namely: Asia, Africa, North America, South America, Antarctica,

Europe and Australia, listed in order of size. The accompanying table indicates that there is great variation in the sizes of continents, the largest, Asia, being more than five times as large as Australia. However, the largest island in the world, Greenland, is only about one fourth the size of Australia. All the continents are completely separated discrete land areas, or nearly so, with the exception of Europe and Asia, which exhibit no clear dividing line. Europe, physically, is a number of peninsulas extending west from Asia, and the two areas are commonly referred to as the single continent of Eurasia.

Size of Continents
(in 000,000 sq. mi.)

Continent	Area
Asia	17.1
Africa	11.8
North America	8.5
South America	6.9
Antarctica	6.0
Europe	4.0
Australia	3.0

The earth's surface, in general terms, has two levels, the lower being at an average depth of three miles below the rest of the crust. The lower level, constituting the ocean basins, occupies by far the larger part of the total surface area of the earth—about 70%. Nearly all of the other, higher surface rises above sea level and constitutes the continents, although the continental margins are shallowly submerged and are referred to as the continental shelf (*q.v.*). The continents however, are not distributed even approximately evenly over the surface of the globe. If a hemisphere map centred in northwestern Europe is drawn, most of the world's land area can be seen to lie within that hemisphere; that is, on the opposite side of the globe from the water areas, mainly the Pacific ocean. More than two thirds of the earth's land surface lies north of the equator, and all the continents except Antarctica are wedge-shaped, wider in the north than they are in the south.

The polar areas exhibit exactly opposite conditions. The antarctic continent lies directly over the south pole and is surrounded by ocean; the north pole lies in the Arctic ocean, which is almost completely surrounded by North America, Greenland and Eurasia.

The continents differ sharply in their degree of compactness. Africa is the most compact, with the most regular coast line, and consequently has the lowest ratio of coast line to total area of any of the continents. Europe, if regarded as a continent, is the most irregular and indented and has by far the highest ratio of coast line to total area.

The distribution of the continental platforms and ocean basins on the surface of the globe and the distribution of the major land form features over each continent and ocean basin have long been among the most intriguing problems for scientific investigation and theorizing. The fields of geology, physics, physical geography, geotectonics, geodesy, astronomy and mathematics have all furnished data and ideas toward the various solutions of the problems. These problems of the origin and distribution of the largest earth features are still among the most highly theoretical and speculative in all of geophysics and physical geography. Changes in ideas and theories have come about partly from the accumulation of traditional data and partly through increased understanding of the physical processes taking place in the earth's crust.

Early Theories of Continental Origins.—One of the earliest scientific hypotheses that offered an explanation for both the arrangement and shape of the continents was the tetrahedral theory of Lowthian Green. Green assumed that the earth is cooling. The outer surface, being relatively cool, was not cooling further, but the inside, which was continuing to cool, was shrinking and thus no longer supporting the outer crust, which would then collapse under the force of gravity. Both theoretical and experimental data caused Green to conclude that the collapsing sphere would tend to develop a tetrahedral form, with the points of the tetrahedron rising above the oceans and the tetrahedron faces forming the ocean basins. This theory is now largely discredited, primarily on grounds of theoretical physics.

Eduard Suess (*q.v.*; 1831–1914) made significant advances over earlier theories when he put forth a hypothesis based on an interpretation of a large mass of observational data concerning the earth's surface. Suess showed that on every continent there were very old sedimentary rocks deposited in the sea in a horizontal position, which still maintained a horizontal attitude. Because they had been undeformed throughout much of geologic history it was clear that those parts of the continental surfaces were rigid and resistant. Between these rigid platforms, in contrast, the surface rocks had been repeatedly buckled, folded and crushed. Suess's theories were far more complex than this brief explanation indicates, but basically he tried to account for most of the earth's features in the general terms just described. For example, the great array of mountains scattered from Spain to China in a roughly east-west orientation he believed to have been crushed between the rigid platforms of the northern and southern hemispheres.

Alfred Wegener (1880–1930) introduced a theory, commonly known as the theory of continental drift, which was so striking and unusual that it attracted world-wide attention, caused scores of scientific papers to be written attacking or defending it, and still has many staunch and convinced adherents despite numerous grave theoretical difficulties. It had long been known that the continental portions of the earth's crust consist chiefly of the lighter and more acid rocks; beneath this, it was commonly supposed, there was a layer of denser and more basic rocks. Wegener essentially proposed that the light continents are floating on the denser underlying material. For a large part of geological history there was but a single land mass which covered about one third of the globe. About 200,000,000 years ago this single land mass broke apart; North and South America floated west and Eurasia and Australia drifted east. One of Wegener's chief arguments was an assertion that eastern North and South America would fit well into the outlines of western Africa and Europe.

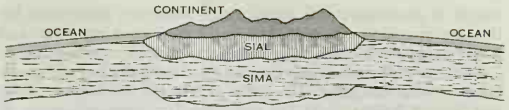
John Joly (1857–1933) presented a theory based on the process of convection. He proposed that heat was generated in the interior of the earth by decay of radioactive elements. Since the heat could not escape sufficiently rapidly by other means, it started convection currents which carried hot material toward the surface where it cooled and sank, thus setting up a convective cell circulation. He suggested that the earth's crust was dragged sidewise at the top of the cell, which caused buckling and folding and thus mountain making, and the crust collapsed above the sinking portion of the convection cell. The greatest difficulty with this theory is a complete lack of observational data indicating any convection currents or cells.

Current Views on the Origin of the Continents.—All early theories concerning the origin of the continents suffered from deficiencies of observational data concerning the topography of the ocean basins and the interior of the earth. Most of the earth's crust (70%) lies beneath the ocean, and very little was known about the topography of the ocean basins because soundings were so extremely expensive and difficult to make before the invention of sonic and electronic sounding equipment. It was not until the 1920s that information concerning the topography of the ocean basins began to accumulate rapidly.

Furthermore, all theories of continental origin are based on knowledge of or theories concerning the nature of the earth's crust and interior. The earth's interior cannot be observed directly. Most of what is known is derived from studies of the behaviour and characteristics of earthquake waves as recorded by seismographs, and it was not until well into the 20th century that world-wide seismograph records were systematically collected and reported.

Geological and seismological evidence both indicate that Wegener's view of the composition of the earth's crust was accurate. Underlying the continents is a layer, approximately 10 to 15 mi. thick, of light-weight rock which is now called sial (Suess called it sal). The sial forming each of the continental platforms may be thought of as resting or floating on a crust of heavier, darker, crystalline material called sima (the original name proposed by Suess), which forms a layer completely enveloping the earth. The

sima layer extends down to an average depth of perhaps 20 mi. Beneath the ocean basins the sima layer (which is largely basalt) is at the surface, but beneath the continents it is severely depressed by the overlying sial that constitutes the continental platforms. The relationships are shown in the accompanying figure.



Two major features of the earth's topography, the earthquake and volcanic zones, have long been known. The high, rugged, youthful mountains of the world are arranged in two relatively narrow bands. The longer of the two bands borders the Pacific ocean and stretches in a long line from the southern tip of South America along the west coast of that continent, through Central America, along the west coast of North America through Alaska, Japan, the Philippines, and down into Indonesia.

When seismologists learned to locate and plot the origins of the several hundred major earthquakes that occur in the course of a year, they discovered that the overwhelming preponderance of them, about 95%, took place along these narrow bands of mountains. Likewise, many of the world's active volcanoes are located along these same narrow zones, and consequently much of the lava that reaches the earth's surface is being deposited there. (*See* also EARTHQUAKE; VOLCANO.)

Many earth scientists believe that such active zones of crustal breaks, volcanic activity, lava and ash deposition, and mountain building have been characteristic of parts of the earth surface throughout all of earth history that is visible in existing rocks. The ocean basins were established relatively early in earth history and have remained basins and, thus, constantly under water since that time. The very ancient continental platforms that have remained relatively stable for hundreds of millions of years were not always so quiet. The rocks that compose them are clearly associated with volcanic activity, and subsequently they were areas of profound crustal movement. Only thereafter did they become quiet and stable.

Each continent has one of these old so-called shield areas which formed from 2,000,000,000 to 4,000,000,000 years ago and is the core of the continent to which the remainder (most of the continent) has been added. In North America the whole northeast quarter of the continent, called the Canadian shield or Laurential shield, and extending into Baffin Land and Greenland, is characterized by the ancient rocks of what might be called the original continent. In Europe, the shield area underlies the eastern Scandinavian peninsula and Finland. The Guiana highlands of South America are the core of that continent. Much of eastern Siberia is underlain by these ancient rocks, as are western Australia and southern Africa. (*See* also PRECAMBRIAN TIME.)

Adjacent to the areas of active mountain building on their seaward sides are huge deep troughs technically called geosynclines. These tremendous trenches are the deepest parts of the oceans. The young, high, actively growing mountains are subject to very active erosion, and the huge quantities of erosion debris are eventually deposited in the adjacent geosynclines. The added weight of this debris in the syncline is thought to depress the earth's crust at that point, with the result that the syncline can receive more sediment. Geological evidence indicates that this process continues for a long time, and enormous thicknesses of sediments accumulate.

After periods of time measured in hundreds of millions of years these geosynclines are lifted above the level of the sea and folded into major mountain ranges—the Sierra Nevada, parts of the Andes and the Himalayas. An enormous episode of this kind is called by geologists a revolution.

In fact, all major mountain chains are produced by the deformation of materials in a geosyncline. After this takes place the zone of fracture and active volcanic mountain building moves seaward. Why this happens or what causes it is one of the major unsolved problems of earth history.

As knowledge accumulates it becomes clear that even the rocks of the extremely old shield areas are older in the centre and younger toward the margins, indicating that this migration process started early. In North America the area of the Appalachian mountains was once a double syncline which was later folded into a chain of mighty mountains and has since been worn down to a rather low mountain chain. The centre of the continent remained stable and was only shallowly submerged and never seriously warped or deformed. Simultaneously the Rocky mountain area became a series of synclines and in a revolution was transformed to a mountain mass; still later the Sierra Nevada-Cascade mountain region had a similar history. Thereby the continent has grown by accretion and by migration of the zone of fracture. The other continents have grown in a similar fashion.

The Kunlun mountains, the Himalayas and the Tibetan plateau of Asia are a recently deformed geosyncline, as is the Iranian plateau with its bordering range.

Thus the tremendous increase in observational data concerning the structure of the earth's crust and the arrangement of features on the continents has largely destroyed the all-embracing theories of the origin of continents, but has given increasing insight into the processes whereby the continents have grown and assumed their present shape and topographic features.

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CONTINENTAL CONGRESS, THE, was the body of delegates who spoke and acted for the people of the colony-states of America collectively during the years 1774–89. It was never truly "continental," since large parts of British North America were not represented in it. The adjective is much more commonly applied to the congresses of 1774 and 1775–76, which are generally designated the first continental and second continental congresses, than to the later congresses.

The first continental congress met in Carpenters' hall, Philadelphia, Pa., on Sept. 5, 1774. The passage by the British parliament earlier in that year of the Coercive (or Intolerable) acts, including the closing of the port of Boston and measures to buttress royal authority in Massachusetts, provoked keen resentment in all the colonies. As early as May 27 the members of the Virginia house of burgesses in unofficial session urged that they present a common front and join in forming a congress. In June the lower house of the Massachusetts assembly issued a call, and all of the colonies except Georgia responded by sending deputies to Philadelphia.

The delegates were not chosen with any particular rule as to number. When the congress assembled there were 44 members, originating as follows: 2 each from New Hampshire and Rhode Island; 3 each from Connecticut, Delaware and Maryland; 4 from Massachusetts; 5 each from New York, New Jersey and South Carolina; and 6 each from Virginia and Pennsylvania. Three delegates arrived later from North Carolina, and when all late comers had reported, the delegates numbered 56. (Georgia did not participate until 1775 during the second congress.) Each delegation had been commissioned by its colony but the credentials furnished were of various sorts. Those for Rhode Island carried the governor's signature, those for Massachusetts, the clerk's; others offered as their credentials the vote of their assemblies. Methods of election varied as well, including election by provincial congresses (Maryland, New Jersey, Delaware, North Carolina), by deputies appointed by the several towns (New Hampshire) and by "a general meeting of the inhabitants," later ratified by the assembly (South Carolina).

Peyton Randolph of Virginia was unanimously chosen president of the congress, and the historic choice of the terms president and congress, for the chairman and the assemblage, were also made at this time. Charles Thomson of Pennsylvania was elected secretary and served in this office during the 15 years that the congress functioned.

The manner of voting was an early subject of debate, with Patrick Henry urging that the delegation from each colony be given

weight in accordance with population. However, spokesmen for the smaller colonies insisted that each colony have one vote, and it was necessary to meet their wishes in order to secure unity.

The first continental congress contained several great and many talented men, including Patrick Henry, George Washington, John and Samuel Adams, John Jay and John Dickinson. Meeting in secret session, the delegates rejected a plan offered by Joseph Galloway (*q.v.*) of Pennsylvania that attempted to reconcile British authority and colonial freedom. Instead, on Oct. 14, the deputies adopted a declaration of personal rights, including those of life, liberty, property, assembly and trial by jury. The declaration also denounced taxation without representation and the maintenance of the British army in the colonies without their consent. However, the congress announced cheerful acceptance of parliamentary regulation of American commerce.

The first continental congress, in addition, sent a petition to the king, adopted on Oct. 26, and an address to the British people. It did not petition parliament. In effect, it demanded of Great Britain redress of grievances accumulated since 1763, and in general a return to the relationship (as the colonists conceived it) that had existed between the mother country and the colonies in that year. Toward forcing Britain to comply, the congress, on Oct. 20, called for the formation of an Association of the colonies to bring economic pressure upon the mother country. The Association provided for nonimportation and nonconsumption of British goods after Dec. 1, 1774, and for nonexportation of American products, except rice, to Britain or the British West Indies after Sept. 10, 1775. It was to be enforced by local committees. Adjourning on Oct. 26, the delegates issued a call for a second congress, to meet on May 10, 1775, and to consider further steps in the light of the behaviour of the British government during the interim.

Before the second continental congress assembled in the Pennsylvania statehouse, hostilities began at Lexington and Concord, Mass. The membership of the new body was much like that of the earlier one but it included Benjamin Franklin and, later, Thomas Jefferson. Peyton Randolph was again elected as president but later withdrew and was replaced by John Hancock. The second continental congress "adopted" the New England forces that had converged upon Boston after the battles of Lexington and Concord, and appointed Washington commander in chief of the American army on June 15, 1775. Assuming general direction of the American war effort, it also acted as the provisional government of the 13 colony-states, issuing and borrowing money, setting up a postal service and creating a navy (*see* AMERICAN REVOLUTION).

Although the congress continued for some months to claim that the Americans were struggling for their rights within the British empire, it gradually cut tie after tie with Britain and encouraged the establishment of revolutionary governments in the several colonies. The continued clash of arms, the failure of Britain to offer satisfactory concessions, the employment by Britain of Hessian troops, a desire for French aid and other circumstances impelled the congress toward complete separation. On July 2, 1776, with New York abstaining, it "unanimously" resolved that "these United Colonies are, and of right ought to be, free and independent states." Two days later it solemnly approved the Declaration of Independence (*q.v.*) which explained why the congress had taken the decisive step of July 2.

The congress continued to direct the American war effort. It prepared the Articles of Confederation, which, after being sanctioned by all the states, became the first constitution of the United States in March 1781; and it continued to function under that constitution until 1789, when it was replaced by the congress under the constitution adopted in 1788.

Sessions of the continental congresses were begun as follows: Sept. 5, 1774, and May 10, 1775, at Philadelphia; Dec. 20, 1776, at Baltimore; March 4, 1777, at Philadelphia; Sept. 27, 1777, at Lancaster, Pa.; Sept. 30, 1777, at York, Pa.; July 2, 1778, at Philadelphia; June 30, 1783, at Princeton, N.J.; Nov. 26, 1783, at Annapolis, Md.; Nov. 1, 1784, at Trenton, N.J.; and Jan. 11, 1785, at New York. The latter continued to be the meeting place until the adoption of the U.S. constitution. From 1781 to 1788, congress met annually on the first Monday in November as provided in the articles of confederation.

See also UNITED STATES (OF AMERICA): *History.*

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CONTINENTAL DIVIDE: *see* WATERSHED.

CONTINENTAL SHELF, the submerged margin of a continental platform (*see* CONTINENT). The surface of the earth lies at two general levels: a lower, which is the floor of the ocean basins, and an upper, the parts of which are the continents. Between these two levels is a comparatively narrow slope. The volume of ocean water is, however, a little too great to be entirely contained in the ocean basins, and so it must lap over somewhat on the lower, outer edges of the continental platforms. Such a submerged outer edge is called the continental shelf.

The shelf varies greatly in width. Almost everywhere it represents simply a continuation of the land surface beneath the ocean margins; hence, it is broad and relatively level offshore from plains, and narrow, rough and steep off mountainous coasts. The shelf thus is narrow off the mountainous western coast of the United States, and wide off the east coast of the United States and off the northwest coast of Europe surrounding the British Isles. Hudson bay is simply a part of the continental shelf.

Some parts of the world's continental shelves are extremely level—for example, that part off the arctic coast of Siberia—but more commonly they exhibit some relief. Close to the coast of New England are submerged glacial deposits. In places ridges or cliffs can be traced from the land onto the continental shelf.

River valleys that have been formed on land and then inundated can be mapped by soundings of the ocean floor on the submerged continental shelf. Where the sea has risen considerably relative to the land, cliffs formed by wave erosion when the ocean stood at a lower level may be submerged 200 ft. or more.

On most of the continental shelves of the world are developed extraordinarily deep canyons, the largest as much as 2,000 or 3,000 ft. deep. The sides of some of these are great vertical cliffs, but others are V-shaped like many youthful land valleys, though in general they are straighter than land valleys. Some of them connect with a system of land valleys, but their origin is one of the great scientific puzzles. (W. C. C.)

CONTINENTAL SYSTEM, the name given to Napoleon's design for paralyzing Great Britain through the destruction of British commerce. The decrees of Berlin (Nov. 21, 1806) and Milan (Dec. 17, 1807) proclaimed a blockade: neutrals and French allies were not to trade with the British.

To this "continental system" England responded by orders in council which subjected France and all countries in alliance with Napoleon to a counterblockade.

The campaign of starvation brought great suffering to the belligerents and vast annoyance to neutrals. It was one of the main causes of the Anglo-American War of 1812. But since the British had an overwhelming superiority at sea, the contest proved disastrous to Napoleon—not only because of the resulting privations, but also because to maintain his system he had to take on responsibilities too great for him. *See* NAPOLEONIC WARS; WAR OF 1812.

CONTINUED FRACTIONS. A continued fraction is obtained from a sequence of ordinary fractions a_1/b_1, a_2/b_2, a_3/b_3, . . . , called partial quotients, by adding each fraction to the denominator of the preceding fraction of the sequence, thus:

$$\cfrac{a_1}{b_1+\cfrac{a_2}{b_2+\cfrac{a_3}{b_3+\;\ddots}}}$$

(*see* FRACTION). To this may be added a number b_0. Each partial numerator a_p and partial denominator b_p may be any real or complex number. The continued fraction may terminate, or there may be infinitely many partial quotients. The ordinary fractions

$$\frac{A_0}{B_0}=\frac{b_0}{1},\ \frac{A_1}{B_1}=\frac{b_0b_1+a_1}{b_1},\ \frac{A_2}{B_2}=\frac{b_0b_1b_2+a_1b_2+a_2b_0}{b_1b_2+a_2},\cdots$$

obtained by cutting off the continued fraction with the successive partial quotients are called the approximants. These may be computed by means of the fundamental recurrence formulas

$$A_p=b_pA_{p-1}+a_pA_{p-2},\qquad p=2,\ 3,\ 4,\cdots$$
$$B_p=b_pB_{p-1}+a_pB_{p-2},$$

starting with the initial values $A_0=b_0,\ A_1=b_0b_1+a_1,\ B_0=1,\ B_1=b_1$. If the denominators B_p are different from zero from and after some value of p, and the sequence of approximants converges to a finite limit V, then the continued fraction is said to converge, and V is called its value. Otherwise the continued fraction is said to be divergent, and is assigned no value.

Continued fractions occupy an important place in mathematics because of their interesting properties and their connections with many different branches of science: number theory, theory of equations, probability, summability, theory of integration, infinite matrices and the theory of functions. They find applications in the physical sciences; for instance, in the theory of electrical networks and in certain problems in dynamics.

Convergence and Divergence.—It is easily seen that the values of the approximants of the continued fraction are unchanged if a_p and b_p are replaced by $c_{p-1}c_pa_p$ and c_pb_p, respectively ($p=1,\ 2,\ 3,\cdots$), where $c_0=1$, and $c_1,\ c_2,\ c_3,\cdots$ is any number sequence with none of its terms zero. This is called an equivalence transformation. If the a_p are different from zero, the c_p can be chosen so that the transformed continued fraction has all its partial numerators equal to unity.

Similarly, if the b_p are different from zero, the continued fraction is equivalent to another whose partial denominators are equal to unity. Thus, most continued fractions can be written in the forms

$$\text{(A)}\quad b_0+\cfrac{1}{b_1+\cfrac{1}{b_2+\cfrac{1}{b_3+\cdots}}}\qquad\text{and (B)}\quad b_0+\cfrac{a_1}{1+\cfrac{a_2}{1+\cfrac{a_3}{1+\cdots}}}$$

If the denominators B_p of the continued fraction are different from zero, then the continued fraction is equivalent, in a certain sense, to the infinite series

$$\frac{A_0}{B_0}+\sum_{p=1}^{\infty}\left(\frac{A_p}{B_p}-\frac{A_{p-1}}{B_{p-1}}\right)$$

In fact, the sum of the first n terms of this series is precisely the nth approximant of the continued fraction (*see* SERIES). If the series converges, its sum is the value of the continued fraction, and if the series diverges, the continued fraction diverges. The general term of the series is $(-1)^{p-1}a_1a_2\cdots a_p/B_pB_{p-1}$. This is an immediate consequence of the determinant formula

$$A_pB_{p-1}-A_{p-1}B_p=(-1)^{p-1}a_1a_2\cdots a_p$$

which is readily obtainable from the fundamental recurrence formulas.

By way of illustration, consider the so-called simple continued fraction, which is of the form (A) where b_0 is an integer, and each of $b_1,\ b_2\ b_3,\cdots$ a positive integer. Then, each B_p is a positive integer, and $B_0\leqq B_1<B_2<B_3<\cdots$. The above series is now $b_0+\sum_{p=1}^{\infty}(-1)^{p-1}/B_pB_{p-1}$. This is an alternating series in which the terms decrease numerically to the limit zero, and is therefore convergent. Hence the simple continued fraction is convergent. If V is its value, then the alternating character of the series shows that the even approximants increase to the limit V, the odd approximants decrease to the limit V, and

$$\left|V-\frac{A_n}{B_n}\right|\leqq\frac{1}{B_nB_{n+1}}<\frac{1}{B_n^2}$$

If the series $\Sigma|b_p|$ converges, then (A) is divergent. Thus, a necessary condition for (A) to converge is that the series $\Sigma|b_p|$ diverge. This condition is sufficient only when the b_p are subject to certain restrictions; *e.g.*, if the b_p are real and positive, or if $b_1\neq 0$ and $0<c\leqq\arg b_p\leqq\pi-c$, $p=1,\ 2,\ 3,\cdots$, where c is a positive number. It may easily be verified that if $b_p=(-1)^{p+1}$, then (A) is divergent although the series $\Sigma|b_p|$ diverges.

The continued fraction (B) converges if $|a_p|\leqq 1/4$, $p=2,\ 3,\ 4,\cdots$. On the other hand, it diverges if $a_p=-1/4-c$, $p=1,\ 2,\ 3,\cdots$, where c is a positive number. For convenience, let $b_0=0$ and $a_1=1$ in (B). In the plane of the complex variable $z=x+iy$, let W denote any bounded subset of the parabolic disk defined by $y^2\leqq x+1/4$ (*see* SET THEORY [THEORY OF AGGREGATES]). If each of the partial numerators $a_2,\ a_3,\ a_4,\cdots$ of (B) is in W, then (B) converges and its value is in the circular disk defined by $x^2-2x+y^2\leqq 0$. The statement concerning convergence of (B) is no longer true if the parabolic disk is replaced by a region having the parabolic disk as a proper subset.

These statements may perhaps serve to indicate some of the remarkable convergence properties of continued fractions.

Arithmetic Theory.—It has been shown that the simple continued fraction is convergent. Every real number has a simple continued-fraction expansion, which terminates if and only if the number is rational. To obtain the expansion of a rational fraction, the familiar Euclidean algorithm for the greatest common divisor is used. For example, $31/17=1+14/17$, $17/14=1+3/14$, $14/3=4+2/3$, $3/2=1+1/2$, so that

$$\frac{31}{17}=1+\cfrac{1}{1+\cfrac{1}{4+\cfrac{1}{1+\cfrac{1}{2}}}}$$

To expand an irrational number w, put $w=b_0+w_1$, where b_0 is the largest integer less than w, so that $0<w_1<1$. Then put $1/w_1=b_1+w_2$, where b_1 is the largest integer less than $1/w_1$, so that $0<w_2<1$. Continuation of this process gives step by step the simple continued-fraction expansion (A) for the number w. For example, if $w=\sqrt{7}$, then $w_1=\sqrt{7}-2$, $w_2=(\sqrt{7}-1)/3$, $w_3=(\sqrt{7}-1)/2$, $w_4=(\sqrt{7}-2)/3$, $w_5=\sqrt{7}-2=w_1$. Therefore, $b_0=2$, $b_1=1$, $b_2=1$, $b_3=1$, $b_4=4$, $b_5=1$, $\cdots$. The partial denominators run 1, 1, 1, 4, 1, 1, 1, 4, 1, 1, 1, 4, $\cdots$, repeating in blocks of four. Thus, the continued fraction is periodic. It can be shown that every quadratic surd has a periodic expansion, and that every periodic simple continued fraction is equal to a quadratic surd. From the above example the following approximations to $\sqrt{7}$ are found 2/1, 3/1, 5/2, 8/3, 37/14, 45/17, $\cdots$. These fractions are alternately less than and greater than $\sqrt{7}$.

It is easy to obtain the value of a periodic continued fraction. For example, let $b_0=1$, $b_p=2$, $p=1,\ 2,\ 3,\cdots$. Then if v is the value, $(v+1)=2+1/(v+1)$, $(v+1)^2-2(v+1)-1=0$, $v=\pm\sqrt{2}$. And since v is not negative, then $v=\sqrt{2}$.

The rational approximants for $\sqrt{N}$ obtained from the simple continued fraction have interesting geometrical properties. Consider the equation $x^2-Ny^2=h$, where h is an integer. This may be written in the form $(x/y)-\sqrt{N}=h/[(x/y)+\sqrt{N}]y^2$. If $x=A_n$ and $y=B_n$ the left-hand member of this equality is less in absolute value than $1/y^2$, and therefore $|h|<(A_n/B_n)+\sqrt{N}$, so that $|h|\leqq 2\sqrt{N}$. This shows that the set $A_n^2-NB_n^2$, $n=0,\ 1,\ 2,\cdots$, is finite. Geometrically, this means that there is a finite set of hyperbolas each having the line $x-\sqrt{N}y=0$ as asymptote, such that for every n the point with co-ordinates $(A_n,\ B_n)$ lies on one of them. If $N=7$, the first six of these points are (as indicated above) (2,1), (3,1), (5,2), (8,3), (37,14), (45,17). There are in this case three hyperbolas, namely $x^2-7y^2=1$, $x^2-7y^2=$

2, $x^2 - 7y^2 = -3$. The equation $x^2 - Ny^2 = 1$ is called Pell's equation. It can be shown that every solution in positive integers of Pell's equation is of the form $x = A_n$, $y = B_n$, where A_n/B_n is the nth approximant of the simple continued fraction for $\sqrt{N}$.

Irrational numbers which are not quadratic surds have infinite, nonperiodic, simple continued fractions. For example, in the simple continued fraction for $e = 2.71828 \cdots$, $b_0 = 2$, and $b_1, b_2, b_3, \cdots$ are 1, 2, 1, 1, 4, 1, 1, 6, 1, 1, 8, $\cdots$. In the case of $\pi = 3.14159 \cdots$, $b_0 = 3$, and $b_1, b_2, b_3, \cdots$ are 7, 15, 1, 292, 1, 1, 1, 2, $\cdots$, where the law of formation is not known. The numbers e and π have been proved to be transcendental; *i.e.*, they are not roots of algebraic equations with integral coefficients. Historically, the first proof of the existence of transcendental numbers was given by Joseph Liouville by means of continued fractions. He showed that if, for each positive integer n, there exists an index k such that $b_{k+1} > B_k^n$, then the value of the simple continued fraction is a transcendental number. For example, $b_{k+1} = 1 + B_k^k$, $k = 0, 1, 2, \cdots$; *i.e.*, $b_1 = 2$, $b_2 = 3$, $b_3 = 50, \cdots$.

Analytic Theory, Applications.—The most important continued fractions in the analytic theory are

$$\text{(C)}\quad \cfrac{1}{b_1+z-\cfrac{a_1^2}{b_2+z-\cfrac{a_2^2}{b_3+z-\cdots}}} \quad \text{and} \quad \text{(D)}\quad \cfrac{1}{k_1z+\cfrac{1}{k_2+\cfrac{1}{k_3z+\cfrac{1}{k_4+\cdots}}}}$$

Here each a_p and k_p is a number not zero, each b_p a number and z is a complex variable; (C) is called a Jacobi-fraction or J-fraction, and (D) is called a Stieltjes-fraction or S-fraction. The J-fraction is closely related to the Jacobi-matrix or J-matrix, which is the infinite matrix of coefficients of the system of equations

$$-a_px_p + (b_p + z)x_{p+1} - a_{p+1}x_{p+2} = 0,$$
$$p = 0, 1, 2, \cdots, (a_0 = 0)$$

The notation is chosen in (C) in such a way as to avoid square roots in the coefficients in this matrix. The theory of the J-fraction may be regarded as a part of David Hilbert's theory of infinite matrices and quadratic forms in infinitely many variables (*see* MATRIX).

T. J. Stieltjes used the continued fraction (D), with the k_p real and positive, to solve his celebrated moment problem. Let $x_1, x_2, x_3, \cdots$ be an increasing sequence of points along the positive half of the x-axis, and let m_p be a positive mass concentrated at x_p. If the sums $c_p = \sum_{k=1}^{\infty} x_k^p m_k$, $p = 0, 1, 2, \cdots$, exist they are called the moments of the distribution of mass. The Stieltjes moment problem is the problem of determining a distribution of mass which will have preassigned moments $c_0, c_1, c_2, \cdots$. Stieltjes found that the problem has a solution if and only if the formal power series $\sum_{p=0}^{\infty} (-1)^p c_p/z^{p+1}$ has an S-fraction expansion (D) in which the k_p are positive. He then constructed from the S-fraction by successive approximation a system of masses having the given moments. He had to permit continuous as well as discontinuous distributions of mass. Moreover, there is just one solution of the moment problem if the series Σk_p diverges. In this case, the S-fraction converges to a function of the form $\int_0^\infty dm(u)/(z+u)$. The function $m(u)$ then gives the distribution of mass, and $c_p = \int_0^\infty u^p dm(u)$, $p = 0, 1, 2, \cdots$. If the series Σk_p converges, then the problem has infinitely many different solutions.

This moment problem has been extended and applied in various directions. For instance, the ideas of Stieltjes formed much of the background for Hilbert's famous theory of quadratic forms in infinitely many variables; they were used by Felix Hausdorff in his method of summing divergent series; and T. Carleman applied the theory to prove fundamental theorems on quasi-analytic functions. The more general problem in which a distribution of mass is allowed along the entire real axis has been solved by means of J-fractions.

An important role of the continued fraction is to serve as an intermediary between a divergent power series and a definite integral. If the power series has a J-fraction or S-fraction expansion of suitable type, then it is asymptotically equal to one or more definite integrals of the form $\int_{-\infty}^{+\infty} dm(u)/(z+u)$. Consider, for example, the totally divergent series $\sum_{p=0}^{\infty} (-1)^p p!/z^{p+1}$.

This has the S-fraction expansion (D) in which $k_1 = 1$, $k_2 = 1$, $k_3 = 1$, $k_4 = 1/2$, $k_5 = 1/3$, $k_6 = 1/4, \cdots$. This S-fraction converges, and its value is $\int_0^\infty e^{-u}du/(z+u)$, a function which may be regarded as the "sum" of the divergent series. The continued fraction can be used in this way to connect divergent series with definite integrals in a wide variety of problems. Continued fractions are used to construct electrical networks having preassigned properties embodied in a given function. If this function is expanded into a continued fraction the characteristics of the required network can be read off immediately.

In certain problems of stability of dynamical systems it is important to have a simple algorithm for deciding whether or not all the zeros of a polynomial $P(z) = z^n + a_1z^{n-1} + a_2z^{n-2} + \cdots$ have negative real parts. In case the coefficients a_p are real, it is only necessary to expand $Q(z)/P(z)$, where $Q(z) = a_1z^{n-1} + a_3z^{n-3} + a_5z^{n-5} + \ldots$, into a continued fraction of the form

$$\cfrac{1}{c_1z+\cfrac{1}{c_2z+\cfrac{1}{c_3z+\ddots+\cfrac{1}{c_nz}}}}$$

The required criterion is that the c_p be positive. This expansion can be obtained by ordinary long division. If k of the c_p are positive and $n - k$ are negative, then k of the zeros of the polynomial have negative real parts and $n - k$ have positive real parts. This algorithm may be modified to cover polynomials with arbitrary complex coefficients.

Continued fractions are often useful in computing values of functions. For example, perhaps the best way to compute values of the integral $\int_0^a e^{-x^2}dx$ is to use the expansion $\sqrt{\pi}/2 - e^{-a^2}K$, where K is the continued fraction in which $b_0 = 0$, the sequence of partial numerators is $1, 1, 2, 3, 4, 5, \cdots$, and the sequence of partial denominators is $2a, a, 2a, a, 2a, a, \cdots$. Carl F. Gauss obtained a continued-fraction expansion for the quotient $F(a, b+1, c+1; z)/F(a, b, c; z)$ of contiguous hypergeometric functions. By specializing the parameters a, b, c, one may obtain expansions for many particular functions.

It is natural to ask whether or not it is possible to express, in a simple way, the sum, difference, product or quotient of two continued fractions as a continued fraction. The answer is in the negative. The operations of differentiation and integration are not suited to continued fractions. The operations which can be performed stem from the fact that a continued fraction is essentially the symbolic product of infinitely many linear fractional transformations in the complex plane. It may also be regarded as arising from a single linear transformation in the space of infinitely many variables. From the first point of view, the continued-fraction theory becomes a part of the theory of Möbius transformations; while from the second point of view, it becomes a part of the theory of infinite matrices and of quadratic forms in infinitely many variables. *See* also NUMBERS, THEORY OF.

BIBLIOGRAPHY.—Several treatises on algebra have chapters on the arithmetic theory of continued fractions. The book of H. S. Wall, *Analytic Theory of Continued Fractions* (1948), deals with questions of convergence and the function-theoretic aspects of continued fractions. The paper of J. S. MacNerney, "Investigation Concerning Positive Definite Continued Fractions," *Duke Mathe. J.*, vol. 26 (1959), deals with continued fractions whose partial numerators and denominators are matrices. (H. S. WL.)

CONTINUITY. The mathematical concept of continuity occurs in geometry and in the theory of functions, and so enter

into their applications to the physical world. Intuitively, an entity is regarded as continuous if it is unbroken; that is, has no gaps. Physical space and time are commonly considered as continuous. On the other hand matter is discrete; that is, it is made up of particles which are separated in space. However, for convenience, matter is frequently treated as if it were continuous, whenever such treatment gives a sufficiently close approximation to the observed facts.

An "equation of continuity" occurs in many branches of physics; for example, *see* MECHANICS, FLUID.

More precise definitions follow. In geometry, a straight line is said to be continuous if the following conditions hold true: (1) between every two points on the line there is a third point on the line; and (2) whenever the line is separated into two pieces there is always an extreme point on one of the pieces which may be taken to define the separation. This property of the straight line is an assumption or postulate, and geometric systems have been studied in which it is absent (*see* LINE). The continuity property of the real number system consists of two corresponding parts: (1) between every two real numbers there is a third real number; and (2) if the real numbers are separated into two subclasses A and B such that every number in A is less than every number in B, then either A contains a greatest number, or else B contains a least number. For the real numbers this property may be proved (*see* NUMBER). Thus the possibility of setting up a correspondence between the real numbers and the points on a line, such as lies at the basis of analytic geometry, depends on the continuity postulate in geometry. The rational numbers do not form a continuous system according to the definition above, since, for example, if A consists of all negative rational numbers and all positive rational numbers whose squares are less than two, and if B consists of the remaining rational numbers, then A contains no greatest number, and B contains no least.

A function $f(x)$ is said to be continuous at a point c if it has a value at c and if $f(x)$ approaches $f(c)$ when x approaches c (*see* FUNCTION). A function is continuous in a domain if it is continuous at every point of the domain. A continuous curve in a plane in which an xy-co-ordinate system has been set up consists of the points given by two continuous functions $x = f(t)$, $y = g(t)$ of a real variable t on an interval $a \leqq t \leqq b$. In topology the notion of continuous curve is used in a somewhat different but equivalent sense (*see* TOPOLOGY, GENERAL).

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(L. M. G.; G. T. WH.)

CONTINUO (BASSO CONTINUO): *see* THOROUGH BASS.

CONTINUOUS VOYAGE, the doctrine in international law that a voyage by way of an intermediate port is in fact continuous. During the Napoleonic Wars, U.S. merchants attempted to evade British blockade restrictions by carrying goods from the French West Indies to France via U.S. ports. British courts ruled that such voyages were in fact continuous and were not entitled to be considered neutral commerce. The U.S. federal government upheld the doctrine in the American Civil War in cases involving British transshipment of goods to the Confederate states. *See* CONTRABAND; NEUTRALITY.

CONTOUR FARMING is the practice of following the contour of the land in cultivation to reduce soil losses from surface erosion and to conserve water in the small furrows. In contour farming the plowman keeps to a level line at right angles to the direction of the slope, the usual result being furrows that curve around the slope and are level.

The early Phoenicians practised terracing and contour cultivation and through their colonizing spread the practice the length of the Mediterranean. In Rome, however, and later in Britain, Europe and the United States, the standard became cultivation in straight furrows rather than with regard to slope.

In the 20th century, agricultural research showed that contour farming reduced soil and water losses, the soil loss on 2% to 8% contoured slopes not more than 300 ft. long being about half that with straight-row cultivation. Dust storms in the U.S. Great Plains area in the 1930s focused new attention on soil erosion, conservation problems and practices including contouring. Demonstrations showed that contouring could, under ideal conditions, increase yields of row crops as much as 50%; increases of 5% to 10% were common. The practice also was extended to contour strip cropping (with strips of close-sown crops alternating with strips of other crops to slow down the run-off) and to contour furrowing of range land.

See SOIL EROSION AND CONSERVATION.

CONTOUR LINE, a line on a map, representing an imaginary line on the land surface all points of which are at the same elevation above a datum plane, usually mean sea level. Imagine a land surface inundated by the sea to a depth of 100 ft.; that is, the intersection of a horizontal plain with the uneven surface of the land. If then a line representing the edge of the sea is drawn on a map of the area, the result would be a contour line, and it would be called the 100-ft. contour. Similar contours could be drawn at successive 100-ft. intervals or at any desired interval. *See* also MAP. (W. C. C.)

CONTRABAND. The restrictions upon the mutual conduct of belligerents and neutrals that were being formulated from the later middle ages on involved the classification of certain supplies as contraband. Belligerents claimed the continuing liberty to appropriate these if they captured them on the way to an enemy. About weapons there could be little controversy; but in regard to things of less immediate military use wide diversity marked both theory and practice.

In his *De jure belli ac pacis,* first published in 1625, Hugo Grotius took note of an already old controversy as to what kind of things might properly be treated in the same way as weapons. He suggested a threefold division which might well have served as a rational solution. Things designed for use in war would always be subject to seizure on their way to enemy territory; things of no military value would always be exempt; and things necessary both in peace and in war would be seizable only if victory depended upon preventing their supply to the enemy. From time to time thereafter classifications on similar lines were advocated by writers or governments, with no visible effect upon practice. Governments issued proclamations at the beginning or in the course of hostilities listing the things they would seize, and these differed from country to country and from one set of wartime circumstances to another. The numerous treaties by which governments sought to limit such restrictions upon the trade of their nationals when neutral, while preserving as much liberty as possible when belligerent, varied too greatly to set anything resembling a fixed pattern. Naval stores and horses were included or excluded as the changing interests of the parties dictated; food and forage appeared in some contraband lists though they were excluded from most; and even saltpetre, an essential component of gunpowder, was sometimes left on the free list.

It was not the neutral state but the owners, and in some circumstances the carriers, that suffered the penalties for shipping contraband. Belligerents asserted the right to visit and search neutral ships, to confiscate contraband found aboard, and, if this exceeded a certain proportion of the cargo, was concealed by false papers or belonged to the shipowner, to take the ship itself as prize.

As for any responsibility attaching to the neutral state as such for supplies from its nationals to belligerents, this began to be acknowledged only after 1873, when the United States and Great Britain submitted to arbitration the depredations of the "Alabama" and other vessels fitted out in British territory for Confederate service in the American Civil War. (*See* "ALABAMA" ARBITRATION.) Even then, the arbitration covered only the building or fitting out of ships of war. The principle, adopted for the purposes of that arbitration, that neutral governments must use "due diligence" to prevent the construction or equipment of warships for belligerent service was recorded in Hague convention XIII of 1907 though the term "means at its disposal" was substituted for "due diligence." The principle was extended to military aircraft in the unratified air rules, drawn up at The Hague in 1923, which

attempted to adapt the surviving principles of maritime contraband to war in the air.

The stronger naval powers tended to expand the lists of contraband, for, having the means of protecting their own supply, they could weaken an enemy by cutting off his trade in essential commodities. The rudiments of economic warfare were understood long before the term came into use. Thus England, in opposition to the continental powers, and for some time to the United States as well, asserted the liberty to take provisions on their way to enemy forces or ports of naval supply. It was the gradual extension of this practice in the 19th century to a variety of goods necessary in war as in peace, with the U.S. contributing after 1812, that led to the general recognition of conditional contraband.

In 1908–1909 ten naval powers met in London to draw up an agreed code regarding belligerent restrictions on neutral trade for the guidance of the International Prize court that had been proposed at the Hague Peace conference of 1907. The resulting declaration of London classified goods as (1) absolute contraband; (2) conditional contraband; and (3) free. The first class was open to seizure on its way to any destination in enemy territory. In addition to arms, munitions and military equipment, it included horses. The second consisted of things such as food, clothing, money, rolling-stock, together with flying machines, which were to be treated as contraband only if in transit to the government or armed forces of an enemy. The third class listed goods not subject to capture.

Though never ratified, the declaration of London was near enough to a general consensus to be provisionally adopted on both sides when war broke out in 1914. But the demands of total war soon demonstrated the futility of such advance distinctions in supplies. Flying machines had become an essential weapon; articles such as rubber, cotton and even soap were moved from the free list to that of absolute contraband; and the taking over of import trade by the belligerent governments eliminated the difference of destination that had separated absolute from conditional contraband. The declaration was explicitly discarded in 1916.

Traditionally, destination was of the essence of contraband. Goods shipped by one neutral to another were in principle innocent. But British and American practice in the 19th century extended the liberty of seizure to goods which, though on their way to an immediate neutral destination, were to be forwarded to an enemy. In such cases the whole transportation, though broken by transshipment, was deemed one continuous voyage and, if goods satisfied the other conditions, those captured in the first part of the voyage were treated as contraband. This extension was recognized in the declaration of London, but, save where the receiving belligerent had no seaport, only in reference to absolute contraband. This exception in favour of conditional contraband was ignored in World War I. Insofar as destination still determined the guilt or innocence of a shipment, it was now uniformly ultimate destination.

Clearly the trend was toward full liberty to deprive an enemy of all benefit of neutral trade. This was emphasized between 1914 and 1918 by the Allied imposition of quotas upon European neutrals to prevent them from supplying the enemy with goods from their own stocks which they would then replace from foreign sources. The quotas were fixed by reference to the average peacetime requirements of the neutral country, and any excess was subject to appropriation by a belligerent. Even ultimate neutral destination of a particular shipment thus ceased to ensure exemption. The centuries-old effort to maintain, by distinctions in the nature of goods and their immediate destination, a measure of commercial liberty for nations remaining at peace, was approaching final defeat.

The swiftness of this development in its later stages was due to changes in the nature and scope of war. From a contest of armed forces, war had become a struggle engaging the entire corporate energies of nations. Anything sustaining those energies was legitimate prey to a belligerent. All commercial interchange, even between neutrals, was subject to interruption. As more and more nations were drawn into the fray, the neutral strength which had been a major factor in restraining belligerent action faded away. Economic strangulation, little hampered by the rules regarding contraband and blockade that 19th-century doctrine and treaties had sought to build into an effective code, became a principal weapon for nations equipped to use it. Where legal justification was thought useful, it was found in the notion of retaliation for violation of law by the enemy. In fact law, hobbled by the demands of modern war, could here keep no pace with power.

When in 1939 proclamations issued by the Allied powers and by Germany again differentiated between absolute and conditional contraband, listing food, forage and clothing under the latter head, this listing did not substantially enlarge the commercial liberties of neutrals. The only secure maritime trade left to them was that covered by the naval certificates ("navicerts") issued by belligerents to approved shippers and cargoes. This practice, already resorted to in World War I, was greatly extended in World War II. Its widespread adoption amounted to official assertion and acknowledgment that in time of war trade by sea was by belligerent licence. *See* also ECONOMIC WARFARE; NEUTRALITY.

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CONTRACEPTION: *see* BIRTH CONTROL.

CONTRACT. The simplest definition of a contract is that it is a promise enforceable by law. If the promise is broken, the remedy sometimes is specific or actual performance of what was promised, but generally is compensatory damages. A usual requisite of a contractual promise is that it must be the product of a bargain; *i.e.,* the person to whom the promise is made (the promisee) must give to the person making the promise (the promisor) something in exchange for the promise. The thing given in exchange (called consideration) may be an act, like the payment of money, performance of service, the transfer of real or personal property, a forbearance to act or the making of a return promise of any of these things. Hence a contract may involve a promise on one side only, in which case it is unilateral, or it may consist of promises on both sides, in which case it is bilateral.

Since a contract is usually a type of bargain, the making of a contract requires the mutual assent of two or more persons. This means that ordinarily there must be an offer by one person (the offeror) and an acceptance by another (the offeree). An offer is a manifestation of an intention to contract on the basis of stated terms, and an acceptance is an appropriate manifestation of assent to those terms. It is usually the reasonable impression created and not the subjective intent of the parties that is significant.

An offer must be accepted within the time specified by it or, if no time is specified, a reasonable time. An offeror also may prescribe the mode of acceptance, but in the absence of such a prescription the offeree may use any reasonable or customary mode.

If the parties deal with each other face to face or by telephone, it is usually assumed that, since instantaneous communication is possible, the acceptance must be communicated (*i.e.,* heard) before it is effective. However, if they are at a distance from each other and if an acceptance by mail, telegram or radiogram is authorized by the offer, the question of when the contract is closed is a debatable one. In the interest of the expeditious closing of commercial transactions, English and nearly all U.S. authorities support the view that the contract is made when the offeree sends the communication of acceptance.

Unless an offeror receives consideration for holding an offer open, he may revoke it with impunity at any time before it is accepted, and a revocation is accomplished by any notice thereof that reaches the offeree.

An adequate description of a contract must include the legal consequences as well as the facts necessary to its creation. The traditional term used to describe these consequences is obligation.

Obligation here means legal duty. One who makes a contractual promise to do an act comes under a legal duty to do the act. Correlatively, the promisee acquires against the promisor a legal right (or claim) that the act shall be done. This means that if the act is not done (there being no legal excuse), the promisee may pursue his judicial remedy against the promisor.

(G. W. Go.)

HISTORY

Enforcement of good faith in matters of bargain and promise is among the most important functions of legal justice. It might not be too much to say that, next after keeping the peace and securing property against violence and fraud so that business may be possible, it is the most important. Yet we shall find that the importance of contract is developed comparatively late in the history of law. The commonwealth needs elaborate rules about contracts only when it is advanced enough in civilization and trade to have an elaborate system of credit. The Roman law of the empire dealt with contract, indeed, in a fairly adequate manner, though it never had a complete or uniform theory; and the Roman law, as settled by Justinian, appears to have satisfied the eastern empire long after the western nations had begun to recast their institutions and the traders of the Mediterranean had struck out a cosmopolitan body of rules and custom known as the law merchant, which claimed acceptance in the name neither of Justinian nor of the church but of universal reason. It was amply proved afterward that the foundations of the Roman system were strong enough to carry the fabric of modern legislation. But the collapse of the Roman power in western Christendom threw society back into chaos.

In this condition of legal ideas, which it would be absurd to call jurisprudence, the general duty of keeping faith is not recognized except as a matter of religious or social observance. Those who desire to be assured of anything that lies in promise must exact an oath, or a pledge, or personal sureties; and even then the court of their people—in England the hundred court in the first instance—will do nothing for them in the first case, and not much in the two latter. Probably the settlement of a blood feud, with provisions for the payment of the fine by installments, was the nearest approach to a continuing contract, as we now understand the term, which the experience of Germanic antiquity could furnish. It is also probable that the performance of such undertakings, as it concerned the general peace, was at an early time regarded as material to the commonweal; and that these covenants of peace, rather than the rudimentary selling and bartering of their day, first caused our Germanic ancestors to realize the importance of putting some promises at any rate under public sanction. The history of the law, and even the form of much law still common to almost all the English-speaking world, can be understood only when we bear in mind that our forefathers did not start from any general conception of the state's duty to enforce private agreements, but, on the contrary, the state's powers and functions in this regard were extended gradually, unsystematically and by shifts and devices of ingenious suitors and counsel, aided by judges, rather than by any direct provisions of princes and rulers. Money debts, it is true, were recoverable from an early time. But this was not because the debtor had promised to repay the loan; it was because the money was deemed still to belong to the creditor, as if the identical coins were merely in the debtor's custody. The creditor sued to recover money, for centuries after the Norman Conquest, in exactly the same form which he would have used to demand possession of land; the action of debt closely resembled the "real actions," and, like them, might be finally determined by a judicial combat; and down to Sir William Blackstone's time the creditor was said to have a property in the debt—property which the debtor had "granted" him. Giving credit, in this way of thinking, is not reliance on the right to call hereafter for an act, the payment of so much current money or its equivalent, to be performed by the debtor, but merely suspension of the immediate right to possess one's own particular money, as the owner of a house let for a term suspends his right to occupy it. This was no road to the modern doctrine of contract, and the passage had to be made another way.

In fact the old action of debt covered part of the ground of contract only by accident. It was really an action to recover any property that was not land; for the remedy of a dispossessed owner of chattels, afterward known as detinue, was only a slightly varying form of it. If the property claimed was a certain sum of money, it might be due because the defendant had received money on loan or because he had received goods of which the agreed price remained unpaid; or, in later times at any rate, because he had become liable in some way by judgment, statute or other authority of law to pay a fine or fixed penalty to the plaintiff. Here the person recovering might be as considerable as the lord of a manor or as mean as a "common informer"; the principle was the same. In every case outside this last class—that is to say, whenever there was a debt in the popular sense of the word—it had to be shown that the defendant had actually received the money or goods; this value received came to be called *quid pro quo*—a term unknown, to all appearance, out of England. Nevertheless, the foundation of the plaintiff's right was not bargain or promise but the unjust detention by the defendant of the plaintiff's money or goods.

Modes of Proof.—We are not concerned here to trace the change from the ancient method of proof—oath backed by "good suit," *i.e.*, the oaths of an adequate number of friends and neighbours—through the earlier form of jury trial, in which the jury were supposed to know the truth of their own knowledge, to the modern establishment of facts by testimony brought before a jury who are bound to give their verdict according to the evidence. But there was one mode of proof which, after the Norman Conquest, made a material addition to the substantive law. This was the proof by writing, which means writing authenticated by seal. Proof by writing was admitted under Roman influence, but, once admitted, it acquired the character of being conclusive which belonged to all proof in early Germanic procedure. Oath, ordeal and battle were all final in their results. When the process was started there was no room for discussion, though any formal irregularity was fatal. So the sealed writing was final too, and a man could not deny his own deed. We still say that he cannot, but with modern refinements. Thus the deed, being allowed as a solemn and probative document, furnished a means by which a man could bind himself, or rather effectually declare himself bound, to anything not positively forbidden by law. Whoever could afford parchment and the services of a clerk might have the benefit of a "formal contract" in the Roman sense of the term. In modern times the form of deed called a bond or "obligation" is, as it stands settled after various experiments, extremely artificial; but it is essentially a solemn admission of liability, though its conclusive stringency has been relaxed by modern legislation and practice in the interest of substantial justice. By this means the performance of all sorts of undertakings, pecuniary and otherwise, could be and was legally secured. Bonds were well known in the 13th century, and from the 14th century onward were freely used for commercial and other purposes; as for certain limited purposes they still are. The "covenant" of modern draftsmen is a direct promise made by deed; it occurs mainly as incident to conveyances of land. The medieval covenant, *conventio*, was, when we first hear of it, practically equivalent to a lease, and never became a common instrument of miscellaneous contracting, though the old books recognize the possibility of turning it to various uses of which there are examples; nor had it any sensible influence on the later development of the law. On the whole, in the old common law one could do a great deal by deed, but very little without deed. The minor bargains of daily life, so far as they involved mutual credit, were left to the jurisdiction of inferior courts, of the law merchant and—last, not least—of the church.

Fidei Laesio.—Popular custom, in all European countries, recognized simpler ways of pledging faith than parchment and seal. A handshake was enough to bind a bargain. Whatever secular law might say, the church said it was an open sin to break plighted faith; a matter, therefore, for spiritual correction—in other words, for compulsion exercised on the defaulter by the bishop's or the

archdeacon's court, armed with the power of excommunication. In this way the ecclesiastical courts acquired much business which was, in fact, as secular as that of a modern county court, with the incident profits. Medieval courts lived by the suitors' fees. What were the king's judges to do? However high they put their claims in the course of the rivalry between church and crown, they could not effectually prohibit the bishop or his official from dealing with matters for which the king's court provided no remedy. Continental jurists had seen their way, starting from the Roman system as it was left by Justinian, to reduce its formalities to a vanishing quantity and to expand their jurisdiction to the full breadth of current usage. English judges could not do this in the 15th century, if they could ever have done so. Nor would simplification of the requisites of a deed, such as has now been introduced in many jurisdictions, have been of much use at a time when only a minority even of well-to-do laymen could write.

There was no principle and no form of action in English law which recognized any general duty of keeping promises. But could not breach of faith by which a party had suffered be treated as some kind of legal wrong? There was a known action of trespass and a known action of deceit, this last of a special kind, mostly for what would now be called abuse of the process of the court; but in the later middle ages it was an admitted remedy for giving a false warranty on a sale of goods. Also there was room for actions "on the case," on facts analogous to those covered by the old writs, though not precisely within their terms. If the king's judges were to capture this important branch of business from the clerical hands which threatened to engross it, the only way was to devise some new form of action on the case. There were signs, moreover, that the court of chancery would not neglect so promising a field if the common-law judges left it open.

Assumpsit.—The mere fact of unfulfilled promise was not enough, in the eyes of medieval English lawyers, to give a handle to the law. But injury caused by reliance on another man's undertaking was different. The special undertaking or "assumption" creates a duty which is broken by fraudulent or incompetent miscarriage in the performance. I profess to be a skilled farrier and lame your horse. It is no trespass, because you trusted the horse to me; but it is something like a trespass, and very like a deceit. An action on the case was allowed without much difficulty for such defaults. The next step, and a long one, was to provide for total failure to perform. A builder, instead of doing bad work, does nothing at all within the time agreed upon for completing a house. Can it be said that he has done a wrong? At first the judges felt bound to hold that this was going too far; but suitors anxious to have the benefit of the king's justice persevered, and in the course of the 15th century the new form of action, called assumpsit from the statement of the defendant's undertaking on which it was founded, was allowed as a remedy for nonperformance as well as for faulty performance. Being an action for damages and not for a certain amount, it escaped the strict rules of proof which applied to the old action of debt; being in form for a kind of trespass, and thus a privileged appeal to the king to do right for a breach of his peace, it escaped likewise the risk of the defendant clearing himself by oath according to the ancient popular procedure. Hence, as time went on, suitors were emboldened to use assumpsit as an alternative for debt, though it had been introduced only for cases where there was no other remedy. By the end of the 16th century they got their way; and it became a settled doctrine that the existence of a debt was enough for the court to presume an undertaking to pay it. The new form of action was made to cover the whole ground of informal contracts, and, by extremely ingenious devices of pleading, developed from the presumption or fiction that a man had promised to pay what he ought, it was extended in time to a great variety of cases where there was in fact no contract at all.

Consideration.—The new system gave no new force to gratuitous promises. For it was assumed, as the foundation of the jurisdiction, that the plaintiff had been induced by the defendant's undertaking, and with the defendant's consent, to alter his position for the worse in some way. He had paid or bound himself to pay money, he had parted with goods, he had spent time in labour or he had foregone some profit or legal right. If he had not committed himself to anything on the strength of the defendant's promise, he had suffered no damage. To sum up the foregoing in modern language, the plaintiff must have given value of some kind, more or less, for the defendant's undertaking. This something given by the promisee and accepted by the promisor in return for his undertaking is what we now call the consideration for the promise. In cases where debt would also lie, it coincides with the old requirement of value received (*quid pro quo*) as a condition of the action of debt being available. But the conception is far wider, for the consideration for a promise need not be anything capable of delivery or possession. It may be money or goods; but it may also be an act or series of acts, further (and this is of the first importance for modern law), it may itself be a promise to pay money or deliver goods, or to do work, or otherwise to act or not to act in some specified way. Again, it need not be anything which is obviously for the promisor's benefit. His acceptance shows that he set some value on it; but in truth the promisee's burden, and not the promisor's benefit, is material. The last and not strictly logical refinement of holding that, when mutual promises are exchanged between parties, each promise (though by itself of no value) is a consideration for the other and makes it binding, was conclusively accepted only in the 17th century. The result was that promises of mere bounty could no more be enforced than before, but any kind of lawful bargain could; and there is no reason to doubt that this was in substance what most men wanted. Ancient popular usage and feeling show little more encouragement than ancient law itself to merely gratuitous alienation or obligations. Also (subject, till quite modern times, to the general rule of common-law procedure that parties could not be their own witnesses, and subject to various modern statutory requirements in various classes of cases), no particular kind of proof was necessary. The necessity of consideration for the validity of simple contracts was unfortunately confused by commentators, almost from the beginning of its history, with the perfectly different rules of the Roman law about *nudum pactum* (a pact made without consideration), which very few English lawyers took the pains to understand.

The doctrine of consideration is in fact peculiar to those jurisdictions where the common law of England is in force, or is the foundation of the received law, or, as in South Africa, has made large encroachments upon it in practice. Substantially similar results are obtained in other modern systems by professing to enforce all deliberate promises, but imposing stricter conditions of proof where the promise is gratuitous.

As obligations embodied in the solemn form of a deed were thereby made enforceable before the doctrine of consideration was known, so they still remain. When a man has by deed declared himself bound, there is no need to look for any bargain or even to ask whether the other party has assented. This rugged fragment of ancient law remains embedded in our elaborate modern structure. Nevertheless, gratuitous promises, even by deed, get only their strict and bare rights. There may be an action upon them, but the powerful remedy of specific performance—often the only one worth having—is denied them. For this is derived from the extraordinary jurisdiction of the chancellor, and the equity administered by the chancellor was not for plaintiffs who could not show substantial merit as well as legal claims. The singular position of promises made by deed is best left out of account in considering the general doctrine of the formation of contracts; and as to interpretation there is no difference. In what follows, therefore, it will be needless, as a rule, to distinguish between "parol" or "simple" contracts, that is, contracts not made by deed, and obligations undertaken by deed.

Promise and Offer.—From the conception of a promise being valid only when given in return for something accepted in consideration of the promise, it follows that the giving of the promise and of the consideration must be simultaneous. Words of promise uttered before there is a consideration for them can be no more than an offer; and, on the other hand, the obligation declared in words or inferred from acts and conduct, on the acceptance of a consideration, is fixed at that time and cannot be varied by sub-

sequent declaration, though such declarations may be material as admissions. It was a long while, however, before this consequence was clearly perceived. In the 18th century it was attempted, and for a time with considerable success, to extend the range of enforceable promises without regard to what the principles of the law would bear, in order to satisfy a sense of natural justice. This movement was finally checked as late as 1840, and traces of it remain in certain apparently anomalous rules which are indeed of little practical importance but which private writers, at any rate, cannot safely treat as obsolete. However, the question of "past consideration" is too minute and technical to be pursued here. The general result is that a binding contract is regularly constituted by the acceptance of an offer at the moment it is accepted. It also follows that an offer before acceptance creates no duty of any kind, which is by no means necessarily the case in systems where the English rule of consideration is unknown. The question of what amounts to final acceptance of an offer is, on the other hand, a question ultimately depending on common sense. The rules that an offer is understood to be made only for a reasonable time, according to the nature of the case, and lapses if not accepted in due time; that an expressed revocation of an offer can take effect only if communicated to the other party before he has accepted; that acceptance of an offer must be according to its terms, and a conditional or qualified acceptance is only a new proposal, and the like, stand on general convenience as much as on any technical ground.

Correspondence.—Great difficulties have arisen, in other systems as well as in the English, as to the completion of contracts between persons at a distance. There must be some rule, and yet any rule that can be framed must seem arbitrary in some cases. On the whole the modern doctrine is as follows:

The proposer of a contract can prescribe or authorize any mode, or at least any reasonable mode, of acceptance, and if he specifies none he is deemed to authorize the use of any reasonable mode in common use, and especially the post. Acceptance in words is not always required; an offer may be well accepted by an act clearly referable to the proposed agreement and constituting the whole or part of the performance asked for—say the dispatch of goods in answer to an order by post, or the doing of work bespoken; and it seems that in such cases further communication—unless expressly requested—is not necessary as a matter of law, however prudent and desirable it may be. Where a promise and not an act is sought (as where a tradesman writes a letter offering goods for sale on credit), it must be communicated; in the absence of special direction, letter post or telegraph may be used; and, further, the acceptor having done his part when his answer is committed to the post, English courts since 1879 have held, after considerable previous doubt, that any delay or miscarriage in course of post is at the proposer's risk, so that a man may be bound by an acceptance he never received. It is generally thought —though there is no English decision—that, in conformity with this last rule, a revocation by telegraph of an acceptance already posted would be inoperative. Much more elaborate rules are laid down in some continental codes. It seems doubtful whether their complication achieves any gain of substantial justice worth the price. At first sight it looks easy to solve some of the difficulties by admitting an interval during which one party is bound and the other not. But, apart from the risk of starting fresh problems as hard as the old ones, English principles, as above said, require a contract to be concluded between the parties at one point of time, and any exception to this would have to be justified by very strong grounds of expediency. We have already assumed, but it should be specifically stated, that neither offers nor acceptances are confined to communications made in spoken or written words. Acts or signs may and constantly do signify proposal and assent. One does not in terms request a ferryman to put one across the river. Stepping into the boat is an offer to pay the usual fare for being ferried over, and the ferryman accepts it by putting off. This is a very simple case, but the principle is the same in all cases. The term "implied contract," current in this connection, is ambiguous. It sometimes means a contract concluded by acts, not words, of one or both parties, but still a real agreement; sometimes an obligation imposed by law where there is not any agreement in fact, for which the name "quasi contract" or "constructive contract" is more appropriate and now usual.

Interpretation.—The obligation of contract is an obligation created and determined by the will of the parties. Herein is the characteristic difference of contract from all other branches of law. The business of the law, therefore, is to give effect so far as possible to the intention of the parties, and all the rules for interpreting contracts go back to this fundamental principle and are controlled by it. Everyone knows that its application is not always obvious. Parties often express themselves obscurely; still oftener they leave large parts of their intention unexpressed, or (which for the law is the same thing) have not formed any intention at all as to what is to be done in certain events. Thus just as there are situations where the parties have made no express contract, either orally or in writing, so that when one man asks another to do certain work and the other does it, the man who does the work will be entitled to reasonable payment for it, so, too, the courts will sometimes imply the existence of certain terms in a contract that is otherwise express. The courts will not, however, make a contract for the parties: all they will do is infer from the express terms of an agreement and from the circumstances what the intentions of the parties were, and seek to give effect to them. Difficulties of interpretation will often arise where one of the parties contends that a contract has been discharged by impossibility of performance, arguing that a term putting an end to the contract in the circumstances that have arisen ought to be implied. There is a wealth of authorities, not always in agreement with each other, on the doctrine of frustration, but it must be emphasized that it is by no means every unexpected turn of events that will bring it into application. It sometimes used to be said that the subject matter of the contract had to be destroyed. The matter is clearly put in *Chitty on Contracts* (22nd ed., vol. 1, p. 1175, Sweet & Maxwell Ltd.): "*Theory of a radical change in the obligation.* In view of the decision of the House of Lords in *Davis Contractors* (1956, A.C. 696), *Ltd.* v. *Fareham U.D.C.*, the proper test for frustration may be formulated as follows: If the literal words of the contract were to be enforced in the changed circumstances, would this involve a significant or radical change from the obligation originally undertaken?" The court cannot add to the contract terms that were not in it originally or take away from them in order to do what is just and reasonable in the circumstances. A rule which can take effect against the judicially known will of the parties is not a rule of construction or interpretation but a positive rule of law. However artificial some rules of construction may seem, this test will always hold. In modern times the courts have avoided laying down new rules of construction, preferring to keep a free hand and to deal with each case on its merits as a whole. It should be observed that the fulfillment of a contract may create a relation between the parties which, once established, is governed by fixed rules of law not variable by the preceding agreement. Marriage is the most conspicuous example of this, and perhaps the only complete one in our modern law.

There are certain rules of evidence which to some extent guide or restrain interpretation. In particular, oral testimony is not allowed to vary the terms of an agreement reduced to writing. This is really in aid of the parties' deliberate intention, for the object of reducing terms to writing is to make them certain. There are apparent exceptions to the rule, of which the most conspicuous is the admission of evidence to show that words were used in a special meaning current in the place or trade in question. But they are reducible, it will be found, to applications (perhaps oversubtle in some cases) of the still more general principles that, before giving legal force to a document, we must know that it is really what it purports to be, and that when we do give effect to it according to its terms we must be sure of what its terms really say. The rules of evidence here spoken of are modern, and have nothing to do with the archaic rule already mentioned as to the effect of a deed.

Performance.—Every contracting party is bound to perform his promise according to its terms and, in case of any doubt, in the

sense in which the other party would reasonably understand the promise. Where the performance on one or both sides extends over an appreciable time, continuously or by installments, questions may arise as to the right of either party to refuse or suspend further performance on the ground of some default on the other side. Attempts to lay down hard and fast rules on such questions are now discouraged, the aim of the courts being to give effect to the true substance and intent of the contract in every case. Nor will the court hold one part of the terms deliberately agreed to more or less material than another in modern business dealings. "In the contracts of merchants time is of the essence," as the supreme court of the United States has said. Certain ancient rules restraining the apparent literal effect of common provisions in mortgages and other instruments were in truth controlling rules of policy. New rules of this kind can be made only by legislation. Whether the parties did or did not in fact intend the obligation of a contract to be subject to unexpressed conditions is, however, a possible and not uncommon question of interpretation, as we have noted above. One class of cases giving rise to such questions is that in which performance according to the real intent of the parties is frustrated by some external cause not due to the promisor's own fault. As to promises obviously absurd or impossible from the first, they are unenforceable only on the ground that the parties cannot have seriously meant to create a liability. For precisely the same reason, supported by the general usage and understanding of mankind, common social engagements, though they often fulfill all other requisites of a contract, have never been treated as binding in law. The singular case has actually occurred of parties framing a complete business agreement and adding an "honourable pledge clause" which expressly excluded legal jurisdiction. Here the manifest intention not to create an enforceable obligation prevents the other specific terms, however precise, from creating any.

Illegality.—In all matters of contract, as we have said, the ascertained will of the parties prevails. But this means a will both lawful and free. Hence there are limits to the force of the general rule, fixed partly by the law of the land, which is above individual will and interests, and partly by the need of securing good faith and justice between the parties themselves against fraud or misadventure. Agreements cannot be enforced when their performance would involve an offense against the law. There may be legal offense, it must be remembered, not only in acts commonly recognized as criminal, disloyal or immoral, but in the breach or nonobservance of positive regulations made by the legislature, or persons having statutory authority, for a variety of purposes. Again, there are cases where an agreement may be made and performed without offending the law, but on grounds of "public policy" it is not thought right that the performance should be a matter of legal obligation, even if the ordinary conditions of an enforceable contract are satisfied. A man may bet, in private at any rate, if he likes, and pay or receive as the event may be; but for many years the winner has had no right of action against the loser. But what is really important under this doctrine of public policy is the confinement of "contracts in restraint of trade" within special limits. In the middle ages and down to modern times there was a strong feeling—not merely an artificial legal doctrine—against monopolies and everything tending to monopoly. Agreements to keep up prices or not to compete were regarded as criminal. Gradually it was found that some kind of limited security against competition must be allowed if such transactions as the sale of a going concern with its good will, or the retirement of partners from a continuing firm, or the employment of confidential servants in matters involving trade secrets, were to be carried on to the satisfaction of the parties. Attempts to lay down fixed rules in these matters were made from time to time, but they were finally discredited by the decision of the house of lords in the Maxim-Nordenfelt company's case in 1894. Contracts "in restraint of trade" will now be held valid, provided that they are made for valuable consideration (this even if they are made by deed), do not go beyond what can be thought reasonable for the protection of the interests concerned and are not injurious to the public. All that remains of the old rules in England is the necessity of valuable consideration, whatever be the form of the contract, and a strong presumption—but not an absolute rule of law—that an unqualified agreement not to carry on a particular business is not reasonable.

The Restrictive Trade Practices act, 1956, which, among other things, established the restrictive practices court, empowered that court to declare contrary to the public interest any agreements, as defined in sec. 6 of the act, under which restrictions are accepted by the parties in respect of prices, the application of any process of manufacture to goods, the terms or conditions of supply, and a number of other matters. Under sec. 21, such agreements are presumed to be against the public interest unless the court recognizes the existence of certain circumstances set out in the section, such as that the removal of the restriction would deny to the public as purchasers, consumers or users of any goods other specific and substantial benefits or advantages enjoyed or likely to be enjoyed by them as such, whether by virtue of the restriction itself or of any arrangements or operations resulting therefrom. If the court declares restrictions under such an agreement to be contrary to the public interest, the agreement will, by virtue of sec. 20, be void in respect of those restrictions. Sections 24–27 of the act prohibit agreements concerning the collective enforcement of conditions as to resale prices, but individual enforcement may be permitted even, in certain circumstances, against a person who was not a party to the original sale.

Fraud.—Where there is no reason in the nature of the contract for not enforcing it, the consent of a contracting party may still not be binding on him because it was not given with due knowledge, or, if he is in a relation of dependence to the other party, with independent judgment. Inducing a man by deceit to enter into a contract may always be treated by the deceived party as a ground for avoiding his obligation if he does so within a reasonable time after discovering the truth and, in particular, before any innocent third person has acquired rights for value on the faith of the contract. (*See* FRAUD.) Coercion would be treated on principle in the same way as fraud, but such cases hardly occur in modern times. There is a kind of moral domination, however, which our courts watch with the utmost jealousy and repress under the name of "undue influence" when it is used to obtain pecuniary advantage. Persons in a position of legal or practical authority—guardians, confidential advisers, spiritual directors and the like—must not abuse their authority for selfish ends. They are not forbidden to take benefits from those who depend on them or put their trust in them; but if they do, and the givers repent of their bounty, the whole burden of proof is on the takers to show that the gift was in the first instance made freely and with understanding. Large voluntary gifts or beneficial contracts, outside the limits within which natural affection and common practice justify them, are indeed not encouraged in any system of civilized law. Professional moneylenders were formerly checked by the usury law; after those laws were repealed in 1854, courts and juries showed a certain astuteness in applying the rules of law as to fraud and undue influence—the latter with certain special features—to transactions with needy "expectant heirs" and other improvident persons which seem on the whole unconscionable. The Money-Lenders act of 1900 and subsequent amendments have fixed and (as finally interpreted by the house of lords) also sharpened these developments. In the case of both fraud and undue influence, the person entitled to avoid a contract may, if so advised, ratify it afterward; and ratification, if made with full knowledge and free judgment, is irrevocable. A contract made with a person deprived by unsound mind or intoxication of the capacity to form a rational judgment is on the same footing as a contract obtained by fraud, if the want of capacity is apparent to the other party.

Misrepresentation.—There are many cases in which a statement made by one party to the other about a material fact will enable the other to avoid the contract if he has relied on it and it was in fact untrue, though it may have been made at the time with honest belief in its truth. This is so wherever, according to the common course of business, it is one party's business to know the facts and the other practically must, or reasonably may, take

the facts from him. In some classes of cases even inadvertent omission to disclose any material fact is treated as a misrepresentation. Contracts of insurance are the most important; here the insurer very seldom has the means of making any effective inquiry of his own. Misdescription of real property on a sale, without fraud, may according to its importance be a matter for compensation or for setting aside the contract. Promoters of companies are under special duties as to good faith and disclosure which have been worked out at great length in the modern decisions. But company law has become so complex within the present generation that, so far from throwing much light on larger principles, it is hardly intelligible without some previous grasp of them.

Mistake is said to be a ground for avoiding contracts, and there are cases which it is practically convenient to group under this head. On principle they seem to be mostly reducible to failure of the acceptance to correspond with the offer, or absence of any real consideration for the promise. In such cases, whether there be fraud or not, no contract is ever formed, and therefore there is nothing which can be ratified—a distinction which may have important effects. Relief against mistake is given where parties who have really agreed, or rather their advisers, fail to express their intention correctly. Here, if the original true intention is fully proved—as to which the court is rightly cautious—the faulty document can be judicially rectified.

Disability.—By the common law an infant (*i.e.*, a person less than 21 years old) was bound by contracts made for "necessaries," *i.e.*, such commodities as a jury holds, and the court thinks they may reasonably hold, suitable and required for the person's condition; also by contracts otherwise clearly for his benefit; all other contracts he might confirm or avoid after coming of age. An extremely ill-drawn act of 1874 absolutely deprived infants of the power of contracting loans, contracting for the supply of goods other than necessaries, and stating an account so as to bind themselves; it also disabled them from binding themselves by ratification. The liability for necessaries was declared by legislative authority in the Sale of Goods act, 1893; the modern doctrine is that it is in no case a true liability on contract. There is an obligation imposed by law to pay, not the agreed price, but a reasonable price. Practically, people who give credit to an infant do so at their peril, except in cases of obvious urgency.

Married women were incapable by the common law of contracting in their own names. They can now hold separate property and can bind themselves to the extent of that property—not personally—by contract. The law before the Married Women's Property acts (1882 and 1893, and earlier acts now superseded and repealed) was a very peculiar creature of the court of chancery; the cases in which it is necessary to go back to it are, of course, very few. But a married woman can still be restrained from anticipating the income of her separate property, and the restriction is still commonly inserted in marriage settlements. (*See* also WOMEN, LEGAL POSITION OF.)

There is a great deal of philosophical interest about the nature and capacities of corporations, but for modern practical purposes it may be said that the legal powers of British corporations are directly or indirectly determined by acts of parliament. For companies under the Companies acts the controlling instrument or written constitution is the memorandum of association. Company draftsmen, taught by experience, nowadays frame this in the most comprehensive terms. Questions of either personal or corporate disability are less frequent than they were. In any case they stand apart from the general principles of our law of contract.

Contract and Property.—The rights created by contract are personal rights against the promisors and their legal representatives, and therefore different in kind from the rights of ownership and the like which are available against all the world. Nevertheless, they may be and very commonly are capable of pecuniary estimation and estimated as part of a man's assets. Book debts are the most obvious example. Such rights are property in the larger sense: they are in modern law transmissible and alienable, unless the contract is of a kind implying personal confidence or a contrary intention is otherwise shown. The rights created by negotiable instruments are an important and unique species of property, being not only exchangeable but the very staple of commercial currency. Contract and conveyance, again, are distinct in their nature, and sharply distinguished in the classical Roman law. But in the common law, property in goods is transferred by a complete contract of sale without any further act, and under the French civil code and systems which have followed it a like rule applies not only to movables but to immovables. In English law, procuring a man to break his contract is a civil wrong against the other contracting party, subject to exceptions which are still not clearly defined. (F. Po.; W. T. Ws.)

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Forms of Contract.—Though a contract originates in offer and acceptance, these, as stated above, need not be express or explicit. A public bus, for example, may stop for a passenger, who boards the bus and drops a coin in the fare box; a contract has been made by which the proprietor of the bus promises to transport the passenger to any station on the bus's route. Again, someone may enter a store where he carries a charge account, pick up an article from the counter and show it to a clerk; if the clerk nods his head and the customer puts the article in his pocket and walks out, a contract has been made by which the customer is bound to pay a reasonable (or marked) price for the article, though no word has been spoken on either side. The term "implied-in-fact" has been applied to this type of contract.

Contracts involving land, goods or large-scale construction are frequently the result of higgling or negotiating about terms. This type of agreement may be oral, or reduced to writing and signed by the parties, or it may be made by an interchange of letters. Such contracts are said to be express.

The standardized contract has become increasingly important in recent years. Firms engaged in particular lines of business have found it feasible and economical to prepare and print their own contract forms in advance. This practice makes it possible for unskilled clerks and salesmen, in negotiating contracts, to use the knowledge and training of the executives and lawyers of the firm. The procedure simplifies interpretation and the settlement of disputes. The standardized contract, while performing a useful economic function, has introduced new legal problems. Someone dealing with a firm that uses a standard form has little opportunity to negotiate or to object to terms; his only choice is to accept or reject the proposal in its entirety. Faced with this situation he frequently does not read more than the main items of the contract. Has he agreed to the terms of the document in any real sense? The courts hold that he should have read it, so that whether he has or not, he is usually bound by its terms. If, however, the court believes the parties to be unequal in bargaining power or if some of the terms are harsh or uncustomary (especially if they are in small type), many courts will refuse to enforce the agreement; and if a term is ambiguous, the doubt will be resolved against the party who drafted the instrument. In many areas of business such as public utilities and insurance, the legislature has intervened to prescribe contract terms. It is evident that the standardized contract and the state regulation of contract forms have substantially restricted the scope of the doctrine of the freedom of contract.

Promissory Estoppel.—An important alternative to the requirement of consideration is that if a promisee foreseeably has detrimentally relied upon a promise, though his detriment was not bargained for, the promise is binding. The principle (called promissory estoppel) has been generally recognized in the United States and has been recommended in England by the English Law Revision committee (1937), but parliament has taken no action upon it. The principle has been most frequently applied to gratuitous bailments, charitable subscriptions and gratuitous promises to convey land, but has recently been extended to a number of other cases.

Contract Under Seal.—A type of contract that does not necessarily originate in bargain is one under seal, variously called a covenant, bond, obligation, specialty or deed. The seal, originally a piece of wax, with the covenantor's identifying mark upon it, may now consist of a mark or scroll or simply "seal" written or

printed upon the document. By the common law, a promise under seal (a covenant) is binding though the covenantor receives no consideration. Thus the seal is a device by which a gratuitous promise can be made binding. In a majority of states of the U.S., the effectiveness of the seal upon contracts has been abolished. In some states it creates a rebuttable presumption of consideration. In other states and in England the seal is still recognized, and its use is required on contracts made by corporations.

The Statute of Frauds.—The fourth section of the Statute of Frauds, enacted by the British parliament in 1677 and re-enacted in whole or in part, in one form or another, in nearly all the U.S. states, provides that the following five kinds of contracts shall be unenforceable unless evidenced by a signed writing: (1) the promise of an executor or administrator to pay a debt of the decedent; (2) a promise to pay the debt of another person; (3) a promise in consideration of marriage; (4) a contract for the sale of land; and (5) a contract not to be performed within a year. By the 17th section of the same statute, a sixth type of contract, one for the sale of goods of the price of £10 or more, is made unenforceable unless the buyer accepts and receives a part of the goods, makes a part payment, or unless the contract is evidenced by a signed writing.

In 1954 parliament repealed these sections of the statute, except the parts covering contracts to pay the debts of another and contracts for the sale of land. No U.S. state has followed suit. While the statute has undoubtedly prevented the enforcement of many fabricated contracts, it has also been the means by which dishonest persons have evaded their promises. Whether the statute has caused more frauds than it has prevented is a much debated question.

Third-Party Beneficiaries.—In England a contract is looked upon as a purely personal transaction. Hence the view is usually taken that a person cannot acquire a right on a contract to which he is not a party. However, some exceptions to the rule have been enacted by statute, and the courts have developed others. Though the Law Revision committee has recommended the general recognition of third-party-contract rights, the recommendation has not been adopted.

In the United States, nearly all jurisdictions follow the view that two persons can make a contract for the benefit of a third person. When such an intent on their part is manifest, the third party acquires a right by virtue of the agreement even though he is not a direct party to it and furnishes no consideration. The right created by the contract may be a gift to the third party, in which case he is called a donee beneficiary; or the purpose of the contract may be to pay a debt owed by one of the contracting parties to the third party, in which case he is a creditor beneficiary.

An illustration of a donee-beneficiary contract is a life insurance policy on the life of A procured by him from B and made payable to A's wife C. An example of a creditor-beneficiary contract is one in which A sells his business to B and, as part consideration, B promises to pay A's debt to C. In each of these cases, C may maintain an action against B on his promise made to A.

Assignments.—Since contracts, unlike property interests, were considered strictly personal at common law, the courts from early times held that it was not permissable for a contract right to be transferred or assigned. However, courts of equity became dissatisfied with this rule and began to break it down. Courts of law took over the law merchant or mercantile law, which recognized the transferability of bills of exchange. This recognition was later extended to other money claims such as ordinary debts and book accounts and finally, with the aid of statute, to other contract rights not involving strict personal performance or confidence. In mid-20th century the general rule both in Great Britain and the United States, with few exceptions, was that contract rights are assignable.

Most states of the U.S. follow the rule that the assignment is complete as of its date, but England and some states take the view that the assignment is not complete until notice is given to the obligor.

A basic principle in the law of assignment is that an assignee takes subject to equities and defenses, whether or not he is a purchaser in good faith. This means that if there are any defects in the right assigned, if it is subject to conditions or if at the time of notice of the assignment the obligor has a counterright against the assignor, these facts can be used against the assignee as a defense or as a means of reducing the assigned claim. In this respect the assignment of a simple contract right is to be distinguished from the transfer (negotiation) of a bill of exchange, where the transferee, if he is a good-faith purchaser, takes the instrument free of personal defenses and equities. (*See* COMMERCIAL PAPER.)

Dependent Promises.—Under the early common law, in an action on a bilateral contract, the plaintiff could recover a judgment whether or not he himself had performed his part of the bargain. The plaintiff's own nonperformance did not excuse the defendant. The respective promises were said to be independent, and each party had his remedy against the other for breach of promise. In the modern law of both England and the United States, however, if a material part of the plaintiff's performance is to be rendered prior to or simultaneously with that of the defendant's, the plaintiff's failure to perform or to tender performance excuses the defendant. The defendant's promise is said to be dependent; performance by the plaintiff is a condition. If the promises on both sides are capable of simultaneous performance they are mutually dependent, neither party being able to recover from the other without himself performing or offering to perform.

A contractual promise also may be conditional upon agreed acts or events. For example, an owner's duty to pay a contractor for constructing a building may be conditional upon the contractor's furnishing an architect's certificate of satisfactory work.. Likewise, a condition may be constructed or implied by the court on the basis of policy or equity. If, for example, a promise is such that it requires co-operative action by the promisee in its performance, co-operation is a condition even though it is not so stated in the contract. If performance on one side can be rendered instantaneously (like paying money) but performance on the other side requires an appreciably longer time (like plowing a garden), it is implied that the act requiring the longer time is a condition precedent to the duty to perform on the other side.

Impossibility and Frustration.—Unless a promisor assumes the risk, supervening impossibility of performing his promise, due to a fortuitous event, excuses him from his duty. In a well-known case, D agreed to let a music hall to P for four days for a grand concert, for which P was to pay £400. Before the time for the concert, the music hall was accidentally destroyed by fire. It was held that D was excused from his duty by reason of impossibility.

Likewise, though performance is possible, if the value of the performance is almost totally destroyed by a supervening event, the promisor is excused. Thus, D agreed to hire from P for £75 a flat in Pall Mall during the days of June 26 and 27, 1902, the dates on which the coronation procession of Edward VII was to pass along that street. When illness of the king caused a postponment of the procession, it was held that D was excused from his duty to pay the rent. Frustration of purpose had destroyed the value of P's performance.

Courts differ in their rationalization of the doctrines of impossibility and frustration. The best explanation of the results seems to be that the courts believe it is inequitable to hold a person to a contract where, because of a fortuitous event, he gets nothing for his promise.

Discharge.—Discharge pertains to the termination of the contractual relation. Only a few of the many methods of discharge can be considered here. Complete performance by both parties is the usual method. If the contract is wholly or partly unperformed on both sides, the contract can be terminated by simple agreement, the surrender by each party of his right serving as consideration for the other's surrender. If the contract is fully performed by one party only, the other party can be discharged by obtaining a valid release. For a release to be valid it must be under seal (where seals are still recognized), or in writing (where statutes so provide), or be supported by consideration. Such a contract also may be terminated by accord and satisfaction. The accord, which states the terms of the discharge, may itself constitute a contract made in substitution of the original claim, in which

case it is an accord and satisfaction. Or the new agreement may require that it be performed to constitute a discharge of the original claim, in which case the new agreement is an accord. Still another method for discharging this type of claim is for the creditor to agree to accept a new debtor in place of the original one. This is called a novation.

Remedies.—In cases where compensatory damages would be inadequate, the equitable remedy of specific performance is sometimes available to a party injured by breach of contract. In granting this remedy, the court orders the defendant to do the specific act he had agreed to do. In practice the remedy is usually limited to contracts for the sale of land and unique chattels.

The usual remedy for breach of contract is compensatory damages. Penal or vindictive damages are rarely awarded. The rule is that the plaintiff is entitled to recover such damages as were or reasonably should have been foreseen at the time the contract was made. In most cases this means that the plaintiff is entitled to be placed in the economic position that he would have occupied had the contract been performed. (*See* also DAMAGES.)

See also references under "Contract" in the Index.

(G. W. Go.)

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CONTRACT BRIDGE: *see* BRIDGE.

CONTRACT LABOUR, a term to describe workers whose freedom is restricted by the terms of a contractual relation and by laws that make such arrangements permissible and enforceable. In American colonial times, indentured servants were a form of contract labour; in the middle and later 19th century, Chinese and Indian labourers, commonly called coolies, moved great distances under contractual arrangements. Deception, kidnapping and coercion were widely used as means of obtaining control of defenseless persons, usually unskilled and poorly educated adult males.

The contractual terms usually reflected the disadvantageous position of the labourer, often to the extent of harshness approaching slavery. Although coercion and harshness no longer prevail, the concept of contract labour continues to imply undesirable attributes of compulsion and cheapness, and hence of unfairness to the labourers directly involved and also to others in the labour force.

Colonial Indenture.—North American indentured labour began with the founding of the colonies and existed concurrently with free labour and slavery until the American Revolution. Its subjects were males and females of western European and mainly British origin. The terms of indenture were harsh to favourable, depending upon the strength of the individual's position and the preferences of his master. The harshest terms and the longest indentures were imposed upon criminals whose death sentences (often for political offenses and numerous crimes now regarded as misdemeanours) were commutable upon entry into colonial indentures.

At the other extreme, those able to negotiate the terms of indenture were able to obtain contracts generally patterned after English apprenticeship customs and were usually free after five to seven years of service. Colonial laws gave some protection to the indentured servant but also sanctioned and enforced performance of the contract whether oral or written.

The indenture of Chinese and Indians also was associated with colonial developments but occurred later, following the abolition of slavery in areas other than the American colonies. Indian emigrant labourers were brought into British, French and Netherlands African colonies and also into Ceylon, Malaya and the Caribbean. Chinese labourers served in many of these areas and also in Peru, Western Samoa, New Zealand and Hawaii. The Chinese, Japanese and Hindustani workers who came to California in the latter 19th century were commonly regarded as coolies, but they were mainly free immigrants, some of whom had completed or escaped from indenture contracts. Their numbers included remigrants from the indentures that were intended to serve the sugar plantations of Hawaii. Although Asian indenture was not free of kidnap, decoy and fraud, it was basically a noncompulsory system to the extent that the governments of China and India were able to protect the interests of their nationals by legislation and negotiation. Poverty in the home country was the foundation of Asiatic indenture. In contrast, American colonial indenture, though founded partly on poverty, was also fed by a harsh penal code characterized by political and religious intolerance.

Aside from other stipulations regarding such matters as repayment of transportation, wages and housing, the essence of the contract labourer's obligation was his surrender of freedom, for a specified period, to quit his work and his master (employer). The acceptance and imposition of such restrictions were in accord with European apprenticeship practices and were sanctioned by the prevailing master-and-servant legislation. Not until the English Employers and Workmen act (1875) did the master-servant practice give way to the concept and practice of free, impersonal labour relations and the reciprocal rights and obligations of employers and employees.

U.S. Legislation.—The periods of large-scale immigration to the United States offered many opportunities for practices that were momentarily advantageous to the emigrant but abusive of more liberal principles. Under various forms of assisted immigration, buttressed by the immigrants' language and financial disabilities, many nationality groups rendered temporary services in such major U.S. industries as railroads and mines under conditions that were not legally enforceable. In 1864 the United States congress, under the pressure of the labour shortage resulting from the Civil War, undertook to validate alien labour contracts in an effort to promote greater importation of alien labour. The act provided that contracts pledging the repayment of expenses of emigration from wages for a 12-month term were valid and enforceable in the federal, state and territorial courts.

Fearing that the U.S. labour market would be flooded by cheap labour, congress repealed the act four years later. Specific prohibitions against the practice of encouraging or assisting labourers of foreign countries to emigrate to the United States were not enacted, however, until congress passed the Contract Labour law of 1885, which forbade the entry of any person, other than a skilled or professional worker, who had previously made a labour contract.

Notwithstanding the 1885 law and subsequent legislation against contract labour, some forms of it continued in the United States. These are more closely related to the coolie system than to European master-servant practices. Twentieth-century labour contracting—which exists in significant volume only in the United States—has its foundation in two factors, both characteristic of the Asian indenture: (1) the sharply contrasting differences in employment opportunities between nations; and (2) the peculiar sanctions that law permits against nonimmigrant aliens.

Although the U.S. immigration law of 1917 continued the 1885 prohibition of contract labour, it also contained a proviso authorizing "the commissioner of immigration and naturalization, with the approval of the attorney general, . . . to control and regulate the admission and return of otherwise inadmissible aliens applying for temporary admission." Under this proviso, a limited importation of Mexican unskilled labour was permitted during World War I. The proviso then remained dormant until World War II, when it was extensively invoked, especially with respect to Mexican workers for agriculture and the maintenance of railway track. Nonagricultural importation was discontinued in 1945, but the importation of alien farm workers continued. Until the Immigration and Nationality act of 1952, the authority utilized to sanction such importation was the ninth proviso of the 1917 law. The 1952 law permits temporary entry of nonimmigrant alien labourers, "if unemployed persons capable of performing such service or labor cannot be found in this country . . . after consultation with appropriate agencies of the Government, upon petition of the importing

employer." The last phrase is crucial, for it specifies that the initiative is governed by employer interest. Importation actions under this authority have been initiated by farm employers only.

After 1952, total nonimmigrant alien entries of farm labourers from Mexico, the Caribbean countries and Japan were approximately 500,000 annually. For Mexican labour, the importation was facilitated and regulated by an intergovernmental executive agreement (not a treaty) and by public law 78 of 1951. Entries are under short-term contracts that are standardized for each nationality group. Governments of the labour-supplying countries negotiate or supervise the terms of these contracts. Public law 78 (relating to Mexico only and a temporary measure that has been extended several times) specifies that importations shall be approved only if domestic workers are not available and such importations "will not adversely affect the wages and working conditions of domestic agricultural workers."

These contractual importations of nonimmigrant aliens are regarded with general favour in the supplying countries but are the subject of intense controversy in the United States. Farm employers allege the insufficiency of domestic labour and their dependency on continued alien importation as a supplemental supply source. However, only a small proportion of U.S. farmers utilize alien labour. Antagonists of the contract alien program argue that, contrary to the requirements of the law, the importations adversely affect the wages and conditions of domestic farm workers, who, even without the competition of alien labour, are one of the least protected segments of the national work force.

See Louise E. Howard, *Labour in Agriculture,* Royal Institute of International Affairs (1935); U.S. Department of Labor, *Farm Labor Fact Book* (1959). (V. Fu.)

CONTRADICTION, LAW OF: *see* Thought, Laws of.

CONTRALTO, or alto, the term for the lowest variety of the female voice, below soprano and mezzo-soprano, and in the four-part choir the second highest voice.

CONTRAPUNTAL FORM: *see* Counterpoint.

CONTREDANSE, a dance derived from the English country dance (*q.v.*), whence also it takes its name, which enjoyed much popularity both in France and Germany during the 18th century and later. Although the derivation of the name has been disputed, it is confirmed by the character of the dance itself, which had obvious features in common with those of its English original. The name was also applied to the music for such dances, of which Beethoven and Mozart both left examples.

CONTRERAS, a hamlet about 8 mi. S.W. of Mexico City, near which, on Aug. 19–20, 1847, the army of Maj. Gen. Winfield Scott opened the final campaign of the war between the United States and Mexico. Pop. (1950) 10,112. Scott's army had crossed the mountain barrier east of the capital on Aug. 10 and entered the valley of Mexico. After reconnoitering possible approaches to Mexico City, Scott decided to move south of Lake Chalco and occupy a position on the Acapulco road, which entered the city from the south. Finding this road blocked by units of Gen. A. L. de Santa Anna's army, Scott planned a flanking movement to the west across lava beds known locally as the pedregal. This was anticipated by General Valencia, who occupied the hill of Padierna, just north of Contreras, with 4,000 men. Advance units of Scott's flanking force established contact with Valencia's men on the afternoon of Aug. 19. During the following night, they passed to the north and west around Padierna and at daylight attacked the defenders from the rear. After an engagement lasting less than 20 minutes, Valencia's men fled in disorder, leaving behind a considerable number of cannon and prisoners. By this success, Scott gained control of several roads leading to Mexico City. Before advancing on the capital, however, he turned aside to attack the forces on the Acapulco road, in the battle of Churubusco (*q.v.*), on the afternoon of Aug. 20. *See* also Mexican War, the.

See R. S. Henry, *Story of the Mexican War* (1950); C. W. Elliott, *Winfield Scott* (1937). (H. W. By.)

CONTROLLING INTEREST: *see* Corporation.

CONTROL SYSTEMS. In the most general sense, a control system is any means, natural or artificial, by which a variable quantity or a set of variable quantities is caused to conform, more or less accurately, to some prescribed norm. A familiar example of an artificial control system is a governor for maintaining the speed of an engine at a desired constant value. Another example of a similar kind is a thermostatic heating system for regulating room temperature. In many cases control systems are not designed to hold the values of the controlled quantities constant but rather to cause those values to vary in prescribed ways. The bodies of living organisms contain numerous natural control systems. These ensure the proper involuntary functioning of organs and the proper performance of voluntary actions. So general is the concept of a control system that it has even been possible to use it, more or less successfully, in the discussion of some psychological and sociological phenomena. However, the control systems which lend themselves best to clear and concise discussion are the artificial ones used in modern technology. It is to these that the remainder of this article is devoted.

Although the use of simple control systems, such as the governor, has a long history, early developments were slow and empirical. It was not until about the time of World War II that the systematic design and use of control systems came to be recognized as an important branch of engineering. Today control systems are used in abundance for a great variety of purposes, including the regulation of manufacturing processes and the guidance of the motions of machines (*e.g.*, the autopilots used on airplanes). An extensive theory relating to control systems and their applications has been developed.

This theory, which has been termed cybernetics (from the Greek word for steersman), formulates the requirements which control systems, intended for different purposes, should satisfy. It provides methods for the theoretical design of various kinds of control systems, and it furnishes criteria for judging the performances of control systems in actual operation. The content of the theory consists essentially of portions of various familiar mathematical and physical subjects (*e.g.* dynamics, theory of differential equations and probability theory), this material being unified and reformulated for application to the novel problems associated with control systems.

The interactions among the constituent parts of a control system, and the ensuing transmission of physical (or other) effects from one part to another, can be advantageously regarded as a flow of signals through the system.

Thus it comes about that some of the basic notions and principles of cybernetics also play important parts in "information theory" (*q.v.*). Just how closely the two theories are related depends on how broadly the somewhat elastic term "information theory" is interpreted.

With few and relatively unimportant exceptions, all modern control systems have two fundamental characteristics in common. These can be described, in somewhat oversimplified form, as follows: (1) The value of the controlled quantity is varied by a motor (this word being used in a generalized sense) which draws its power from a local source rather than from an incoming signal. Thus there is available a large amount of power to effect necessary variations of the controlled quantity and to ensure that the operations of varying the controlled quantity do not load and distort the signals on which the accuracy of the control depends. (2) The rate at which energy is fed to the motor, in order to effect variations in the value of the controlled quantity, is determined more or less directly by the difference between the actual and desired values of the controlled quantity. Thus, for example, in the case of a thermostatic heating system, the supply of fuel to the furnace is determined by whether the actual temperature is higher or lower than the desired temperature. (Contrast this with a conceivable, but impractical, heating system in which fuel is fed to the furnace according to a schedule which is established a priori, and is independent of the actual temperature achieved.)

A control system possessing these fundamental characteristics is called a closed-cycle control system, or sometimes a servomechanism. Open-cycle control systems are of comparatively little importance.

It can be said briefly that a closed-cycle control system functions by means of a controlled release of energy from a local

source. This being the case, it is evident that unless the system is carefully designed, energy may be released from the source more rapidly than is necessary to effect the required adjustments of the value of the controlled quantity. When such an excessive release of energy occurs, the control system is unstable; and the controlled quantity, instead of settling down to the desired value, typically goes into a state in which it oscillates to and fro through a large range of values. Since an instability in a control system would defeat the very purpose of the system, the primary problem in its design is that of ensuring that the system is stable. The way in which this problem is attacked and solved depends somewhat on the particular kind of control system that is under consideration.

Linear Control Systems.—The control systems with the most familiar theoretical basis are those governed by systems of equations of motion which are linear differential equations with constant coefficients. General dynamical theory shows that such a linear control system has associated with it a certain characteristic equation, $F(p) = 0$, which can be written explicitly when the physical structure of the system is specified. The general theory shows also that whether or not the system is stable depends on the nature of the roots of this equation. Specifically, the system is stable in a strong sense if, and only if, all of the roots of the characteristic equation have negative real parts. Mathematical analysis affords various criteria for determining whether or not all of the roots of an algebraic equation have negative real parts.

Any of these criteria serves to determine whether or not a proposed design will result in a stable control system. One criterion, known as Nyquist's stability criterion, is particularly useful since it frequently suggests structural modifications which will stabilize an unstable system or improve the stability of an inadequately stable one. In effect, this criterion is merely a reformulation, in terms which are convenient for the purposes of cybernetics, of a theorem of A. L. Cauchy stating that the number of roots of an algebraic equation $F(p) = 0$ within a closed curve C in the complex plane is $(2\pi)^{-1}$ times the net variation of the argument of $F(p)$ as the point p describes C in the positive sense.

The stability problem for other linear control systems (such as systems having equations of motion which are linear difference equations or linear difference-differential equations) can be solved by appropriate modifications of the methods just considered. Also, these methods, with appropriate modifications and reservations, are frequently used in cases of nonlinear systems.

Once the stability of a control system has been assured, the designer must consider a number of important secondary problems. These relate to the speed and accuracy of the system, and to its insensitivity to accidental disturbances (noise). Essentially, these are problems which arise in connection with most, if not all, communication systems.

At least in the case of linear systems, satisfactory solutions are provided by the methods and results of modern communication engineering. For example, $x(t)$, the desired value of the controlled quantity, may be regarded as an input signal and $y(t)$, the actual value of the controlled quantity, as the corresponding output signal. From this point of view a well-designed linear control system is usually a low-pass filter, having a certain cut-off frequency. One of the basic results of communication engineering (or information theory) shows that the speed of the system, defined in any one of several possible ways, is proportional to this cut-off frequency.

Nonlinear Control Systems.—Nonlinearities may be present in a control system as incidental imperfections in a system which is designed to be essentially linear, or they may be present intentionally as a part of the fundamental design of the system. In the first of these cases the effects of the nonlinearities can usually be neglected or dealt with by means of the appropriate methods of perturbation theory. However, in the second case, the one in which nonlinearities are introduced intentionally, a theory differing radically from the theory of any linear system is required. Because of the great variety of nonlinearities which can be employed in different applications, little exists in the way of a practically useful general theory. Most of the theory of nonlinear control systems consists of a collection of partial theories dealing with various more or less particular situations.

Among the more important of the control systems possessing intentionally introduced nonlinearities is the so-called "on-off" system. Such a control system is characterized by the fact that if the desired value of the controlled quantity exceeds the actual, the motor exerts a certain maximum force to increase the actual value, while if the actual value exceeds the desired value, the motor exerts a certain maximum force to decrease the actual value. Thus the motor admits of only three states: the state in which it exerts no force, the state in which it exerts a positive force of a fixed magnitude and the state in which it exerts a negative force of a fixed magnitude. The functional relation between the force and the error (*i.e.*, the difference between the actual and desired values of the controlled quantity) is nonlinear. An on-off control system can be constructed with parts that are simple, rugged and reliable. Hence such systems, although they do not afford the precision of control that is obtainable from some of the other systems, have a wide field of usefulness. They are particularly helpful in situations where the control involves the motions of large masses and the expenditure of large amounts of power.

In the usual on-off control systems the only important nonlinearities are the nonlinear relations between the forces and the errors defined above. Hence, as long as the error remains of one sign, such a system is equivalent to a linear system; but the equivalent linear system changes with the sign of the error. Such a system belongs to a class of nonlinear systems called piecewise-linear. Since a nonlinear control system can usually be approximated by a piecewise-linear system, and since the piecewise-linear systems are relatively easy to study, the investigation of these systems forms a natural approach to the study of nonlinear control systems in general. *See* also CYBERNETICS; SERVOMECHANISM.

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CONVECTION, the transference of a mass of fluid against the force of gravity. If a fluid is heated from below, the lower part of it becomes less dense than that above and rises while the latter falls to take its place. This motion involves an upward transfer of heat and is quite distinct from conduction, whereby heat is transferred in all directions equally by the vibrations of the molecules (for isotropic media), and from radiation, which is transmitted through space without the aid of a material medium.

In the atmosphere, convection is the most important means by which heat is transferred, the absorption of radiation being small and the heat conduction being negligible by comparison. *See* HEAT: *Transference of Heat; see* also references under "Convection" in the Index volume. (H. R. B.)

CONVENT, the body of persons associated together in a monastery, whose official designation is "the abbot (or prior, etc.) and convent" of the place in question (Lat. *conventus,* from *convenire,* "to come together"). The modern popular use of the word for a house of nuns, as distinct from a monastery or house of male religious, is inaccurate: all houses of religious communities are monasteries, irrespective of the sex of the convent that inhabits them, and the term convent is equally free from such limitations. *See* MONASTERY.

CONVENTION, NATIONAL (U.S.): *see* NATIONAL CONVENTION.

CONVERSE, FREDERICK SHEPHERD (1871–1940), U.S. composer whose essentially romantic music is coloured with some impressionistic touches, was born in Newton, Mass., Jan. 5, 1871. He studied music at Harvard (1889–93) and later with G. W. Chadwick in Boston and J. G. von Rheinberger in Munich. He was on the staff at Harvard university (1901–07) and at the New England Conservatory of Music (1899–1901 and 1930–38).

Converse attracted national attention with his "romantic grand opera" in one act, *The Pipe of Desire* (1906), the first opera by an American to be given by the Metropolitan Opera company (New

York, March 18, 1910). His symphonic fantasy *Flivver Ten Million* (1927), written to celebrate the manufacture of the 10,000,000th Ford automobile and scored in an appropriately modernistic manner, aroused momentary interest as an example of "machine music." Converse composed six symphonies; the symphonic poems *The Festival of Pan* (1900), *Endymion's Narrative* (1901), *The Mystic Trumpeter* (1904), *Ormazd* (1911); chamber music, and many songs. He died in Westwood, Mass., June 8, 1940.

(N. Sy.)

CONVERSION (IN LOGIC AND MATHEMATICS). For the converse of a categorical proposition, and for conversion as an immediate inference, *see* Logic, and the section on Aristotle in Logic, History of.

In mathematics the term *converse* is used for the proposition obtained by the transformation of $\mathbf{AB} \supset \mathbf{C}$ into $\mathbf{AC} \supset \mathbf{B}$, or of $(\mathbf{x}_1)\ (\mathbf{x}_2) \ldots (\mathbf{x}_n) \cdot \mathbf{AB} \supset \mathbf{C}$ into $(\mathbf{x}_1)\ (\mathbf{x}_2) \ldots (\mathbf{x}_n) \cdot \mathbf{AC} \supset \mathbf{B}$, where $\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n$ are variables of any kinds; and where **A, B, C** are propositional forms, of which some may be themselves conjunctions, or **A** may as a special case be absent. (For explanation of the notation and terminology, *see* Logic.) This may in some instances be reduced to the simple converse of an *A* proposition in the sense of traditional logic—for example: *Every equilateral triangle is* [an] *equiangular* [triangle], and conversely, *every equiangular triangle is* [an] *equilateral* [triangle]. But such a reduction becomes either impossible or very artificial in cases like that of Euclid I 25 and its converse (*If two sides of a triangle are equal, respectively, to two sides of another triangle, and the third side of the first is greater than the third side of the second, then the angle opposite the third side of the first triangle is greater than that opposite the third side of the second triangle,* and conversely, *if two sides of a triangle are equal, respectively, to two sides of another triangle, and the angle opposite the third side of the first triangle is greater than that opposite the third side of the second triangle, then the third side of the first triangle is greater than the third side of the second*).

In this sense of conversion, the passage from a proposition to its converse is not in general a valid inference. And though often a mathematical proposition and its converse may both hold, separate proofs must be given for them. (Ao. C.)

CONVERTER STEEL. The principle of removing unwanted constituents from molten pig iron by blowing air through it, converting the iron to steel, was discovered about the middle of the 19th century. Oxygen in the air combined with and literally "burned out" the undesirable elements, as described under *Converter Principles,* below. This article traces the development of the converter process; outlines converter principles, design and operation; and identifies the properties and applications of converter steel. For additional information on the chemical reactions involved and the uses of the process in the steel industry, *see* Iron and Steel Industry: *Bessemer's Invention; Thomas-Gilchrist Discovery. See* also Furnace, Metallurgical: *Converters;* Metallurgy.

William Kelly, of Eddyville, Ky., began experimental work utilizing the principle as early as 1847. During the period when Kelly was developing his process, Henry (later Sir Henry) Bessemer (*q.v.*) of England independently conceived a similar steelmaking method, which he made public in 1856, and the process came to be known as the Bessemer process. With the perfection of converter technique, it became possible to produce low-cost steels (alloys of iron and carbon) of good quality by the ton and at a rapid rate, as compared to earlier methods which produced only small quantities of steel by slow and costly methods. This brought about an industrial revolution, a change from the age of iron to the age of steel. The Bessemer process and others employing similar principles (such as the Peirce-Smith process for converting copper) are sometimes referred to generically as pneumatic processes because of the use of air (or other oxidizing gases) as the means for purifying the metal. Commercial success of the Bessemer process was due to an Englishman, Robert Mushet, who in 1856 recognized the necessity of adding manganese for deoxidation and recarburization following the blow (*see* Manganese Steel). G. F. Göransson of Sweden, who improved converter design and operation, also contributed to the early success of the process in 1858 by increasing the tuyère (nozzle for the injection of air) area and decreasing the air volume.

Converter Principles.—Molten pig iron, gaseous oxygen and steel scrap are the main constituents for making steel in the converter. Pig iron contains carbon, manganese, phosphorus, sulfur and silicon, in addition to iron. Steel contains similar constituents, but in different proportions. Steelmaking, therefore, consists of eliminating or adding certain constituents which control the properties of the ultimate product. All the elements discussed, including iron, have a strong affinity for oxygen, which in the converter process may be obtained from air, oxygen-enriched air, pure oxygen, steam-oxygen mixtures or additions of iron oxide. Oxygen enrichment of the blast increases thermal efficiency, permitting the melting of additional scrap. The use of steam with oxygen instead of air decreases thermal efficiency but results in a low-nitrogen steel. The reaction of all these elements with oxygen results in the production of heat.

The essential principle of the converter process consists of blowing air through a body of molten metal or introducing oxygen onto the surface of the molten metal, thus rapidly oxidizing the various elements, which enter the slag or, in the case of carbon, leave the converter as a gas. The heat generated is sufficient to maintain the metal in a liquid state and melt some scrap. At the end of the blow the vessel contains metal covered with a layer of slag. In order to convert the molten metal into steel, manganese, silicon, carbon and a small amount of aluminum are added. Proper deoxidation and additions of suitable elements make the steel suitable for rolling and fabrication. Positions in the operation of a bottom-blown converter are shown in fig. 1.

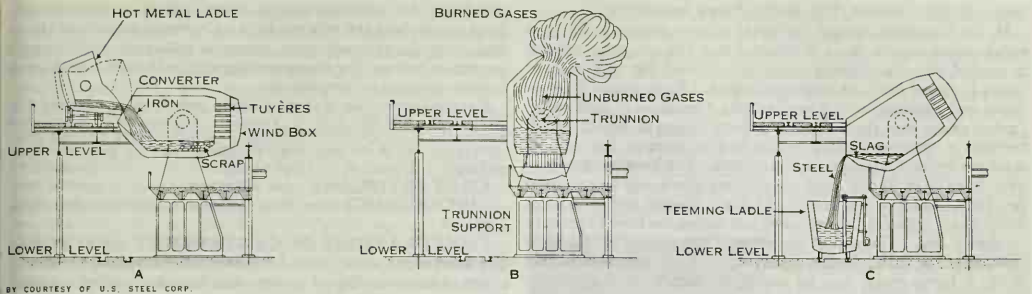
Converter steel is designated as either acid or basic depending on whether the converter lining is composed primarily of silica (acid), and an acid slag is produced; or of dolomite lime or magnesite (basic) and a basic slag is produced. The early converters were acid converters, and in this process, which is the one used in the United States, carbon, silicon and manganese are removed during the blow. Molten iron for the acid process must be low in sulfur and phosphorus, as these elements are not oxidized or removed. After the Bessemer converter process had been successfully developed, open-hearth and electric-furnace processes to produce basic steel were introduced; and by 1910 the production of open-hearth steel in the United States surpassed that of Bessemer converter steel. One of the reasons for this was the almost complete change from the use of acid Bessemer rails to basic open-hearth steel rails, which were of more uniform quality. Later, growth of the automobile industry created a demand for even larger quantities of basic open-hearth steel. In addition, the open-hearth process made possible a greater utilization of scrap and produced steel with a lower nitrogen and phosphorus content.

Beginning in 1878, an Englishman, Sidney Gilchrist Thomas (*q.v.*), developed a basic bottom-blown converter process utilizing (1) a basic lining; (2) basic flux; and (3) an afterblow. This is the Thomas process, and carbon, manganese, silicon, phosphorus and sulfur are removed during the blow. Phosphorus elimination occurs after removal of carbon during a period known as the afterblow, in which the phosphorus is oxidized and combines with a basic slag containing lime.

In western Europe the Thomas process retained its position as a major process for producing carbon steels. The smelting of high-phosphorus ores in Europe resulted in high-phosphorus pig iron ideally adapted for steelmaking, provided that the basic-lined converter was used. The basic converter steelmaking process which utilizes an oxygen lance or jet (fig. 2) was experimentally introduced in 1949, and several plants were placed in operation in the 1950s.

Converter Design.—There are no essential differences between the design of the bottom-blown acid and basic converters as shown in fig. 2, except for the bottom construction. Both types of converters are blown through an arrangement of tuyères which are below the molten metal and above the wind box.

In 1862 Bessemer developed a side-blown converter, but it was not until 1891 that F. A. Tropenas designed a converter with the



BY COURTESY OF U.S. STEEL CORP.

FIG. 1.—SCHEMATIC DRAWING OF THE POSITIONS IN THE OPERATION OF A BOTTOM-BLOWN CONVERTER SHOWING (A) CHARGING; (B) BLOWING; (C) POURING

air blast directed upon the surface of the bath through the side of the converter. This type of converter with an acid lining became known as the Tropenas side-blown converter and is used in the steel foundry. A basic lining may also be used in a side-blown converter.

Bessemer in 1856 recognized the possibility of using pure oxygen in the converter process, but the cost was prohibitive. When oxygen is directed through a lance downward on the bath of a solid-bottom converter the process is called the basic oxygen converter process. This process, also called the basic oxygen steel process or basic oxygen furnace process, is used both in Europe and the United States. Carbon, manganese, phosphorus, sulfur and silicon are removed from the iron. An afterblow is not required for phosphorus removal providing the phosphorus content of the iron is not too high. Appreciable quantities of scrap may be melted.

The rotating basic converter using an oxygen lance which is directed at the surface of the molten metal was developed during 1948 in Sweden. The lance is located in one end of a rotating refractory-lined vessel. Rotation increases the slag-metal reaction. Operation of the converter is similar to the basic oxygen furnace converter.

In a converter steel plant one of the vessels shown in fig. 2 is the principal unit. In the acid process a siliceous material (micaceous schist or sandstone) and in the basic process calcined dolomite or magnesite are used for the lining. The capacity of the vessel varies from 2 tons for an acid side-blown foundry converter to 200 tons for a basic oxygen converter. The normal capacity of a bottom-blown converter is 30 tons. The detachable bottom developed by Bessemer in 1863 consists of tuyères for the introduction of the air blast at 20–30 lb. per square inch (p.s.i.) from the wind box to the liquid metal. In the side-blown converter, tuyères for air at 5 p.s.i. are located on one side of the vessel above the molten iron.

In the top-blown oxygen converter process, pure oxygen at 125 p.s.i. is introduced with a water-cooled lance through the mouth of the vessel. The vessel is supported on trunnions and may be rotated through an angle of 360° by two independent electric motors. A hollow trunnion for the air blast from the turboblowers is used for bottom-blown converters.

Converter Operation.—The operation of a top-blown concentric solid-bottom converter is illustrated in fig. 3. The mouth or top of the vessel is concentric in shape, and it may be charged on one side and tapped or discharged on the opposite side. Scrap is charged to control the temperature; and molten pig iron with about 4% carbon from a storage vessel called a mixer, or directly from a blast furnace, is then added to the converter. The bottom-blown converter is charged in a similar manner.

The charged converter is rotated into the blowing position, and air is introduced through the bottom as shown in fig. 1 (an eccentric type of converter charged and tapped from the same side). In the bottom-blown acid converter, a short transparent flame extends from the mouth of the converter during the first period or silicon blow. The flame starts to lengthen after about four minutes, and the second period or carbon blow begins. Manganese is removed during both periods. If the blow becomes too hot, steam may be added with the air. If the blow becomes too cold, the vessel may be side-blown by turning the vessel to a nearly horizontal position. The bath boils and the flame may extend 30 ft. above the mouth of the converter. As the flame gradually drops, the colour changes from golden yellow to red, and this change is designated as the end point which may be determined by the spectrograph or photoelectric cell. In the acid process, the bath contains about 0.04% carbon at the end point. In the bottom-blown basic process, an afterblow, controlled by timing the blow after a chemical analysis of the bath is obtained, occurs for several minutes after the end point. Also in the basic process, flux materials such as lime and iron oxide are added to remove phosphorus.

The side-blown acid converter is similar in operation to the bottom-blown acid converter. Reactions are started by blowing air through the tuyères located on the side of the vessel and by rocking the converter if necessary. In side-blowing, the temperature of the blow is increased by oxidation of carbon monoxide to carbon dioxide inside the vessel above the bath. Also, since the nitrogen of the air is not blown through the molten metal as in bottom-blowing, side-blown converters can produce steel with a

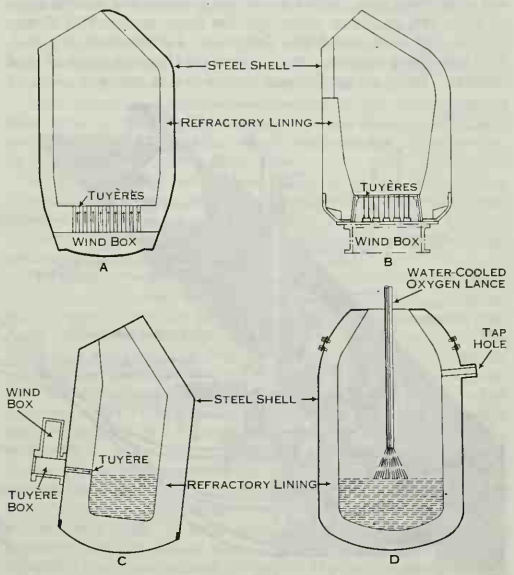


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FIG. 2.—TYPES OF CONVERTERS: (A) BOTTOM-BLOWN ACID CONVERTER; (B) BOTTOM-BLOWN BASIC CONVERTER; (C) SIDE-BLOWN ACID CONVERTER; (D) TOP-BLOWN BASIC OXYGEN CONVERTER

lower nitrogen content than bottom-blown converters.

In the top-blown oxygen converter process shown in fig. 3, a water-cooled oxygen lance is inserted into the converter after it is rotated into the blowing position. A hood for collection of fumes is placed over the converter mouth. Pure oxygen is introduced and impinges on the surface with formation of iron oxide. Carbon reacts with the iron oxide to form carbon monoxide, which provides a vigorous boiling action and accelerates the refining reactions without emission of iron pellets. The blowing time may vary from 10 to 30 min., and one to three blows may be produced per hour. Lime or limestone, mill scale, fluorite and sometimes dolomite are added at the beginning and during the blow to produce a suitable slag. The end of the blow is determined by chemical analysis of the bath. In the basic oxygen converter vessel shown in fig. 2, blown metal may be poured through a tap hole on the side of the vessel, which separates the slag.

The blowing time of an acid or basic bottom-blown converter also may vary from 10 to 30 min. and one to three blows may be produced per hour. At the end of a blow, ferromanganese, ferrosilicon or carbon may be added to the vessel or to the ladle as the metal is poured from the vessel into the ladle. In addition, aluminum may be added to the ladle, particularly if it is desired to render the nitrogen content of the steel inactive. Carbon is added as anthracite coal, graphite or, in the acid process, as molten iron. Steel in the ladle is teemed (poured) into ingot molds where special additions may also be made. After pouring the blow, repairs may be made to the lining if necessary, and a new charge introduced. In the basic process, greater care of the lining is required.

Properties and Applications.—The properties of converter steel may be similar to open-hearth or electric-furnace steel. However, in certain types of converter steel, the phosphorus, sulfur or nitrogen may exceed that usually found in open-hearth steel. Larger quantities of these elements will change the properties of the material. Therefore, when the phosphorus or nitrogen exceeds that found in open-hearth steel, converter steel may require special treatment, which may involve either deoxidation practices in making the steel or thermal treatment after rolling.

The acid and basic bottom-blown converter steels are used for the production of butt-welded pipe, seamless pipe, free-machining and reinforcing bars, certain flat-rolled products and several types of wire, and as blown metal for the basic open-hearth duplex process (*see* IRON AND STEEL INDUSTRY: *Variations in Process*). Acid side-blown converter steel is used for the production of steel castings. Basic oxygen furnace steel is low in nitrogen and used principally for low-carbon strip, plates, tubular products, structural shapes, bars and wire products. Converter steels have tensile properties, fatigue properties, corrosion resistance, high strength properties and welding characteristics similar to open-hearth steels having comparable compositions.

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CONVERTIPLANE: *see* AIRPLANE.

CONVEYANCE: *see* REAL PROPERTY AND CONVEYANCING, LAWS OF.

CONVOCATIONS OF CANTERBURY AND YORK.

The word convocation (from Lat. *convocatio*, a "calling together") refers to any assembly of persons who have been called together. The term is applied with a narrower meaning to a number of bodies in universities and elsewhere and, in England, especially to two ecclesiastical assemblies, namely, the convocation of the province of Canterbury and the convocation of the province of York. In Europe the expression has usually been confined to assemblies of bishops; but in England each convocation has consisted, and does consist, of two houses, an upper house of bishops and a lower house of the inferior clergy.

Their origin can be traced back before the Conquest. Later they became, in effect, a parliament wherein, in addition to transacting ecclesiastical business, the clergy taxed themselves for the benefit of the royal exchequer. Indeed, provincial synods for the discussion of purely ecclesiastical business were called by legates or archbishops on their own authority, usually when parliament was not sitting; while the convocations were summoned by the archbishops, usually in response to a royal writ during the time of parliament, in order to provide money for the king and to deal with his business.

At the Reformation, the Act of Submission of the Clergy (1533) provided that convocation was not to meet without the permission of the king. For the next 140 years the convocations were busy with the Reformation settlement, working in close co-operation with the monarch and with parliament. After the Restoration of Charles II in 1660, in compliance with a private understanding between Archbishop Gilbert Sheldon and Lord Clarendon, the lord chancellor, the clergy appear tacitly to have agreed to abandon their claim to tax themselves. In 1663 they voted subsidies for the king; but since then they have been taxed, like the rest of the nation, by parliament and they have exercised the parliamentary franchise. With the Reformation settlement not only apparently accomplished but also firmly consolidated on a statutory basis, and with the business of taxation abandoned, the immediate use of convocation was no longer so apparent.

Convocation, moreover, after the Revolution of 1688, began to exhibit an independence of thought which was embarrassing to the government, particularly over the question of the nonjurors. In 1717 Benjamin Hoadly (*q.v.*), bishop of Bangor, who had written against the nonjurors, followed this with a sermon preached before George I which also expressed distinctly unusual views about the nature of the church, but which so pleased the king that he ordered it to be published. Upon this the lower house of Canterbury joined issue with the bishop, whereupon the king, to avoid the certain and probably unanimous condemna-

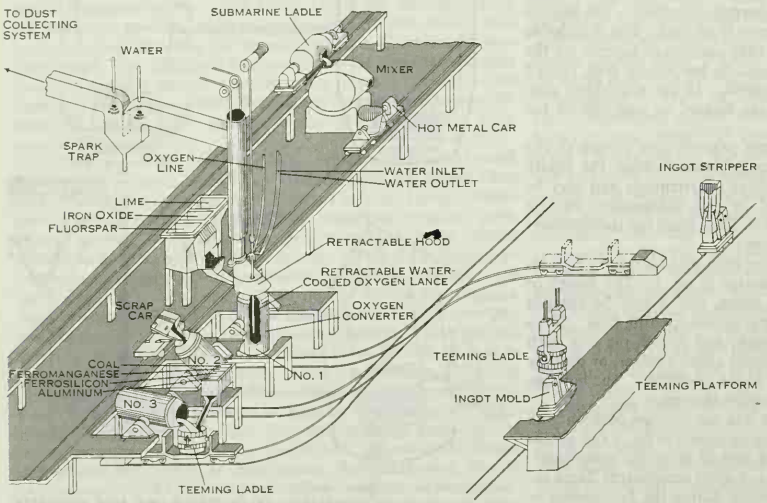

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FIG. 3.—SCHEMATIC ARRANGEMENT OF THE BASIC OXYGEN CONVERTER PROCESS

tion of these views, hastily prorogued convocation. From then until nearly the middle of the 19th century it never met again except to pass some loyal and innocuous motion and then be formally prorogued. Since the mid-19th century, however, it has met frequently, even, in the 20th century, twice or three times a year, and has concerned itself actively with ecclesiastical business, particularly the reform of the canons of ecclesiastical law.

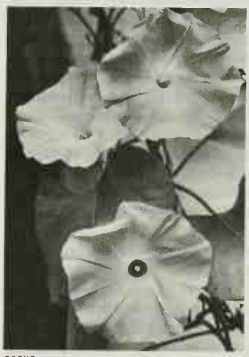
Both convocations have been divided since the 15th century into two houses, the upper consisting of the archbishop and the diocesan bishops of the province, the lower of the deans of the cathedrals and the two senior archdeacons in each diocese (and, in the province of Canterbury, the deans of Westminster and Windsor, and also the provost of Eton, if in priest's orders), all of whom are ex officio members, together with proctors (or representatives) of those clergymen who are beneficed or who hold a bishop's licence to officiate. Proctors must themselves be in priest's orders and in York must be beneficed in the diocese for which they are elected, or resident therein and with a licence to officiate. Clergymen in the universities also return proctors to convocation. Suffragan bishops do not sit in the upper house; but, though not of the inferior clergy, they may sit in the lower house, if by election or otherwise they are qualified; and, since often a suffragan bishop is also an archdeacon, a number of suffragans is to be found in the lower houses of both convocations. Normally the archbishop is the president of the convocation and of the upper house in his province and, in his absence, the senior bishop; but the sovereign would preside, if present, and in the reign of Henry VIII Thomas Cromwell presided as vicegerent and vicar general. The lower house elects one of its number as prolocutor and he presides, when the lower house is sitting alone, and, like the speaker of the house of commons in its dealings with the lords, he represents the lower house in its dealing with the upper house. Joint sittings of both houses together are common, and there have even been joint sittings of both convocations.

Convocation is summoned by the archbishop, who, in obedience to a writ from the sovereign, issues a mandate. In York the mandate issues to each diocesan bishop, requiring him to cite the clergy; in Canterbury it issues to the bishop of London in his capacity as dean of the province. Members of convocation enjoy a similar privilege from arrest as do members of parliament. Convocation is dissolved or prorogued by the archbishop's mandate in obedience to a writ from the sovereign. In 20th-century practice convocation has acted as though it is not dissolved by the demise of the crown, although formerly it was always thought otherwise, and there is no statute governing the matter as there is in the case of parliament. It is generally held, too, that convocation is automatically dissolved by the dissolution of parliament.

The sovereign may issue letters of business to the convocations, when he desires their opinion on any matter. They may also, when lawfully assembled, discuss any other matter of interest to them, and they sometimes pass resolutions known as acts of convocation, which, though influential, have no effect in law. They legislate by passing canons; but their powers in this respect are very limited. They cannot confer to make a canon without the royal licence; every canon requires the royal assent in order to become law; even so, it is invalid, if it be contrary to the royal prerogative, to common law, to statute law or to the general custom of the realm; nor are canons binding except upon the clergy, though, of course, they may thus indirectly affect the laity.

While the legislative powers of convocation are strictly limited, its influence is considerable in reaching and expressing the common mind of the church (or, at least, of a prominent and professional part of it) and in giving a lead in the affairs of the church, though, even here, the effect is lessened by the absence of any lay element. But a misleading picture may be formed, unless account is also taken of the Church of England Assembly (Powers) act, 1919, commonly called the Enabling act, which gave legal recognition and wide powers to the National Assembly of the Church of England, commonly called the Church assembly. This consists of three houses, namely, a house of bishops, a house of clergy and a house of laity. The house of bishops consists of the members of the upper houses of the two convocations; the house of clergy consists of the members of the lower houses of the two convocations; and the house of laity consists of the elected representatives of the laity (together with a few co-opted members). A measure of the Church assembly, on receiving the royal assent, has the full force of an act of parliament. Although, therefore, the legislative powers of the convocations are limited, those of its members are considerable and, further, it must be remembered that 26 of the bishops also have seats in the house of lords. (E. G. Mo.)

CONVOLVULACEAE, the morning-glory family of plants, members of which belong to the tube-flowered series of the group of dicotyledons having joined petals. The family contains about 40 genera with more than 1,000 species, and is found in all the warmer parts of the world, but is best developed in tropical Asia and tropical America. The most characteristic members are twining plants with generally smooth heart-shaped leaves and large showy white, pink, blue or purple flowers, as, for instance, the greater bindweed of American and English hedges, *Convolvulus sepium*, and many species of the genus *Ipomoea*, the largest of the family including the common morning-glory of the garden, *I. purpurea*.



ROCHE

COMMON MORNING-GLORY (IPOMOEA PURPUREA)

The largest genus, *Ipomoea* (true morning-glory), has about 400 species; *Convolvulus* (bindweed) has about 150 species, mainly in temperate climates. *Cuscuta* (dodder, love vine) has nearly 100 species in the warmer and temperate regions; two are British.

In North America, the largest genera are *Ipomoea*, *Cuscuta* and *Convolvulus*. The creeping or trailing type is common, as in field bindweed (*Convolvulus arvensis*), which has also a tendency to climb, and *C. soldanella*, the sea bindweed, the long creeping stem of which forms a sand binder on temperate seashores; a widespread and efficient tropical sand binder is *Ipomoea pes-caprae*. In hot dry districts such as Arabia and northeast tropical Africa occur several genera with a low, much-branched, dense, shrubby habit, with small hairy leaves and very small flowers.

Some exceptional members of the family are represented by *Humbertia* (a native of Madagascar), which forms a large tree; and dodder (*q.v.*), a leafless parasite with slender, yellow, orange or pink threadlike twining stems.

The flowers of the family stand singly in the leaf axils or form cymose inflorescences; they are sometimes crowded into small heads. The bracts are usually scalelike, but sometimes leaflike; *e.g.*, in *Convolvulus spithamaeus, C. hederaceus* and others they are large and envelop the calyx.

The parts of the flower are in fives in calyx, corolla and stamens, with two carpels that unite to form a superior ovary. The sepals, generally free, show much variation in size, shape and covering, and afford characters for the distinction of genera. The corolla is generally funnel-shaped, more rarely bell-shaped or tubular; the outer face is often marked out in longitudinal areas, five well-defined areas tapering from base to apex, and marked with longitudinal striae corresponding to the middle of the petals and alternating with five nonstriated weaker triangular areas. The slender filaments of the stamens vary widely, often in the same flower; the anthers are linear to ovate in shape, attached at the back to the filament and open lengthwise. The ovary is generally two chambered, with two inverted ovules standing side by side at the inner angle of each chamber. The style is simple or branched, and the stigma linear, capitate or globose. The fruit is usually a capsule opening by valves; the seeds, where four are developed, are each shaped like the quadrant of a sphere; the seed coat is smooth, warty or hairy; the embryo is large with generally broad cotyledons surrounded by a horny endosperm.

However, *Cuscuta* has a threadlike spirally twisted embryo with no trace of cotyledons. Some types having large showy flowers are visited by insects for the honey secreted by a ringlike disk below the ovary; large-flowered species of *Ipomoea* with narrow tubes are adapted for the visits of birds.

The tuberlike roots of *Ipomoea batatas* are rich in starch and sugar, and, as the sweet potato (*q.v.*), form one of the most widely distributed foods in the warmer parts of the earth. Several species are used medicinally for the strong purging properties of the milky juice they contain. One of these, jalap (*q.v.*), is derived from *Exogonium purga* (*I. purga*). Ipomoea or orizaba jalap, similar in action, is obtained from the dried root of *I. orizabensis*, a native of Mexico. The resinous cathartic scammony is obtained from the root of *C. scammonia*, native to Asia Minor.

Species of *Ipomoea, Convolvulus* and *Calonyction* (moonflower) are cultivated as ornamental plants. *Convolvulus sepium* and *C. arvensis* (bindweed) are pests in fields and gardens and many of the dodders (*Cuscuta*) cause damage to crops.

See Morning-Glory; Bindweed.

CONVOLVULUS, a genus of twining plants of the family Convolvulaceae (*q.v.*), commonly known as bindweeds or wild morning-glories, comprising 200 or more species widely distributed in temperate and tropical regions. *See* Bindweed; Scammony.

CONVOY, a term used in naval warfare to denote one or more merchant or other noncombatant vessels sailing under the protection of warships.

Originally, merchant vessels formed convoys in order to protect themselves against pirates. Since the 17th century neutral powers have claimed the "right of convoy," that is, immunity from search for neutral merchant vessels sailing under the convoy of a warship of the neutral. England, the dominant naval power, refused to recognize this right.

Attempts by Russia in the "armed neutrality" compacts of 1780 and 1800 to secure recognition of neutral convoys were unsuccessful. The United States, Austria and France were among the states which recognized the "right of convoy." Great Britain deviated from its position only during the Crimean War in order to harmonize its practice with that of its French ally. The principal powers, including Great Britain, recognized and formalized the right of neutral convoy in the declaration of London, 1909. The belligerent warship was permitted, however, to ask, in case of suspicion, that ships in the convoy be searched by the commander of the convoy who was bound to give his findings in writing and to withdraw protection from the offending ship in case the suspicion of violation of neutrality was well founded. Any controversy between the neutral and the belligerent commanders was to be settled through diplomatic channels. The London declaration failed to enter into force. During World War I, the right of convoy was invoked on only one or two occasions.

During World War I, convoys were to serve a totally different purpose, namely, the protection of belligerent merchant shipping, largely against German surface raiders and submarines. (*See* Submarine: *Submarine Warfare.*) There was much controversy in Great Britain about the advantages and disadvantages of convoying vessels transporting vital cargo from the United States and other countries. The German practice of proclaiming as war zones large areas of the high seas and waging unrestricted submarine war on belligerent and neutral commercial shipping left no alternative. In 1917 the convoy system was adopted and justified itself fully during the balance of World War I.

WORLD WAR II

During World War II, the convoy system was adapted, developed and played a decisive role in achieving victory against heavy odds. To ensure the most rational use of available tonnage, steps were taken to co-ordinate British and U.S. policies. After Pearl Harbor there were two shipping pools (one British and one U.S.) and two centres of control (Washington and London), with an Anglo-American Combined Shipping Adjustment board in general command. British ships were detailed for U.S. service by the British member and U.S. ships were allocated to British service by the U.S. member. The over-all direction was in the hands of the British prime minister, Winston Churchill, and Pres. Franklin D. Roosevelt, inasmuch as shipping was a function of grand strategy.

Additional measures gradually put into effect to overcome one of the main drawbacks of the convoy system, delay in the assembly and dispatch of convoys, were concerned with avoidance of overcrowding at ports of departure and arrival, and accelerating the turn-round, principally in British and U.S. ports but also in ports in the middle east, Persian gulf, India, Ceylon and elsewhere. It was also found that tonnage could be used to greater advantage by more expert crating of heavy equipment, dehydrating some foods and shipping beef without bones.

In Aug. 1942 the interlocking convoy system was put into effect. This combined into one system coastal convoys in the United States with transatlantic convoys from New York to Britain. The system operated like a railroad on a tight schedule, the coastal convoys being scheduled to arrive just in time for the departure of transatlantic convoys. The coastal convoys operated from Key West and from Guantánamo (Cuba) to New York. The latter were extended in 1943 to Aruba (Netherlands Antilles), Trinidad and finally to Rio de Janeiro with the Brazilian navy participating in the escort from Recife to Rio. Local convoys from the Gulf of Mexico and the Caribbean were fed into Key West and Guantánamo. The effectiveness of the system depended, of course, upon the availability of ships for escort duty both in kind and number.

A convoy consisted of a varying number of merchant vessels, arranged in columns at a predetermined distance from each other, and an escort of warships stationed ahead and on the flanks. The merchant vessels were under the command of a convoy commodore, usually a high-ranking naval officer recalled from retirement for active duty. The entire convoy was under the command of the senior officer in the escort, who in turn was controlled by Washington or London up to "Chop" (change of operational control). The escort commander was authorized to deviate from the prescribed route to meet unforeseen circumstances. He might also order a fast (9 knots) or a small convoy to zigzag, or a slow convoy ($6\frac{1}{2}$ knots) to steer an evasive course in order to avoid attack. In the latter case, the base course would be changed 20°–40° on each side for a period of several hours.

The escort commander received information regarding enemy submarines and instructions from London or Washington. Information concerning location of submarines was obtained through shore-based or ship-borne high-frequency direction finders (HF/DF, called "Huff-Duff"). Convoys included, after 1942, specially designed rescue ships, and also tankers carrying fuel for escorting destroyers. Escort disposition around convoys was gradually improved to meet changing tactics of submarines. Communication within the convoy was generally by voice radio (TBS) and communication between air escort and surface escort was also provided for. U.S.-Canadian escorts were in charge of convoys from the Atlantic seaboard to "Momp" (mid-ocean meeting point), where they were turned over to a waiting U.K. escort.

Radar as well as sound detection devices like sonar (sound navigation ranging) installed in escorting vessels and microwave radar in aircraft proved most valuable in fighting the submarine and ensuring the safety of convoys, as did refined methods in the use of depth charges and the forward-thrown "squid" adopted by the British navy in 1945. Other types of forward-thrown antisubmarine weapons like the "hedgehog" and "mousetrap" were less effective. The usual weapons carried by escort vessels —guns and machineguns—were also useful against submarines and their crews respectively.

The use of these antisubmarine devices was substantially developed by operations research first instituted in Britain and later adopted by the U.S. navy.

Whereas in World War I the greatest need for protection was for ships in close vicinity of Great Britain, these waters became relatively secure in World War II because of defense by shore-based aircraft. It was on the high seas that there was the greatest need for protection in World War II, although extremely severe losses were inflicted on shipping along the Atlantic coast of the United States during the first few months of 1942, before coastal

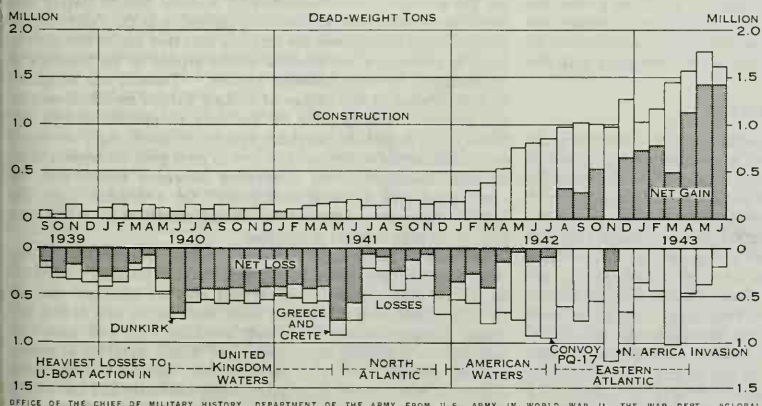
convoys were organized. The number of convoys that could be organized in any area depended upon the availability of escort vessels of which initially there were very few on either side of the Atlantic. When the convoy system was introduced in Britain in 1917, 339 destroyers were available for escort duty, and a normal escort consisted of 8 to 10 vessels. In Aug. 1940 Britain disposed of only 181 destroyers and the normal escort consisted of 2 to 3 ships. In the last quarter of 1940, after the consummation of the "destroyer deal" between the U.S. and Britain, the average escort was increased to 8 to 12 vessels but was reduced to 4 to 6 vessels in 1942. Scarcity of escorts also limited the distance over which protection could be afforded. Thus, until spring 1940, convoys were protected for only a short distance and had to make their way across the Atlantic without escort. Between June 1940 and the end of 1941, British shipping consequently suffered a total loss of about 7,000,000 dead-weight tons representing about 36% of the total British merchant fleet in June 1940. The first convoy across the Atlantic under continuous escort sailed over the northern route from Halifax, N.S., on May 27, 1941; over the southern Atlantic route from Sierra Leone on the west coast of Africa on July 14, 1942; and the first convoy on the Gibraltar route on July 10, 1941. In Sept. 1941 the United States began to participate in escorting convoys across the northern Atlantic and the U.S.S. "Reuben James" was sunk by a German U-boat on Oct. 30, 1941. However, in July 1941, the United States had already relieved the British in Iceland and the navy began escorting vessels of any nationality to and from Iceland.

Convoys were primarily concerned with protection of cargo vessels. Troop transports from the United States to Britain, beginning July 10, 1942, also sailed under heavy escort and suffered no loss whatsoever during the entire war with the exception of some losses suffered by troopships to Greenland and Iceland. Fast ships like the French S.S. "Pasteur," Canadian S.S. "Empress of Britain" and the British "Queen Mary" and "Queen Elizabeth" served as troop transports after Aug. 1942, and sailed without escort and without any incident. Even cargo vessels of about 14 knots and over needed no protection and sailed independently.

From 1941 on the German submarine command under Adm. Karl Doenitz replaced attack by individual U-boats by "wolf packs." These consisted of 8 or more, sometimes up to 20 submarines, spread out over probable convoy routes. They were to intercept a convoy and attack it at night. One or two submarines were to lure escorts away from the convoy in order to enable others to close in on, or to penetrate, the convoy. Wolf packs concentrated on transatlantic convoy routes in the mid-Atlantic which, in 1942–43, did not enjoy the protection of shore-based aircraft, and in the Atlantic narrows between Brazil and Africa. As the interceptor submarines reported the sighted convoy to Doenitz, who directed the rest of the pack to the convoy, it was possible for the Allies to locate the pack. To counter Allied attack from the air, German commanders were instructed to fight back rather than submerge. This proved a costly defense against expanding Allied air superiority.

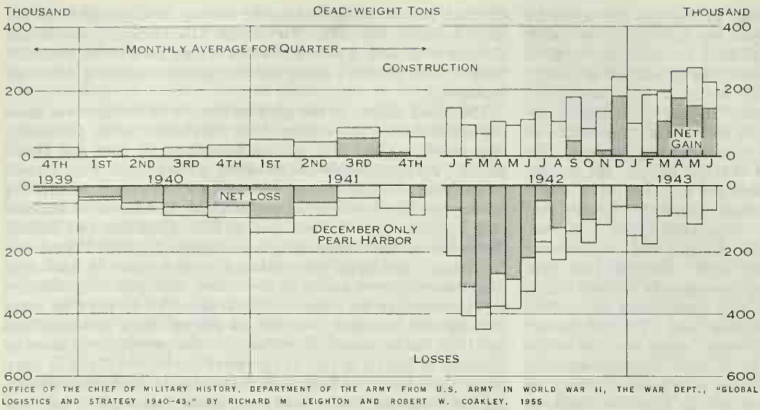
The Allied answer to the growing menace to convoys was more and better escorts, and arming of the merchant vessels. Gradually, ships were supplied with guns and anti-aircraft guns and armed guards. All available vessels including private yachts were pressed into service. Destroyers and destroyer escorts were most effective for convoy duty but they became available in substantial numbers only by mid-1943. In addition to U.S., Canadian and British, destroyers of such other nations as France, Norway, Poland, the Netherlands and Brazil were included in the screen. In April 1943 escort carriers were added to the screen, thus providing effective air cover outside the range of coastal aircraft. In 1943 the range of these was extended from 600 to 900 mi. from Newfoundland and from 700 to 900 mi. from Britain. The permission granted by Portugal to Britain in Oct. 1943, and to the United States in 1944, to use the Azores as a base made it possible to extend aircraft protection to an area which was known as the "black pit." All these developments permitted the Allies to adopt more aggressive and flexible methods for protecting the convoys by keeping the submarine out of range, and at the same time for destroying the submarine where it was most abundant, namely, in the vicinity of convoys. Escort carriers were instructed to seek out U-boat packs at considerable distances from the convoy. The formation of "hunter-killer" groups, patterned after the British "seek and strike" tactics of following up contact with submarines and destroying them, was the final stage in the evolution of convoy protection and antisubmarine warfare.

Allied shipping losses are detailed on the charts (fig. 1 and 2). Particularly heavy losses occurred after Pearl Harbor in areas under the primary responsibility of the United States. Between January and June 1942, 297 ships (1,612,900 gross tons) were sunk. Allied losses reached the peak in June 1942: 140 ships (700,000 gross tons) sunk in all waters. In March 1943, 95 ships (567,400 gross tons) were sunk in the Atlantic and Arctic. From then Allied losses declined and the destruction of submarines increased. In May 1943, "black May" for German submarines, 41 were sunk. Losses continued heavy in the Indian ocean where no escort and no air protection could be provided. Over the North Atlantic route to Russia, the most dangerous of all convoy routes, which was exposed to the German battle fleet and aircraft based on Norway, 40 convoys carried 4,000,000 gross tons between Aug. 1941 and the end of the war, 720 merchant vessels arriving and 63 vessels being lost. One convoy, the P.Q. 18, consisting of 40 vessels and protected by 77 warships, lost 13 ships. The British home fleet, which had responsibility for this route, suffered grievous losses keeping Russia supplied. In 1944, the year of D-day, 266 convoys escorted by 2,000 warships sailed over the North Atlantic route to Britain. Of about 13,000 merchant vessels, 10 were sunk. Over the central Atlantic route, between Nov. 1942 and May 1945, 11,000 merchantmen sailed in 189 convoys, 9 ships being lost. The appearance of the "schnorkel" (*see* SUBMARINE) in 1945 turned the shipping situation against the Allies and for a while brought about losses comparable with those of 1943. This development was too late to make any difference to the Allied cause. Had the schnorkel-type submarine become operational earlier, as Doenitz had planned and hoped, it might have been dan-



OFFICE OF THE CHIEF OF MILITARY HISTORY, DEPARTMENT OF THE ARMY FROM U.S. ARMY IN WORLD WAR II, THE WAR DEPT., "GLOBAL LOGISTICS AND STRATEGY 1940–43," BY RICHARD M. LEIGHTON AND ROBERT W. COAKLEY, 1955

FIG. 1.—CHART SHOWING THE CONSTRUCTION AND LOSSES OF DRY CARGO SHIPS OF THE U.S. AND ALLIED AND NEUTRAL NATIONS FROM SEPT. 1939 TO JUNE 1943



OFFICE OF THE CHIEF OF MILITARY HISTORY, DEPARTMENT OF THE ARMY FROM U.S. ARMY IN WORLD WAR II, THE WAR DEPT., "GLOBAL LOGISTICS AND STRATEGY 1940–43," BY RICHARD M. LEIGHTON AND ROBERT W. COAKLEY, 1955

FIG. 2.—CHART SHOWING THE CONSTRUCTION AND LOSSES OF TANKERS OF THE U.S. AND ALLIED AND NEUTRAL NATIONS FROM SEPT. 1939 TO JUNE 1943

gerous because aircraft were not successful against it. It was necessary to revert to the tried and tested method of depth charges but the schnorkel was much more difficult to locate and destroy than its predecessor.

The last battle against a submarine of the schnorkel type was fought off Narragansett bay, Rhode Island, three days before Germany surrendered unconditionally. Convoys were ordered discontinued on May 28, 1945. The total German effort to cut the lifelines of supply of men and material involved nearly 1,200 U-boats of which about 700 were sunk by the Allies while nearly 100 perished for other reasons, taking about 32,000 officers and men with them to the bottom. The British losses in merchant seamen were below 30,000. Out of a total of 5,887 vessels lost (23,176,485 gross tons), 2,700-odd Allied and neutral merchant vessels totaling nearly 15,000,000 gross tons were sunk by submarines in World War II (1939–45). Of these, less than 30% were torpedoed while sailing in convoy, over 60% were unescorted and the rest were stragglers from convoys. From 1939 to 1942, 4,435 Allied and neutral ships (17,408,849 gross tons) were lost from all causes including U-boats. From 1943, when the convoy system became fully operational, to the end of the war, only 1,452 Allied and neutral ships (5,767,636 tons) were lost.

In the spring of 1943, the back of the German submarine warfare was broken and the initiative passed to the Allies. The convoy system kept England supplied, carried essential supplies to Russia and made possible the tremendous build-up of Allied power for the invasions of Africa, Italy and finally of Europe. Among the many types of escort vessels, the escort carriers constructed in the United States were the best answer to the submarine until the schnorkel made its appearance.

LEGAL ASPECTS

Neutral Convoys.—As noted above, the rules concerning the neutral convoys were neither applied nor tested to any extent in World War I. Many jurists, however, continued to adhere to the declaration of London of 1909, that belligerent warships may not visit and search vessels under neutral convoy. There is no evidence that during World War II neutral powers claimed the right of convoy. In order to escape visit and search (*q.v.*), neutrals were offered by belligerents in both wars the opportunity to obtain a cargo or a ship navicert. Great Britain introduced this system in World War I and again in Nov. 1939. A cargo navicert was a document, in the nature of a pass for approved cargo, issued by the belligerent. A ship navicert declared that the entire cargo of the ship had been approved by the belligerent. Originally, absence of a navicert was no ground for, nor was its possession a guarantee against, seizure. It was a convenience offered by Britain to meet legitimate needs of neutrals. By the Reprisal order in council of July 31, 1940, Britain made absence of a navicert presumption of enemy destination and a ground for seizure.

Belligerent Convoys.—The waging of unrestricted submarine warfare even against neutral ships by Germany in World War I persuaded many neutrals to seek the protection of British or U.S. convoys for their merchant vessels. Regarding the legal position of neutral ships in belligerent convoys, there were two theories. According to Anglo-American opinion such ships were liable to capture. The underlying view was that by joining a belligerent convoy the neutral vessel sought to escape legitimate acts of naval warfare, namely visit, search and eventual seizure, by the opponent.

Germany, however, sank neutral ships in belligerent convoys. Their view was that by seeking the protection of a belligerent convoy, the neutral merchantman joined a military unit of the belligerent and was liable to sinking at sight. Anglo-American legal opinion assimilated the neutral merchant vessel in belligerent convoy to an enemy merchant vessel; German legal opinion assimilated it to a warship.

This point was explicitly recognized in several international arbitrations arising from World War I, in the French Instructions of 1934 and the Italian Law of Neutrality of 1938. Moreover, it was also generally conceded that sailing under belligerent convoy was equivalent to forcible and illegal resistance to visit and search which exposed the vessel to all the consequences, including sinking. This legal consequence appeared further supported by the fact that merchant vessels, both neutral and belligerent, under escort, were armed in World War I as well as in World War II. This deprived them of the protection afforded by international law to merchant vessels generally. Unarmed merchant vessels may not be sunk by surface warships or submarines unless passengers, crew and ship's papers have first been put into a place of safety.

Admiral Doenitz was accused before the International Military tribunal in Nürnberg of waging unrestricted submarine warfare. The tribunal found Doenitz guilty but imposed no sentence on this ground: "In view of all the facts proved and in particular of an order of the British Admiralty announced on May 8, 1940, according to which all vessels should be sunk at sight in the Skagerrak, and the answers to interrogatories by Admiral Nimitz stating that unrestricted submarine warfare was carried on in the Pacific Ocean by the United States from the first day that that nation entered the war, the sentence is not assessed on the ground of his breaches of international law of submarine warfare." Doenitz was acquitted by the tribunal of the charge of sinking British merchantmen on this ground: "Shortly after the outbreak of war the British Admiralty . . . armed its merchant vessels, *in many cases convoyed them with armed escort*, gave orders to send position reports upon sighting submarines, thus integrating merchant vessels into the warning network of naval intelligence. On 1 October, 1939, the British Admiralty announced that British merchant ships had been ordered to ram U-boats if possible."

The United States Law of Naval Warfare, promulgated by the chief of naval operations, Sept. 1955, states accordingly in article 503b (3): "Enemy merchant vessels may be attacked and destroyed, either with or without prior warning, in any of the following circumstances: 1. Actively resisting visit and search or capture. . . . 3. Sailing under convoy of enemy warships or enemy military aircraft." It also declares that "neutral vessels under convoy of enemy warships acquire enemy character and are always liable to capture" (note 10, pp. 5–9) and that "neutral merchant vessels and aircraft acquire enemy character and are liable to the same treatment as enemy merchant vessels and aircraft when

engaging in the following acts: 1. Operating directly under enemy control, orders, charter, employment, or direction; 2. Resisting an attempt to establish identity, including visit and search." Under the constructive resistance doctrine mentioned above, neutral vessels in belligerent convoys appear to be exposed to sinking at sight. However, the measures which had been adopted by the enemy—proclamation of war zones and all-inclusive contraband lists—had left the neutrals only the choice between stopping altogether a profitable trade or choosing the protection of convoys and accepting the attendant risks.

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CONVULSIONS, the pathological body condition characterized by abnormal, violent and involuntary spasmodic contractions and relaxations of the voluntary muscles, taking the form of a fit. Convulsions may be a symptom resulting from various diseases; *e.g.*, in uremia, eclampsia, rabies, tetanus, hysteria, epilepsy, strychnine poisoning, cerebral tumour and other diseases. They are usually, but not always, accompanied by loss of consciousness. Popularly, the term is commonly restricted to the infantile variety, occurring in association with causes which upset the child's nervous system. The treatment should be prompt but sedative. Convulsions are symptoms of other conditions which must be recognized and properly treated. In infants and children they may be analogous to a chill in the adult which occurs with the onset of some acute diseases. First-aid treatment includes quiet and prevention of injury from falling, biting the tongue or cheek, and bodily warmth and comfort. Medical advice is essential.
(F. L. A.)

CONWAY, MONCURE DANIEL (1832–1907), U.S. liberal clergyman and social reformer, was born of Methodist slaveholding parents in Stafford county, Va., on March 17, 1832, and educated at Dickinson college, Carlisle, Pa. While serving in the Methodist ministry, he became converted to Unitarianism and enrolled in the Harvard divinity school, graduating in 1854. Because of his outspoken expression of abolitionist views he was dismissed from his first Unitarian pastorate in Washington, D.C. In Cincinnati, O., to which he then moved, he was active in abolitionist causes, even settling a colony of fugitive slaves at Yellow Springs, O. In 1860 he edited in Cincinnati a short-lived literary journal named after the earlier New England *Dial*, and in 1862 became co-editor in Boston of the *Commonwealth*, an antislavery paper. During the Civil War he went to England to lecture on behalf of the North, remaining until 1884 as minister of a liberal congregation in London, which he served again from 1892 to 1897. Conway contributed to newspapers and magazines in both England and the U.S., and wrote over 70 books and pamphlets on a great variety of subjects—social, religious, political and literary—becoming increasingly free in his views. His most scholarly works, standard for a half-century, are *Life of Thomas Paine*, 2 vol. (1892) and *Collected Works of Thomas Paine*, 4 vol. (1894–96). His *Autobiography* (1904) is valuable for sketches of important 19th-century figures. Conway died in Paris on Nov. 15, 1907.

See Mary Elizabeth Burtis, *Moncure Conway, 1832–1907* (1952), which contains a bibliography.

CONWAY, ROBERT SEYMOUR (1864–1933), English classical scholar, was noted for his service to classical learning through his support of the classics and, in smaller degree, of the study of Indo-European philology, in particular of the ancient languages of Italy. He was born on Sept. 20, 1864, the son of a Congregationalist minister in London. He was educated at the universities of London and Cambridge, winning various distinctions and honours. From 1893 to 1903 he was professor of Latin at University college, Cardiff, and from 1903 to 1929 at the University of Manchester. His most important work was his *Italic Dialects* (1897). A successful teacher, he also won renown for his research and as a lecturer in the United States, New Zealand and elsewhere. Conway was a man of great enthusiasm for the cause of classical learning, but of fiery temper and at times of unwise judgment. He died in London on Sept. 28, 1933.

See J. Whatmough, "R. S. Conway," *Biographisches Jahrbuch für Altertumskunde*, vol. 266, pp. 21–40 (1939), supp. to K. Bursian, *Jahresbericht über die Fortschritte der klassischen Altertumswissenschaft* (1873 *et seq.*). (J. Wh.)

CONWAY (Conwy; formerly Aberconwy), a municipal borough of Caernarvonshire, Wales, lies astride the Conway estuary 15 mi. E.N.E. of Bangor and near the easterly entrance of the Menai strait. The borough (charter 1284) also comprises the towns of Deganwy and Llandudno Junction. Pop. (1961) 11,392.

From its rock above the river at the southeastern corner of the town walls, the castle (*c.* 1284) dominates Conway, one of Europe's few almost perfectly walled towns. The castle is roughly rectangular with four towers, each 40 ft. in diameter, along both sides. The town walls describe a harp-shaped circuit of about 1,400 yd. with 21 towers rising above the general level. Originally there were three main entrances to the town, each with two strong towers. In modern times the walls have been breached at three further points. Castle and walls were constructed by the conquering Edward I as part of his policy of establishing English boroughs along the north Wales coast. In doing so he moved the Cistercian abbey of Aberconwy, burial place of Llewelyn the Great, up river to Maenan. The unfinished abbey church (*c.* 1185) became the parish church of St. Mary. While at Conway castle in 1399 Richard II was betrayed by the earl of Northumberland to Henry Bolingbroke (afterward Henry IV). During the Civil War the castle was garrisoned for the royalists by John Williams, archbishop of York (a native of Conway), but in 1646, appreciating that the cause was lost, he assisted in delivering the town to Gen. Thomas Mytton to save it from destruction. The castle was partly dismantled in 1665 but, with the town walls, is now in the care of the ministry of works.

The original street pattern seems to have changed little. A 16th-century drawing shows High street, Castle street and Upper Gate street on their existing sites. Aberconwy, a medieval house (*c.* 1500) at the junction of High street and Castle street, now belongs to the National trust. Plâs Mawr ("the great house"), an Elizabethan mansion (1577–80), houses the Royal Cambrian Academy of Art. The Black Lion, Castle street, built in 1582 as a vicarage, was later used as a coaching inn.

From the eastern end of the castle the river is spanned by Thomas Telford's graceful suspension bridge (1826), Robert Stephenson's tubular railway bridge (1848) and the modern road bridge opened in 1958. Conway is on the Chester-Bangor trunk road and the Euston-Holyhead main line, with branch line services.

Since Roman times mussels have been gathered in the estuary—originally for their pearls. A small coastal fishing fleet is based on the town which is a holiday and tourist centre. There is some boatbuilding; agriculture predominates in the surrounding area.

Deganwy.—In 517, Maelgwyn Gwynedd, who is said to have succeeded King Arthur as king of Britain, built his castle there. A later Norman castle was captured and completely demolished by Llewelyn ap Gruffydd (*c.* 1262). The town (Gannow) had been granted a charter by Henry III (*c.* 1252) and was gradually fused, after 1284, into the new borough of Conway. Little remains of the old fortifications. The Deganwy Castle hotel (*c.* 1640) is one of the oldest buildings. Deganwy is now a holiday resort, residential area and yachting centre.

Llandudno Junction is within the ancient parish of Llangwstenin where, formerly, there were a few scattered farms and residences. With the coming of the railway a community sprang up taking its name from the junction station, one of the busiest in north Wales. This is now the industrial portion of the borough containing a large domestic appliance factory and several storage and distribution depots. (R. C. Gr.)

CONWAY OF ALLINGTON, (WILLIAM) MARTIN CONWAY, 1st Baron, of Allington, Kent (1856–1937), Eng-

lish art historian and mountaineer, was born at Rochester, Kent, April 12, 1856, and was educated at Repton school, Derbyshire, and at Trinity college, Cambridge. After a period of European travel and university extension lecturing (1882–85), Conway held the Roscoe chair of art at University college, Liverpool (1885–88). He was Slade professor of fine arts at Cambridge, 1901–04, and director-general of the Imperial War museum, London, from 1917. His most enduring contributions to the history of art are *The Van Eycks and Their Followers* (1921; as *Early Flemish Artists*, 1887), and *The Literary Remains of Albrecht Dürer* (1889). He formed a great library of about 100,000 photographs and reproductions of works of art which he gave to the University of London Courtauld Institute of Art in 1932.

It was for his achievement in surveying 2,000 sq.mi. of the Karakoram in 1892 that Conway was knighted (1895). During this survey he made the first ascent of a major Himalayan peak, reaching 23,000 ft. He produced several books on mountain climbing including *The Zermatt Pocket Book*, the prototype of the handbook for climbers not using guides. *The First Crossing of Spitsbergen* (1897) was a record of his pioneer journey across the main island (1896–97). During expeditions to South America in 1898 he climbed Aconcagua (22,834 ft.), Sorata (Illampu) (21,276 ft.) and Illimani (21,184 ft.); and explored Tierra del Fuego.

Conway was Unionist member of parliament for the combined English universities' constituency from 1918 until his elevation to the peerage in 1931 (at the instance of Ramsay MacDonald). He considered his best book to be *The Crowd in Peace and War* (1915). He died in London on April 19, 1937.

See Lord Conway, *Episodes in a Varied Life* (1932), *A Pilgrim's Quest for the Divine* (1936).

CONWELL, RUSSELL HERMAN (1843–1925), U.S. clergyman and the most noted lecturer of the Chautauqua circuit, who for years toured the country with his famous lecture "Acres of Diamonds," was born in South Worthington, Mass., on Feb. 15, 1843. He entered Yale university in 1860. In 1862 he raised a company to serve in the American Civil War, and attained the rank of lieutenant colonel. In 1865 he was admitted to the bar. He practised law in Minneapolis and Boston, and later published two newspapers—the *Minneapolis Daily Chronicle* and the *Somerville* (Mass.) *Journal*. A run-down Baptist church in Lexington, Mass., enlisted his interest, and when he succeeded in reviving it, he was ordained its minister in 1879. In 1882 he was called to Grace Baptist Church in Philadelphia, a small congregation struggling with debt. Within ten years the church had a new home—the Baptist Temple—and was well on its way to becoming the largest and most famous "institutional" church in the country, with a university and three hospitals numbered among its progeny.

Conwell delivered his lecture "Acres of Diamonds" no fewer than 6,000 times with total earnings, including royalties from its sale in printed form, of $8,000,000. The theme of the lecture was that opportunity lurks in everyone's backyard, that everyone can and ought to get rich and then use his money for the good of his fellow men. "Keep clean, fight hard, pick your openings judiciously, and have your eyes forever fixed on the heights toward which you are headed," was his simple formula for success and the central emphasis of his preaching. He died on Dec. 6, 1925.

The authorized biography by Agnes Rush Burr, *Russell H. Conwell* (1926), includes one of the many recensions of "Acres of Diamonds." (W. S. H.)

CONY (CONEY), a name originally applied to the rabbit (*q.v.*) and still sometimes used for it, notably in the fur trade. The cony of the old world and of the Bible is a different animal, which, although superficially rodentlike, is a hoofed mammal of dubious affinities, and is better termed the hyrax (*see* HYRACOIDEA). The true cony, or pika, is a relative of the rabbit. It is a small, stocky guinea-piglike inhabitant of rocky niches in the hills and mountains throughout Eurasia and North America. *See* PIKA.

CONYNGHAM, GUSTAVUS (*c.* 1747–1819), U.S. naval officer, was born in County Donegal, Ire., about 1747. He was taken to America in his youth and apprenticed to a captain in the West Indian trade. Advancing to shipmaster, he was employed to bring gunpowder from Holland at the outbreak of the American Revolution, but became stranded in Holland. The American commissioners in France supplied him with a commission dated March 1, 1777, and sent him forth from Dunkerque in May in an armed lugger. He captured a packet plying with mail between England and Holland and brought it and another prize back to Dunkerque. Upon British protest, Conyngham and his crew were imprisoned, the prizes restored and the captain's commission confiscated. The commissioners secured his release, supplied him with a new commission and the cutter "Revenge," and sent him again on a cruise out of Dunkerque. Sailing around the British Isles and operating off Spain and in the West Indies, he took 29 prizes in the ensuing two years, but was finally captured, carried to England, and threatened with death as a pirate. Amid threatened reprisals on the part of the continental congress, Conyngham escaped to Holland, where, in 1780, he joined John Paul Jones in a cruise in the frigate "Alliance." From the end of the war until his death in Philadelphia on Nov. 27, 1819, he waged a hopeless fight to gain recognition by congress of his rank in the navy. Almost a century after his death the commission the French had confiscated and which could have substantiated his claim was found in the collection of a Parisian autograph dealer. (W. B. CK.)

COOCH-BEHAR, a town and district in northern West Bengal, India, to the south of the Himalayas. The town (pop. [1951] 33,242) is situated on the east bank of the Torsa river, 275 mi. N.E. of Calcutta, and is connected with that city by air and rail. It is planned with a grid pattern of streets, beautifully laid out parks and deep tanks, or artificial lakes. Lansdowne hall, with a clock tower 79 ft. high, constructed in 1892, stands on the west of the Sagardighi, the largest and finest of the tanks.

COOCH-BEHAR DISTRICT forms part of the piedmont plains of north Bengal, sloping gently southward from 180 to 150 ft. Pop. (1961) 1,019,747; area 1,291 sq.mi. The Jaldhaka, Torsa and Raidak are the important rivers; the Tista just touches the district on the west. The shifting of river courses is very common. Just below high riverbanks, loamy and well-drained soils yield rich crops of rice and jute. Tobacco and sugar cane are usually grown on higher ground. The district is a land of foliage and flowers and in its forests roam rhinoceros, tiger, gaur or "Indian bison" and black bear.

Dinhata (pop. [1951] 5,848), a market town, stands on Rangpur road, 16 mi. S. of Cooch-Behar town. Matabhanga (pop. 4,256), the largest tobacco-marketing centre, is on the right bank of the Jaldhaka river. Haldibari, Mekliganj and Tufanganj are the other market towns.

Cooch-Behar was a princely state before its merger with West Bengal (1950). (S. P. C.)

COOK, ARTHUR JAMES (1883–1931), British labour leader, who became widely known during the 1920s for his championship of the miners' cause, was born on Nov. 22, 1883, at Wookey in Somerset, the son of a professional soldier. Cook started work as a farmer's boy but he migrated to the Rhondda valley in south Wales at the age of 16 and became a coal miner. He studied at the Central Labour college, London, in 1911–12. During World War I he was a strong pacifist and in the aftermath a prominent local agitator. In 1918 and again in 1921, his trade-union activities led to prison sentences. In 1924 he was elected secretary of the Miners' Federation of Great Britain and in the following years of bitter industrial strife he symbolized the determined but ineffective resistance of the miners. He was an impassioned orator with a great following in the coal fields. As a negotiator he was much less successful, and his part in the general strike of 1926 received considerable criticism from other trade-union leaders.

Cook died in London on Nov. 2, 1931. (R. J.)

COOK, JAMES (1728–1779), English circumnavigator, hydrographer, and explorer of the Pacific and Antarctic oceans, who in three great voyages from 1768 to his death did more to clarify the geographical problems of the southern hemisphere than had been done by all his predecessors. He was the first of the really scientific navigators and his voyages made great contributions to many fields of knowledge besides geography. His charting of the

North American coast on its Pacific side alone is a work of considerable importance.

Cook was born on Oct. 27, 1728, in the village of Marton-in-Cleveland, Yorkshire. His father, a day labourer, shortly became hind, or foreman, on the farm of Thomas Scottowe at Great Ayton, where Cook spent his boyhood, attending the village school at Scottowe's expense. At the age of 17 he was apprenticed to a grocer and haberdasher of Staithes; but finding himself more strongly attracted to the sea, his apprenticeship was transferred in July 1746 to John Walker, a well-known Quaker shipowner and coal shipper at Whitby, with whom his friendship was lifelong. Cook's ability struck Walker, who sent him to sea at once, while keeping him home in the winter working hard at mathematics and navigation. Out of indentures, he spent two years before the mast in the Baltic trade, returned to Walker's service (1752) as a mate, and in 1755 was offered a command. The experience he had gained of the navigation of colliers on the treacherous east coast of England was an invaluable foundation for his later work.

Instead of accepting Walker's offer of a ship he took the chance of a wider life offered by the near outbreak of war with France, and on June 17, 1755, volunteered into the navy as an able seaman. His first ship was the "Eagle" (60 guns); within a month he was promoted to master's mate and, after channel service (1755–57), to master in the "Pembroke" (64 guns). In Feb. 1758 the "Pembroke" crossed the Atlantic to take part in operations under Adm. Charles Saunders—the siege of Louisburg and the naval side of the assault on Quebec. In the charting of the St. Lawrence before the fleet moved up Cook played an important part; after the capitulation of Quebec he was transferred to the "Northumberland," the flagship of Lord Colville, who succeeded Saunders. While her master he improved his mathematical and astronomical knowledge, learned surveying from Samuel Holland, the military engineer, and built up a high reputation as a marine surveyor. In 1763, after a brief period in England, he was appointed to the Newfoundland survey, commanding the schooner "Grenville," making detailed observations in the summer and returning to England in the winter for desk work on his charts. These were published, at first by Cook himself, later in the *North American Pilot*. During this period, in 1766, he observed very accurately an eclipse of the sun from Burgeo Islands; the observations, and a calculation of the longitude therefrom, were published in the Royal society's *Philosophical Transactions* for 1767, with the remark that the observer was "a good mathematician and very expert in his business." It was therefore as a good seaman, a good hydrographer and a good observer that Cook could be commissioned by the admiralty in 1768 as lieutenant in command of H.M.S. "Endeavour Bark," a Whitby-built collier bought into the navy to take out observers to Tahiti (discovered by Capt. Samuel Wallis) to observe the transit of Venus for the Royal society. The two observers appointed by the society were Charles Green and Cook himself.

The "Endeavour" had two missions. The first was to ensure that the transit was observed as the British part in an international scientific effort which had for its object the determination of the earth's distance from the sun. The second was to carry on the process of geographical discovery set in motion by the admiralty with Adm. John Byron's voyage of 1764–66. Cook's instructions were, after leaving Tahiti, to sail south to latitude 40° S. in search of supposed continental land, and if he did not meet with it to turn west and pick up the coast of New Zealand, last visited by Abel Tasman in 1642–43; then to return home via Cape Horn or the Cape of Good Hope, as seemed to him best. The ship sailed from Plymouth on Aug. 25, 1768. On board also were the young Joseph Banks and his friend the Swedish botanist Daniel Solander, excited by the prospect of natural history studies in the Pacific. Cook entered the Pacific around the Horn and passing through the Tuamotu Islands anchored at Tahiti on April 13, 1769; on Point Venus the necessary observations, seemingly good ones, were carried out on June 3; but unfortunately the nature of the planet made all observations, wherever taken, uncertain, and the subsequent calculations varied so violently as to destroy the value of that side of the voyage. Cook had, however, maintained excellent relations with the Tahitians, of great value for the future, while the ethnological and botanical work of Banks and Solander laid the foundation for similar work subsequently done in the area. Leaving Tahiti on July 13, Cook first visited and named the Society Islands and then struck south. Unsuccessful in finding a continent, he sighted New Zealand near Poverty bay on Oct. 7, and proceeded to circumnavigate the islands in a figure of eight, making friends with the New Zealanders after some preliminary difficulties, and making also a quite brilliant running survey and chart of the country. On April 1, 1770, he left New Zealand, choosing to return home via the hitherto unknown eastern coast of Australia, which he charted equally brilliantly, in spite of deadly peril from the Great Barrier reef on two separate occasions. He then rediscovered Torres strait and passed through it to Batavia, where his ship's company, so far remarkably healthy, fell victims to malaria and dysentery. In spite of a tragic mortality, Cook brought his ship home safely on July 12, 1771, and was promoted commander.

His interest in the continental problem having been thoroughly roused, he now suggested a further voyage which would take advantage of the westerly winds in high latitudes and circumnavigate the globe as far south as possible, the winters being spent refreshing at bases in New Zealand and Tahiti. He was given command of two ships, "Resolution" and "Adventure" (Capt. Tobias Furneaux); left England July 13, 1772; and sailed southeast from the Cape at the end of November. In three antarctic cruises (Atlantic-Indian ocean sector, Dec. 1772–March 1773; Pacific sector, Nov. 1773–Feb. 1774; and Atlantic sector, Jan.–Feb. 1775) he completely dissipated the old continental theory, but was convinced that there must be land somewhere beyond the ice fields. His farthest south was latitude 71° 10′ S., longitude 106° 54′ W., on Jan. 30, 1774. In between these cruises he made further visits to New Zealand (off which the ships parted, Oct. 30, 1773) and an astonishing series of discoveries and rediscoveries, mainly on a great tropical sweep, Feb.–Oct. 1774, which took in Easter Island, the Marquesas, the Society Islands, Niue, Tonga, the New Hebrides, New Caledonia and a number of smaller islands. On the last part of the voyage he discovered and charted South Georgia and the South Sandwich Islands, and was home again on July 30, 1775. This voyage was notable not merely for a masterly technique in antarctic navigation, in preserving the health of seamen and in hydrographic work but also for its proof of the value of the chronometer as an aid to finding longitude. Cook was elected a fellow of the Royal society and given its Copley medal for his paper on the methods he used in combating scurvy.

Promoted post captain and appointed to a berth in Greenwich hospital, Cook almost immediately volunteered to take command of a third voyage, its object being to examine narrowly the northern Pacific coast of America for a possible northwest passage. He sailed again in the "Resolution" on July 12, 1776, the "Discovery" (Capt. Charles Clerke), his consort, catching him up at the Cape. After leaving the Cape, he called at Van Diemen's Land, New Zealand, Tonga and the Society Islands, before sailing north on Dec. 8, 1777, and discovering the Hawaiian group on Jan. 18, 1778. Thence he made the American coast, working up it as closely as gales would permit, around the Aleutian Islands, through Bering strait and as far north as latitude 70° 44′ N. before he was stopped by pack ice. He determined to winter at Hawaii, where, after some coastal surveying, he anchored in Kealakekua bay from Jan. 17 to Feb. 4, 1779. After leaving he had to put back to repair a sprung topmast, and on Feb. 14 was killed in an unhappy scuffle with the natives ashore. Clerke took command and was beaten back again by the ice beyond Bering strait; he too died, of consumption, and the ships returned to England on Oct. 4, 1780, under John Gore.

Cook's career cut him off largely from domestic life; in 1762 he married Elizabeth Batts, who survived him for 50 years. Of six children three died in infancy, and the three sons who lived longer (of whom two entered the navy) were all dead by 1794.

No man was ever better fitted by character, training and native abilities to be a great nautical explorer, and his second voyage was possibly the greatest voyage ever made. He was a supremely good planner and administrator, and his management of seamen

was masterly. No one was ever more greatly admired by men of his own calling.

Cook's *Account of a Voyage Round the World in the Years 1768–71* was published in J. Hawkesworth's *Voyages*, vol. ii and iii (1773); his *A Voyage Towards the South Pole and Round the World* was edited by J. Douglas in two volumes (1784). Cook and J. King's *A Voyage to the Pacific Ocean . . . for Making Discoveries in the Northern Hemisphere* was also edited by Douglas in three volumes (1784). Later editions are *Captain Cook's Journal*, edited by W. J. L. Wharton (1893), and *The Journals of Captain James Cook*, edited by J. C. Beaglehole in four volumes for the Hakluyt society (1955 *et seq.*).

See also references under "Cook, James" in the Index volume.

Bibliography.—Arthur Kitson, *Captain James Cook* (1907); R. T. Gould, *Captain Cook* (1935); A. H. Carrington, *Life of Captain Cook* (1939); J. A. Williamson, *Cook and the Opening of the Pacific* (1946). (J. C. Be.)

COOK, SIR JOSEPH (1860–1947), Australian statesman, who was prime minister in 1913–14, was born in England at Silverdale, Staffordshire, on Dec. 7, 1860. From the age of nine he worked in a coal mine, until he emigrated to Australia in 1885. He entered the New South Wales parliament in 1891, as a member of the new Labor party, but he soon crossed the floor of the house and held office from 1894 to 1899 as a conservative. He was elected member for Parramatta in the first commonwealth parliament (1901), succeeded to the leadership of the Free Trade party in 1908 and became minister for defense under Alfred Deakin in 1909–10. On the defeat of the Labor party in 1913 he became prime minister, but his party was defeated in the 1914 election. In 1917 he joined W. M. Hughes's coalition government, and was for a time a member of the imperial war cabinet in London. Cook was high commissioner in London from 1921 to 1927, when he retired. He died in Sydney on July 30, 1947. An efficient administrator, he was never a commanding figure, and his accession to leadership marked a decline in political enthusiasm after the early drive of the postfederation era. (O. M. R.)

COOK, THOMAS (1808–1892), English travel agent who founded Thomas Cook and Son, was born at Melbourne, Derbyshire, on Nov. 22, 1808. Leaving school at the age of ten, he earned his living at various jobs; in 1828 he became a Bible reader and missionary for the Baptist association and later took up the cause of temperance as well. In 1841 Cook persuaded the Midland Counties Railway company to run a special train between Leicester and Loughborough for a temperance meeting on July 5, believed to be the first publicly advertised excursion train in England. In 1844 he entered into a permanent arrangement with the Midland Railway company to place trains at his disposal, for which he would provide passengers. During the Paris exhibition of 1855 Cook conducted excursions from Leicester to Calais, followed in 1856 by the first grand circular tour of Europe. In the early 1860s he ceased to conduct personal tours and became an agent for the sale of English and foreign tickets, the holder of which traveled independently. During the 1880s his firm performed military transport and postal services for England and Egypt. The firm now has agencies all over the world. Cook died July 19, 1892, in Leicester. (W. H. D.)

COOKE, HENRY (*c.* 1616–1672), English bass singer, choirmaster and composer, noted for building up the choir of the Chapel Royal after the Restoration, was born probably at Lichfield, *c.* 1616, and brought up as a chorister in the Chapel Royal. He fought for Charles I in the Civil War, whence his title of "Captain" Cooke. During the Commonwealth he taught music, and may have studied in Italy. Appointed a bass in the Chapel Royal and Master of the Children at the Restoration, within three years he built up a great choir, although he began with only five former members, and with the order of service forgotten by most organists. His military discipline, combined with an ability to choose the right boys (William Turner, John Blow, Pelham Humfrey and Thomas Tudway were among his earliest Children), and to teach them well, made his work famous. The boys learned not only sight-singing and composition but also how to play the violin, organ, lute and harpsichord.

Probably on Charles II's suggestion, Cooke introduced instrumental music into the services; he also used sackbuts (trombones) in processions to enable the singers to keep pitch. He frequently sang solos at the services, and both Pepys and Evelyn recorded their praise of him. As a composer he contributed to Sir William Davenant's *Siege of Rhodes* (1656) but was mainly concerned with anthems, music for court functions, including coronation music, and the compositions required for his official position. He died at Hampton Court, July 13, 1672. (B. P.)

COOKE, JAY (1821–1905), U.S. financier who rendered important services to the federal government during the American Civil War, was born at Sandusky, O., on Aug. 10, 1821. At the age of 18 he entered the Philadelphia house of E. W. Clark and Co., private bankers. Three years later he became a member of the firm. In 1858 he retired from the firm to reorganize some of the abandoned Pennsylvania railways and canals. In 1861 he opened in Philadelphia the private banking house of Jay Cooke and Co. and floated a war loan of $3,000,000 for the state of Pennsylvania. Cooke was engaged by the treasury department in 1862 as special agent for the sale of $500,000,000 worth of bonds. He appointed 2,500 subagents and before the machinery he set in motion could be stopped he had sold $11,000,000 more than had been authorized, an excess which congress immediately sanctioned. To promote the establishment of national banks Cooke organized two, in Washington, D.C., and Philadelphia, soon after such institutions were authorized by congress in 1863. In 1865, when the needs of the government were pressing and the sale of notes by national banks had been disappointing, Cooke's services were again secured. Between February and July 1865 he disposed of three series of notes totaling $830,000,000. After the Civil War Cooke became interested in the development of the northwest. In 1870 his firm undertook to finance the construction of the Northern Pacific railway, but failed at the approach of the financial crisis of 1873. By 1880 he had discharged all his obligations and had again become wealthy. He died at Ogontz, Pa., on Feb. 18, 1905.

See E. P. Oberholtzer, *Jay Cooke, Financier of the Civil War* (1907). (W. H. D.)

COOKE, ROSE (née Terry) (1827–1892), U.S. writer, whose fiction dealt mainly with New England country life, was born at West Hartford, Conn., Feb. 17, 1827. She was educated at the Hartford Female seminary and then found employment as a teacher. Her intense nature soon found vent in writing, however, and before she was 20 she had contributed to many magazines. She published in 1860 a volume of *Poems*. After her marriage in 1873 to Rollin H. Cooke she was best known for her fresh and realistic stories, though in 1888 she published more verse in her *Complete Poems*. Her chief volumes of fiction were *Happy Dodd* (1878), *Somebody's Neighbors* (1881), *Root-Bound and Other Sketches* (1885), *The Sphinx's Children and Other People's* (1886), *Steadfast*, a novel (1889). She died at Pittsfield, Mass., July 18, 1892.

See Jean Downey, "Rose Terry Cooke: A Bibliography," *Bulletin of Bibliography*, vol. xxi, pp. 159–163 (1955).

COOKE, THOMAS (1703?–1756), English author best known for his translation of Hesiod into rhymed couplets, which gave him the nickname of "Hesiod" Cooke, was born at Braintree, Essex, probably on Dec. 16, 1703. His first important work was *The Battle of the Poets* (1725), a poem attacking some of the leading authors of the day, most notably Alexander Pope and Jonathan Swift. Pope later retaliated by mentioning Cooke unfavourably in his *Dunciad*. Cooke wrote many other original works and also translated some Latin works. From 1741 he edited *The Craftsman*. He died in London in Dec. 1756.

COOKE, SIR WILLIAM FOTHERGILL (1806–1879), English inventor who worked with Charles Wheatstone in developing the electric telegraph, was born at Ealing, Middlesex, May 4, 1806. In 1836, after attending a demonstration in Heidelberg, Ger., of an experiment in transmitting messages by wire, he began to experiment with electric telegraphy and soon afterward formed a partnership with Wheatstone, who had also been working with the telegraph. In June 1837 they were granted their first patent, but their early model proved too expensive to be practical. The partners quarreled over which should have principal credit

for their invention. The dispute was settled amicably in 1841 but flared again a few years later. While Wheatstone is considered the more important of the two in the history of the telegraph, Cooke at least contributed his superior business skill to the partnership. The patent for the partnership's most important invention, an electric telegraph employing only a single needle, was issued in 1845. Cooke died in Surrey on June 25, 1879.

(W. H. D.)

COOKING: *see* Food Preparation; Home Equipment.

COOKING UTENSILS: *see* Home Equipment.

COOK ISLANDS, a group of islands in the southwest Pacific, politically a dependency of New Zealand. They have a total land area of 93 sq.mi. and are widely scattered over an area extending from latitude 8° S. to almost 23° S., and between longitude 156° W. and 167° W. Physically they form two contrasting groups. The southern group, or Lower Cooks, consists of volcanic islands (Rarotonga, Aitutaki, Atiu and Mangaia), of low coral islands (Mauke, Mitiaro and Takutea), and Manuae, an atoll. Most have a broken or hilly interior and a fringing coral reef. Rarotonga rises centrally to 2,140 ft.

The seven islands of the Northern Cooks are low coral atolls. Their population (1956) of 2,504 was mainly concentrated on Penrhyn, the largest island (3.8 sq.mi.), Manihiki and Pukapuka. Palmerston, Nassau and Rakahanga supported much smaller numbers and Suwarrow (Suvorov) was uninhabited. These islands produce some copra and most of the Cook Islands exports of pearl shell.

Of the navigators, explorers and missionaries who visited the group from the 16th century onward, the most important were Capt. James Cook in 1773, Lieut. William Bligh in 1789 and the Rev. John Williams in 1823. Led by Williams (*q.v.*), the London Missionary society gained a strong footing and was for long the predominant governing and law-making institution. The islands were first proclaimed a British protectorate in 1888 and were annexed to New Zealand in 1901. The total population (1956) of the group was 16,680, of whom 307 were Europeans. The Cook islanders are Polynesians closely related in tradition, language and customs to the New Zealand Maoris. After 1945 a large and increasing number of Cook Islanders migrated to New Zealand.

The seat of administration is at Avarua on Rarotonga (1956 pop. 7,212; area 26 sq.mi.), the largest and most important island. Government is by an elected legislative assembly whose decisions must be ratified by a resident commissioner appointed by New Zealand.

The main exports are citrus fruits, tomatoes, copra, manufactured clothing and jewelry, and pearl shell. Trade is mostly with New Zealand. Despite the predominantly agricultural economy nearly one-third of imports consist of foodstuffs. Until 1960 a fortnightly flying-boat service connected Aitutaki with Tahiti and Fiji; a monthly steamer service links Rarotonga with New Zealand. Transport within the group is by schooners or small craft.

See Department of Island Territories, *Reports on the Cook, Niue and Tokelau Islands* (annually). (R. M. Fr.)

COOKSTOWN, a market town and urban district of County Tyrone, N.Ire., 45 mi. N.W. of Belfast. Pop. (1961) 4,964. It is bounded on the north and west by the Sperrin mountains, and on the south and east by the Ballinderry river, which has free trout and salmon fishing. This plantation town, named after Alan Cook who founded it in the 17th century, consists of one long, wide street with several branch streets. Its main industries are millinery including fur felt hats, and corsetry. Cookstown, which is rapidly expanding, lies 6 mi. S.W. of Lough Neagh and is served by bus transport. About three miles south rises the rath of Tullaghoge, former residence of the O'Hagans, justiciars of Tyrone; the O'Neill chiefs of Ulster were inaugurated there until the inauguration stone was destroyed by Lord Mountjoy in 1602.

(A. My.)

COOKTOWN, a seaport of Queensland, Austr. It lies at the mouth of the Endeavour river at the foot of Cape York peninsula, 1,359 mi. N.N.W. of Brisbane by road. In 1770 Capt. James Cook beached the "Endeavour" there to repair damage. Cooktown became a municipality in 1876, having been founded in 1873 to serve the Palmer gold field (now inactive) to the westward, with which it was linked by rail in 1885. Pop. (1954) 447.

It is a port of call on the steamer route between Brisbane and Thursday Island and is a centre of the *bêche-de-mer* and pearl fishery on the Great Barrier reef. Tin is mined in the area. Cooktown is the chief port of Queensland for the New Guinea trade, and became the seat of a Roman Catholic vicariate in 1887. Airline services link it with Cairns and Thursday Island.

COOKWORTHY, WILLIAM (1705–1780), English potter renowned for his discovery in Cornwall of the only supply of china clay (kaolin) and china stone (petuntse) in England, and the first man to produce in England a hard-paste (or true) porcelain, similar to the Chinese and the German, was born at Kingsbridge, Devon, on April 12, 1705. At 14 years of age he began his apprenticeship with a London apothecary named Bevans, who afterward set him up in business in Plymouth under the title of Bevans and Cookworthy. In England the manufacture of porcelain was first attempted about 1745, when factories producing soft-paste (or artificial) porcelain were established. In 1745 Cookworthy entertained André Duché, who, having discovered in Virginia a supply of china clay and china stone, from which he had made true porcelain, wished to set up an export trade to England. A few years later Cookworthy located "immense quantities" of both these materials near St. Austell, Cornwall. He made many experiments before taking out a patent in 1768 and establishing the Plymouth China factory for the production of hard-paste porcelain. He died at Plymouth on Oct. 17, 1780.

See F. S. Mackenna, *Cookworthy's Plymouth and Bristol Porcelain* (1946). (H. Tr.)

COOLEY, CHARLES HORTON (1864–1929), was one of the pioneers in the development of sociology in the United States. He was born in Ann Arbor, Mich., on Aug. 17, 1864. He graduated from the University of Michigan, and beginning in 1892 taught there for 37 years, from 1894 in the then new field of sociology. His contributions appear in three published works. *Human Nature and the Social Order* (1902) presents a socio-psychological approach to the understanding of human society. It is mainly concerned with the social determination of the self, arising through interaction with other persons. From this follows Cooley's fundamental theory that the mind is social and society mental. In *Social Organization* (1909) he presents what may be regarded as the objective consequences of his psychological views. There it is shown that the ideal of moral unity, involving qualities of loyalty, justice and freedom, is derived from participation in primary groups where face-to-face relationships are sustained, as in the family and in play or neighbourhood groups. In the absence of such moral experience, social disorganization is likely to develop. Consistent with these socio-psychological views is Cooley's treatment of institutions which he regards as established phases of the public mind. In a final work on *Social Process* (1918) Cooley made a sociological application of the Darwinian principles of natural selection and adaptation.

If the foregoing views appear somewhat philosophical, it is to be noted that Cooley regarded social reality as qualitatively different from physical reality, and therefore less subject to measurement. Cooley died at Ann Arbor on May 8, 1929. *See* also Sociology. (A. E. Wd.)

COOLEY, THOMAS McINTYRE (1824–1898), U.S. educator and jurist, well known for his writings on U.S. constitutional law, was born near Attica, N.Y., on Jan. 6, 1824. Moving to Michigan in 1843, Cooley was admitted to the Michigan bar in 1846. In 1857 the Michigan legislature chose him to compile the state statutes, and from 1858 to 1865 he was official reporter to the state supreme court. In 1859 the regents of the University of Michigan appointed Cooley one of three professors in the newly organized law department. For years he was secretary, and later the first dean of the department, concurrently serving as a state supreme court justice from 1864 to 1885. In 1884 Cooley resigned his law professorship. Failing re-election to the state supreme court, he accepted a history professorship at the University of

Michigan. From 1887 to 1891 he served as chairman of the newly established U.S. Interstate Commerce commission, doing much to shape its policies. Between 1889 and his death at Ann Arbor, Mich., on Sept. 12, 1898, Cooley lectured on the commission to Michigan law students.

Besides fulfilling his teaching, administrative and judicial obligations, Cooley wrote extensively. His works included state supreme court opinions; periodical articles; editions of Blackstone's (1871) and Story's (1873) *Commentaries;* and treatises on *Constitutional Limitations* (1868), *The Law of Taxation* (1876), *Law of Torts* (1879) and *Constitutional Law* (1880). (E. G. Bn.)

COOLIDGE, (JOHN) CALVIN (1872–1933), 30th president of the United States, was born at Plymouth, Vt., on July 4, 1872. He came from a long line of frugal, modest and unpretentious New England farmers and storekeepers. His father had held a number of local elective positions and provided Calvin with an example of shrewd and practical political activity. The son faithfully mirrored his background.

After being educated in local schools, he graduated from Amherst college in 1895, studied law the following year and entered law practice at Northampton, Mass., in 1897. For Coolidge, law was the means for entering a succession of political posts. From his election in 1899 as a councilman of Northampton he moved up the ladder from one public office to another. He served as city solicitor, clerk of the courts, member of the general court (legislature) of Massachusetts, mayor of Northampton, state senator and lieutenant governor for three terms, beginning in 1916. Along the way Coolidge established himself as a rising politician, entrenched himself in the state Republican party and acquired the respect of the voters.

Coolidge's success in politics was the result of skilful bargaining ability in the political game. Plain in appearance and habits, he gained the allegiance of voters with his faithfulness to duty, honesty, discretion and practical common sense. A characteristic statement was: "Let men in public office substitute the light that comes from the midnight oil for the limelight." Coolidge's faith and principles, drawn from his Yankee origins and attractive to the nation after World War I, were fundamental and familiar. He held in high regard the law as a foundation for national stability; he gave national traditions deep respect; and he regarded the hard-working, moral individual as the basis of American civilization.

Governor.—Elected governor of Massachusetts in 1918, Coolidge began his administration capably and with moderation. He introduced economies by working for the elimination of offices and was the first governor of the state to submit an executive budget. Suddenly, in Sept. 1919, as a result of his actions in connection with the Boston police strike, Coolidge became a national figure. Boston's policemen, in defiance of the police commissioner, had organized a labour union that sought affiliation with the American Federation of Labor. They also requested recognition for their union from Massachusetts authorities and asked for improved conditions in the police force. Receiving no satisfaction, the police went on strike, walking off their posts late in the day, Sept. 9, 1919. In Boston the suspension of law enforcement resulted in disorder and riots for two nights and a day, despite the efforts of volunteer policemen and the Boston forces of the state guard, which had been called up by the mayor. Not until the opportune moment to move with greatest effect did Governor Coolidge order the entire state guard to duty in Boston to restore law enforcement and to demonstrate the principle that public servants must not desert their posts. Upon refusal of police authorities to reinstate policemen who had struck, Samuel Gompers, president of the American Federation of Labor, appealed to Governor Coolidge on behalf of the policemen. The governor replied publicly: "There is no right to strike against the public safety by anybody, anywhere, any time." In a tense nation beset by labour problems and fearful of civil disorder through repetition of events such as the Boston police strike, the Seattle general strike and the steel strike, Coolidge's words and actions received nationwide approval and acclaim.

Vice-President.—Soon after the Boston episode Coolidge was re-elected governor by a large majority and his name was frequently mentioned as a possible Republican nominee for president in 1920. At the Republican national convention Coolidge was among a number of minor candidates for the presidential nomination, but a prolonged contest ended with the selection of Warren G. Harding. Coolidge was easily nominated for vice-president on the first ballot. In Nov. 1920 Harding and Coolidge won the election with 404 electoral votes to 127 for the Democratic candidates.

As vice-president, Coolidge broke precedent by attending President Harding's cabinet meetings, but otherwise he performed his duties with little public notice. He faithfully supported the administration's policies but was not involved with Harding's circle of friends and advisers. On Aug. 3, 1923, upon the death of Harding, Coolidge succeeded to the office of president. He broke precedent again by taking the oath of office from his father, a notary public, at Plymouth, Vt., where the vice-president was visiting.

President.—When President Coolidge came to office he inherited from Harding a divided party, a fractious congress, a national administration discredited by scandals, and pressing problems of domestic and foreign policy. Cautiously, quietly and with skill Coolidge brought about a reformation in the administration and gained control of his party so that when the Republicans met in national convention in June 1924, his nomination for president proceeded smoothly. By minimizing problems and pointing with pride to traditional institutions for security and faith, President Coolidge became a fondly accepted symbol of calm, practical, common-sense leadership. Coolidge's speeches on economy, better local government, the need of the spiritual element in politics, obedience to law and religious toleration were accepted as covering the principal problems facing the nation at that time. Aiding Coolidge in the public view was his charming wife, Grace Goodhue Coolidge, and public sympathy was freely given to both upon the death of their younger son on July 7, 1924. As president, Coolidge was restrained and avoided issues whenever possible. He left many matters to his cabinet officers and relied upon such advisers as Secretary of the Treasury Andrew Mellon and Secretary of Commerce Herbert Hoover for initiative in the development of positive policies.

In the 1924 election campaign the Democratic party was torn by dissensions. The independent Progressive candidacy of Sen. Robert M. La Follette was not widely popular, but it enabled Republican campaigners to speak of "Coolidge or Chaos" and to call upon the voters to "Keep Cool With Coolidge." Such negative factors and the absence of appealing issues combined with business prosperity to give Coolidge 15,700,000 popular votes and 382 electoral votes to 8,400,000 popular votes and 136 electoral votes for John W. Davis, the Democratic candidate. The Progressive candidate, Senator La Follette, polled 4,800,000 popular votes and 13 electoral votes.

Coolidge's administration was distinguished by absence of crises, lack of spectacular political leadership and the expansion of prosperity. An outstanding Coolidge policy was noninterference by government in the affairs of business and industry. Regulatory agencies became institutions for the assistance of business, a program of tax reductions favoured capital, and a high protective tariff was maintained. Coolidge was particularly attached to government efficiency and economy as means for reducing tax burdens, declaring, "Economy is idealism in its most practical form." The president's policies of limited government participation in economic affairs and of governmental economy put him firmly in opposition to effective farm relief proposals and the payment of a bonus to World War I veterans. Congress passed the bonus over his veto in 1924, but he was able to stop the McNary-Haugen farm relief bill by vetoes in 1927 and 1928. To Coolidge the deep-seated farm problem was a passing thing that would cure itself in time without substantial government assistance.

President Coolidge reflected general public sentiment by pursuing a foreign policy of aloofness. His administration was not extremely isolationist: it wished to assist in the furthering of good

relations, peace and disarmament, but without entanglements. Coolidge unsuccessfully urged U.S. adherence to the World court but wished the nation to remain free of the League of Nations; he favoured naval disarmament as a step toward peace and as an economy measure but maintained that the war debts should be repaid to the United States. The "Good Neighbour" policy toward Latin America was forecast when Coolidge appointed Dwight Morrow to be ambassador to Mexico. The most notable event in the administration's foreign relations was the negotiation in 1927 of the Kellogg-Briand pact to outlaw war. Coolidge's negative policies of detached economic nationalism and noninvolvement in economic trends meant the postponement of problems. This, together with his complacent encouragement of the speculative boom in the stock market, produced predicaments for future administrations.

Toward the end of his administration, Coolidge issued on Aug. 2, 1927, the statement: "I do not choose to run for president in 1928." The full meaning of this cryptic declaration then and later aroused speculation. As a result, the way was cleared for Herbert Hoover to move forward as the principal candidate for the Republican presidential nomination in 1928. President Coolidge stepped down from his office, being succeeded by Hoover, on March 4, 1929.

Coolidge thereupon entered a brief period of retirement during which he wrote his autobiography and contributed occasional articles to newspapers and magazines. He died on Jan. 5, 1933, at Northampton, Mass. *See* also UNITED STATES (OF AMERICA): *History.*

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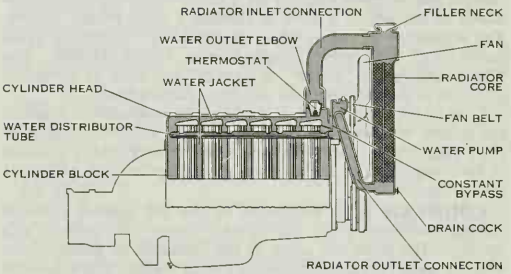
COOLIDGE, WILLIAM AUGUSTUS BREVOORT (1850–1926), pioneer alpinist and authority on alpine geography and history, was born on Aug. 28, 1850, near New York city, and educated at St. Paul's school, Concord, N.H.; Elizabeth college, Guernsey; and Exeter college, Oxford. From 1880 to 1881 he was professor of English history at St. David's college, Lampeter, and until 1885 he was modern history tutor at Magdalen college, Oxford, where he was elected a fellow. He was ordained in 1882 and acted for 12 years as honorary curate at South Hinksey, Oxford. He was introduced to the Alps in youth by his aunt, and climbing and the study of the Alps became the main interest of his life; in 1896 he went to Switzerland and settled at Grindelwald. His chief ascents were made between 1865 (Col du Géant) and 1898 (Ortler), and he made the first winter ascent of the Wetterhorn and Jungfrau (1874) and the Schreckhorn (1879). His guide was the famous Christian Almer and later Almer's son. Coolidge made more than 1,700 expeditions in the French, Swiss and Italian Alps. His most notable books are *Swiss Travel and Swiss Guidebooks* (1889), *Josias Simler et les origines de l'alpinisme jusqu'en 1600* (1904) and *The Alps in Nature and History* (1908). He edited the first volume of the revised edition of J. Ball's *Alpine Guide* (1898), and two issues of Murray's *Handbook to Switzerland,* 19th ed. (1904). He was the sole author of several volumes in the *Climbers' Guide* series. He died at Grindelwald on May 8, 1926. (D. MN.)

COOLIE, a term applied generally to Asian unskilled plantation labourers, especially Indian or Chinese emigrants of this class. In many tropical countries it was found impossible in the 19th century, after the abolition of slavery, to obtain adequate local supplies of labourers for the planting industries. The deficiency was remedied by the importation of poverty-stricken men, known as coolies, often under contract, from India and China.

See CONTRACT LABOUR.

COOLING SYSTEMS. Many machines and industrial processes require cooling systems for proper functioning. The automobile engine is a familiar example. The cylinders of all internal-combustion engines (*q.v.*) require cooling because of the inability of the engine to convert all of the energy released by combustion into useful work. A typical automobile cooling system is illustrated below. The coolant is delivered by the pump to the front of the cylinder block and is directed along the row of cylinders by the distributor tube. Flow is then upward to the cylinder head and forward to the thermostat which opens for flow to the radiator at the design jacket temperature, 160° to 180° F. The bypass maintains circulation and equalizes temperatures within the cylinder block when the thermostat is closed. The cooling system is usually pressurized to raise the boiling point of the coolant so that a higher outlet temperature can be maintained to improve thermal efficiency and increase the heat-transfer capacity of the radiator. A pressure cap on the radiator maintains this pressure by valves that open outwardly at the design pressure and inwardly to prevent a vacuum as the system cools.



CUT-AWAY VIEW OF AUTOMOBILE COOLING SYSTEM

Some engines, particularly aviation engines and small units for lawn mowers, chain saws, etc., are air cooled directly. Air cooling is accomplished by forming thin metal fins on the exterior surfaces of the cylinders to increase the rate of heat transfer by exposing more metal surface to the cooling air. Air is forced to flow rapidly through the spaces between the fins by fans or blowers. Airplane engines are especially well adapted to air cooling because the propeller air stream provides ample cooling air without any power consumption. Few motor vehicles have used air cooling, principally because the temperature cannot be closely regulated as it is when water cooled.

Condensation of vapours by cooling is necessary for equipment operating on closed cycles, such as refrigerating systems and steam-turbine plants. The condenser (*q.v.*) is a heat exchanger (*q.v.*), with one path provided for the circulation of the ammonia vapour or steam to be condensed and a second path for the cooling water. Large-capacity cooling systems are necessary to recool water for the condenser.

Spray ponds are sometimes employed with nozzles that discharge the water upward. Cooling towers are more efficient, require less space and conserve water. The cooling tower is erected over a concrete basin with a ventilated casing and a redwood framework. Inlet louvers admit air at the lower portion of the structure and induced-draft fans discharge it at the top. The water to be cooled is distributed near the top of the tower to a system of spray nozzles uniformly disposed over the area. The water descends through wooden fill racks that retard the falling drops and increase the surface in contact with air. The water is cooled as it descends to the catch basin both by heat transfer to the air and by evaporation of some of the water. A pound of water, in evaporating, acquires its latent heat of evaporation of nearly 1,000 B.T.U. from the surrounding air and water droplets. One pound of water evaporated in this manner will reduce the temperature of 100 other pounds of water by nearly 10°.

Closed systems are used when the water to be cooled is expensively treated feed water. A heat exchanger is then located in the base of the cooling tower with the treated water circulated through it and cooled by raw water flowing over its surface. The raw water is then pumped to the top of the tower and recirculated.

Electrical equipment requires cooling, principally to prevent damage to the insulating material. Large transformers are surrounded by insulating oil that circulates by thermosiphon action

through vertical tubes extending from top to bottom outside the housing. Forced circulation of the oil and cooling air is sometimes necessary. Large electrical generators are cooled by air that has passed through heat exchangers and is recirculated by blowers in a closed system.

Large metal-processing shops have cooling systems that circulate a coolant composed of water and soluble cutting oil to be flowed over the metal-cutting tools. Dies for the extrusion of wire and other metal shapes require cooling, as do the rolls in steel mills.

See also Air Conditioning; Heating and Ventilation.

(O. C. C.)

COOMB (Coombe, Combe), a term frequently used in southwestern and southern England for a short, closed-in valley, either inland on the side of a down or forming a small coastal feature. The etymology of the word is uncertain. It appears in place names; *e.g.*, Ilfracombe, Temple Combe, Combe Martin. The Welsh *cwm* means "hollow" or "valley" and may be compared with *cum* in several Cumbrian and Scots place names.

Coombs occurring in the chalk lands of southeastern England are usually waterless and partly filled with a rubble of angular chalk fragments. This is known as coomb rock and is believed to have originated as a glacial sludge during the later phases of the Ice Age. (L. D. S.)

COONCAN is an adaptation of the old Spanish game of conquian—derived from the Spanish words *con quién*, "with whom." The game was taken by the Spaniards to Mexico, from where it spread to the southwestern United States. It also invaded England, where it is still played; in the United States it has been almost entirely supplanted by its offspring rummy.

As in all rummy games, the object in cooncan is to get rid of one's hand by forming it into sets of three or more cards of the same rank or of the same suit in sequence. Two full 52-card packs are used, plus 2 jokers, which are wild and therefore may be named to represent any card to complete a set. Local rules differ as to whether a completed set may or may not be melded; *i.e.*, placed face up on the table. When a set is melded, other players may add cards to it. In some variations cards left in players' hands are scored, a popular scale being: jokers 15 each, aces 11, face cards 10 and other cards their number, or index value. The game can be played by any number of players up to seven. It is best for four or five. *See* also Rummy. (G. Mh.)

COOPER, ALEXANDER (before 1609–1660), English miniaturist, elder brother of Samuel Cooper (*q.v.*), was probably born in London. He died in Stockholm at the beginning of 1660, having spent the greater part of his life out of England. He was a pupil of his uncle John Hoskins and perhaps of Peter Oliver. Cooper was in Holland by 1631 or 1632, where he painted a series of miniatures (now in Berlin) of the king and queen of Bohemia and their seven children. During 1644–46 he was at The Hague and in 1647 went to Stockholm, where he worked for Queen Christina and her successor, Charles X. He seems to have been in Copenhagen in 1656. There are two miniatures by Cooper in the Victoria and Albert museum, London, and one in Stockholm.

See B. S. Long, *British Miniaturists* (1929); G. Reynolds, *English Portrait Miniatures* (1952). (P. J. My.)

COOPER, SIR ASTLEY PASTON (1768–1841), English surgeon, whose operation (1817) of tying the abdominal aorta for aneurism is historic, was born at Brooke, Norfolk, on Aug. 23, 1768, the son of a clergyman. He studied under Henry Cline, surgeon at St. Thomas' hospital, London, and attended the lectures of John Hunter. He was connected with St. Thomas' as demonstrator in anatomy (1789–91), joint lecturer with Cline on anatomy and surgery (1791–1800), and then went to Guy's hospital as surgeon. In 1813 he became professor of comparative anatomy to the Royal College of Surgeons, of which body he was president in 1827 and 1836. Cooper was vice-president of the Royal society in 1830 and received a baronetcy in 1820. He died in London on Feb. 12, 1841.

The greatness of Cooper's achievement in tying the abdominal aorta can be appreciated only when it is borne in mind that the operation was accomplished before the days of antiseptic surgery. In the first volume of the *Transactions* of the Medico-Chirurgical society, of which he was one of the founders, he published (1805) an account of an attempt to tie the carotid artery. Of his numerous works the most important is *The Anatomy and Surgical Treatment of Hernia.*

See *Life of Sir Astley Cooper*, by his son, B. B. Cooper (1843).

COOPER, GARY (Frank James Cooper) (1901–1961), U.S. motion-picture actor whose portrayal of homespun characters established him as a glamourized image of the average man, was born in Helena, Mont., May 7, 1901. His father, Charles Henry Cooper, who had emigrated from England to Montana as a young man and married a British-born Montana girl, was a successful lawyer.

On a ranch owned by his father, Frank Cooper acquired the practical experience that later made it possible for him to get cowboy parts in Hollywood westerns—but impossible, he commented, to take them seriously.

In 1924 he dropped his enrollment at Grinnell college, Ia., went to Hollywood and earned a precarious living as a cowboy "extra." He advanced to leading parts in low-budget westerns and was rechristened Gary Cooper by his agent. Brief appearances in the pictures *It* (1927) and *Wings* (1929), in both of which Clara Bow was the feminine lead, led to his being selected to star with her in *Children of Divorce*. A far more characteristic role, however, was that of the unsophisticated small-town man fighting for his concept of integrity in *Mr. Deeds Goes to Town* (1936). Working on his 88th picture in London in 1960, he confessed to being a tired man, but added: "The urge to act stays with you."

He died at Los Angeles, Calif., May 13, 1961. (J. Ay.)

COOPER, JAMES FENIMORE (1789–1851), the first major U.S. novelist, best known as the author of the Leatherstocking tales, was born at Burlington, N.J., Sept. 15, 1789. When he was a year old, the family moved to Cooperstown, N.Y., a frontier village founded by his father. There Cooper lived as a boy in the lake region of New York state. He grew up as a youth of wealth and position, whose father was one of the large landowners of the state. (His father was also a notable figure in New York politics, a stanch Federalist, and a Quaker so belligerent that he lost his place in the Society of Friends.)

Cooper entered Yale college at the age of 13, the youngest member of his class. Of his college career little is known, except that he was the best Latin student of his class, and that he was expelled in his junior year for some prank—there is a story of his exploding a charge of gunpowder in the lock of a tutor's door. In 1806 he sailed as an apprentice seaman to England, and in 1808 became a midshipman in the U.S. navy. His father was killed in 1809 by a political opponent. In 1811 he married Susan De Lancey, daughter of a Tory family; he resigned from the navy and settled down to the life of a country gentleman.

"I could write you a better book than that myself," Cooper is supposed to have said to his wife, concerning a current English novel. Then rising to her inevitable challenge, he wrote his first work of fiction, *Precaution* (1820), a poor novel. Having thus begun writing at the age of 30, Cooper went on to produce 50 separate works during the remaining 32 years of his life. Thirty-one of his works are novels. He became famous with his second novel, *The Spy* (1821); in this story of the American Revolution "the Cooper hero" appears for the first time, the unsung spy of democracy, Harvey Birch. The book was immensely popular in many countries, in a period of rising democratic nationalism. With *The Pioneers* (1823), Cooper entered upon the Leatherstocking tales, and in the same year produced *The Pilot*, the first sea story of its kind.

In 1826, at the height of his fame, he went abroad, remaining in Europe for seven years. Writing rapidly, he moved from a strongly American subject matter and attitude (*The Last of the Mohicans*, 1826; *The Prairie*, 1827) to a treatment of men and manners in European settings. He now wrote travel books and social criticism as well as fiction. In 1833 he returned to the U.S. and moved back to Cooperstown where he lived during the rest of his life. He wrote still other kinds of books, including a history of the U.S. navy (1838). Of his later novels, a few of the best are

Afloat and Ashore (1844), *The Wing-and-Wing* (1842), *Satanstoe* (1845), the best of a trilogy on New York state antirentism and the later Leatherstocking tales.

Cooper's great work was the Leatherstocking tales, which form an authentic American "myth," if by that term we mean a story which has appealed to readers at every level of sophistication from its own day to ours, which is known world over, and which has placed its hero, the Leatherstocking, very near the head of any list of American heroes of fiction. The five novels of the series were not published in their narrative order, but can best be mentioned in that sequence. The tales open with *The Deerslayer* (1841), in which Natty Bumppo appears at the age of 20, in the year 1740, on his first warpath. In *The Last of the Mohicans* (1826) he is known as Hawkeye, and appears at the height of his powers in Cooper's most rapid-fire story of flight, pursuit and capture. As the Pathfinder in the novel of that name (1840) he takes part in the French and Indian wars on Lake Erie, the "inland sea," in a novel which is both sea story and frontier story. *The Pioneers* (1823), the first written of the series but the fourth in narrative order, depicts Bumppo and his Indian companion Chingachgook as old men, at the low ebb of their fortunes, living in a frontier village. In this story Chingachgook dies. As "the old trapper," the hero makes his last appearance in *The Prairie* (1827), of which the setting is the Great Plains in 1804. He dies in this story, in exile and honour among the Pawnee Indians of the west. The tales make up an epic of heroic action occurring through 60 years of time, over the space of half a continent. Cooper's epic intention was explicit; he sought to achieve "the elevation of romance," by which he meant the level of prose epic. The most interesting of the novels to a modern reader might be *The Pioneers*, a realistic picture of life in a frontier town; or *The Deerslayer*, which was in D. H. Lawrence's eyes "a lovely myth"; or *The Pathfinder*, which Cooper himself most liked for its intricate plot and action.

Cooper's characteristics as a novelist are those of an energetic and impatient craftsman. The best of his novels are marked by both grandeur of conception and carelessness of detail. His style is uneven, and was even in its own day a somewhat old-fashioned instrument patterned after 18th-century models. His characters are simple, strong, and strongly contrasted, and are not rendered in what the modern reader may think of as psychological detail. Both Cooper's Indians and his women have been harshly criticized. His women are in fact genteel, dimly seen, and often incidental to the story—in at least one novel he inadvertently changed his heroine's name halfway through the narrative. His Indians are a different matter; though Cooper has been described as a portrayer of "the noble Red Man" only, his many Indian characters do in fact range from heroic to ignoble and are of many sorts. That he depicted "mere savages" as heroic at all was offensive to some "realists" in his own time and later. Cooper's plots are loose and often extravagant, rising to power in scenes of pursuit and combat; he tended to think of his stories as sequences of such "pictures" of violence. Coincidence looms large in some of his stories. It is for a few central heroic characters that Cooper is most admired: the Leatherstocking and his friend Chingachgook, the Great Serpent; Long Tom Coffin (of *The Pilot*); Harvey Birch, the spy. Finally, Cooper's novels are, to a greater extent than is often realized, founded on intellectual premises and moral convictions: his characters embody values, his plots are dramas of intellectual and moral conflict, and his aim is often (in his words) "the delineation of principle."

American scholars have also discovered in Cooper a significant social critic. In *The American Democrat* (1838) and other nonfiction works, as well as in the novels *Homeward Bound* and *Home as Found* (also 1838) Cooper both defended and criticized American democracy. In the age of Jacksonian "leveling," he was concerned to maintain a difficult position: that a political democracy, in which he wholeheartedly believed, should yet preserve the best of such traditional values as good taste, intellectual and artistic standards, and the moral excellences embodied in the concept "gentleman." Arguing for his ideal of a democratic gentleman, he was attacked by both social conservatives and political radicals as an "aristocrat" and worse. He was also subjected to such personal abuse and calumny in the press that he brought libel suits against his attackers, winning most of them and doing much, in the process, toward the establishment of effective libel laws in the American courts. In Cooper's fiction there is also social criticism; an interesting example is *The Bravo* (1833), a novel about a dictatorship of an élite, which has strong relevance to problems of the 20th century.

Cooper's fame in his own day was great, and continued high through the 19th century. Mark Twain struck his reputation its severest blow with his essay, "Fenimore Cooper's Literary Offenses" (1895), in which he assailed his predecessor for breaking "eighteen" of the "nineteen rules governing literary art." Mark Twain attacked particularly Cooper's style, which is indeed the opposite of his own, being complex and Latin derived rather than simple and Anglo-Saxon.

Cooper was a careless stylist in his narratives of action, but in his more thoughtful writings used his terms with some precision —"agreeably to Johnson," as he put it. Mark Twain's opinion, which became the conventional view of Cooper early in the 20th century, can perhaps be balanced by the opinions of other novelists: Balzac admired him greatly, taking his fiction as a model for his own first serious novel (*Les Chouans*), which reads like a *Last of the Mohicans* set in Brittany. Victor Hugo rated him higher than Sir Walter Scott. To Joseph Conrad he was "a rare artist . . . one of my masters." Other novelists from Herman Melville to D. H. Lawrence have admired him as "the American novelist."

Of Cooper's sources and development as a novelist, a few observations may suffice. His first novel reads like a poor imitation of Jane Austen, and the Austen novel of manners may well have influenced Cooper's later interest in the social novel. But Scott was his elder contemporary, and as time went on his chief rival in the historical romance. Cooper's negative aim was to avoid the extravagances of the "sentimental" and "Gothic" schools of fiction. Cooper's early novels are his most realistic in detail, and show more of what he called his "native fire" than his late works; his late fiction presents idealized characters, scenes and action.

Cooper's place in literary history is secure on two counts—as the first U.S. professional man of letters, and as a literary innovator. Both the sea romance and the frontier adventure story of flight and pursuit are kinds of fiction which he invented. He is one of a very few American authors who have had literally a world audience from his own day to the present.

Bibliography.—For Cooper's nonfiction prose, *see* Robert E. Spiller, *James Fenimore Cooper: Representative Selections* (with introd., bibliog., and notes) (1936). For his life, *see* Thomas R. Lounsbury, *Fenimore Cooper* (1882); James Grossman, *James Fenimore Cooper* (1949). For a critical analysis, *see* Arvid Shulenberger, *Cooper's Theory of Fiction* (1955). (Ad. Sr.)

COOPER, JOHN MONTGOMERY (1881–1949), U.S. anthropologist and Roman Catholic priest, who specialized in the ethnology of South America, was born Oct. 28, 1881, in Rockville, Md. He received his Ph.D. (1902) and S.T.D. (Doctor of Sacred Theology, 1905) at the American college in Rome. In 1923 he began teaching anthropology at the Catholic university, in Washington, D.C.; in 1935 he became head of the department of anthropology—the first such department in a U.S. Catholic institution. His field work was done among the Naskapi, Cree and other Algonkian tribes of northern Canada, and among the Gros Ventre of Montana. Although he never traveled to South America, he became an authority on the region. His first ethnological work, *An Analytical and Critical Bibliography of Tierra del Fuego* (1917), marked his lifelong interest in the "marginal peoples" of southern South America, northern North America and other regions, whom he saw as having been pushed back into less desirable territories by later migrations, and as representing cultural survivals from the past. This thesis was presented in his *Temporal Sequence and the Marginal Cultures* (1941). Cooper was president of the American Anthropological association (1940) and founder and editor of the quarterly *Primitive Man*, to which he frequently contributed. He died on May 22, 1949, in Washington, D.C.

Cooper's other works include articles in vols. 1, 2 and 5 of the *Handbook of South American Indians*, Bureau of American Ethnol-

ogy *Bulletin 143* (1946–50), Julian Steward, ed.; and *The Gros Ventres of Montana* (1957).

See also R. Flannery, "John Montgomery Cooper, 1881–1949" with a complete anthropological bibliography by J. Stine, in *American Anthropologist*, vol. 52 (January–March 1950). (R. Fv.)

COOPER, PETER (1791–1883), U.S. manufacturer, inventor and philanthropist, probably best known as the founder of the Cooper union (*q.v.*), was born in New York city on Feb. 12, 1791. He entered into various industrial activities early in life and in about 1828 built the Canton ironworks in Baltimore, Md., the foundation of his great fortune. In 1830 Cooper designed and constructed the first steam locomotive built in the U.S., "Tom Thumb," which was about the size of a modern handcar. Cooper's other notable accomplishments in the industrial world included first construction of iron structural beams (1854), first U.S. use of the Bessemer process (1856), and construction of the largest blast furnace in the country at that time. Actively interested with Cyrus Field in the Atlantic cable, Cooper was president of the New York, Newfoundland and London Telegraph company and the North American Telegraph company. He took a prominent part in educational affairs and conducted the campaign of the Free School society to its successful issue in 1842, when a New York state law was passed forbidding the support from public funds of any "religious sectarian doctrine." Previously a hard-money Democrat, Cooper joined the Greenback party after the Civil War and in 1876 was its presidential candidate. He died in New York city on April 4, 1883. He published *The Political and Financial Opinions of Peter Cooper, With an Autobiography of His Early Life* (1877) and *Ideas for a Science of Good Government, in Addresses, Letters and Articles on a Strictly National Currency, Tariff and Civil Service* (1883). (W. H. D.)

COOPER, SAMUEL (1609–1672), English miniaturist, was perhaps the most celebrated of all English artists in his own day, enjoying a European reputation as a portraitist. He was the younger brother of Alexander Cooper (*q.v.*) and, like him, a pupil of their uncle, John Hoskins. Cooper worked for Oliver Cromwell, making the most celebrated likeness of the lord protector, and also for the restored monarchy and court and is mentioned several times in the diaries of both John Evelyn and Samuel Pepys. The latter paid £30 for a miniature of Mrs. Pepys. Cooper, who may have been of Dutch refugee descent, was widely traveled and an excellent linguist. He died in London on May 5, 1672. There are examples of his work in the British royal collection, in the Victoria and Albert museum, London, and at Oxford and Cambridge.

See B. S. Long, *British Miniaturists* (1929); G. Reynolds, *English Portrait Miniatures* (1952). (P. J. Mv.)

COOPER (Couper), **THOMAS** (*c.* 1517–1594), English bishop and author of a famous dictionary, was born in Oxford, where he was educated. He became master of Magdalen College school, and afterward practised as a physician in Oxford. In 1565 appeared the first edition of his most notable work, *Thesaurus Linguae Romanae et Britannicae*. Three other editions followed: 1573, 1578 and 1584.

Queen Elizabeth I was greatly pleased with the *Thesaurus*, which became known as *Cooper's Dictionary*. Cooper, who had been ordained about 1559, was made dean of Christ Church, Oxford, in 1567. Two years later he became dean of Gloucester, in 1571 bishop of Lincoln and in 1584 bishop of Winchester. Cooper defended the practice and precept of the Church of England against the Roman Catholics on the one hand and against the Martin Marprelate writings and the Puritans on the other. He died at Winchester, April 29, 1594.

Bibliography.—Cooper's *An Admonition to the People of England* (1589) was reprinted in 1882 and his *Answer in Defence of the Truth Against the Apology of Private Mass* (1562) in 1850.

COOPER, THOMAS (1759–1839), U.S. educator, chemist, expert on jurisprudence and political philosopher described by John Adams as "a learned, ingenious, scientific, and talented madcap," was born in London, Oct. 22, 1759, and studied at Oxford. He emigrated to the United States about 1793 and began the practice of law, becoming president-judge of the 4th district of Pennsylvania in 1806. Thomas Jefferson secured for him the appointment as first professor of natural science and law in the University of Virginia, a position that Cooper was forced to resign under the fierce attack made upon him by the Virginia clergy. In 1819 he went to South Carolina college, Columbia, where he taught chemistry and political economy, and in 1821 became president of the college. He resigned his presidency in 1833 and, in the following year, his professorship, because of the opposition within the state to his liberal religious views. A born agitator, he constantly preached the doctrine of free trade and tried to show that the protective system was especially burdensome to the south. His remedy was state action against the tyrannical acts of the federal government, and he exercised considerable influence in preparing the people of South Carolina for nullification and secession. Cooper died in Columbia on May 11, 1839. As a philosopher he was a physiological materialist and a severe critic of Scottish metaphysics.

Among his publications in various fields were *Some Information Respecting America* (1794); *Political Essays* (1800); *Lectures on the Elements of Political Economy* (1826); *A Treatise on the Law of Libèl and the Liberty of the Press* (1830); *Statutes at Large of South Carolina*, 5 vol. (1836–39); *Introductory Lecture* on chemistry (1812); and a translation of Broussais' *On Irritation and Insanity* (1831), with which were printed several of his own essays.

COOPER, THOMAS (1805–1892), English Chartist and writer whose political epic, *The Purgatory of Suicides*, versified the Chartist principles for which he worked and suffered imprisonment, was born at Leicester, March 20, 1805. He had a passion for knowledge, and studied extensively while working as a shoemaker. In 1827 he became a schoolmaster and in 1829 a Methodist lay preacher, but he held few positions long. His conversion to Chartism (*q.v.*) led to his dismissal from the *Leicestershire Mercury* (1841), and he became editor of the *Midland Counties Illuminator* and other Chartist weeklies. He organized the Leicester hosiery knitters into an "army" to study Chartism and literature, and in 1842 toured the Potteries urging support of the general strike.

Convicted of sedition in 1843, he spent two years in Stafford jail, where he wrote his verse epic, in Spenserian stanzas, and a collection of tales, both published in 1845. After his release he became a lecturer, but he quarreled with the Chartist leader Fergus O'Connor and gradually his political enthusiasm declined. After 1856 most of his writings and lectures were in defense of Christianity. He died at Lincoln, July 15, 1892.

He also wrote *Poetical Works* (1877) and the *Life of Thomas Cooper, Written by Himself* (1872).

See R. J. Conklin, *Thomas Cooper, Chartist* (1936).

COOPERAGE, the trade of making barrels from staves and hoops. Wood is commonly used for the staves and steel for the hoops. In the packaging trade, cooperage refers to barrels themselves as well as the manufacture of them. Cooperage is of great antiquity; Pliny ascribes its invention to the inhabitants of the Alpine valleys.

There are two types of cooperage, slack and tight. Slack barrels are made to hold dry products; they can be made of soft woods and do not require precise workmanship. Tight barrels are made to hold liquids and must be constructed very carefully of high-grade woods. Another difference is that the tight barrel has a bunghole for filling and emptying; the slack barrel does not.

Slack barrels usually are made of pine, although hardwoods are used for some relatively high-value products. Tight barrels are usually made from white oak. The highest grades of sap-free white oak that are quarter-sawed with the grain from straight-grain timber are used for making whisky barrels. Tight barrels also may be made of red oak, gum, ash and Douglas fir. The type of wood that is used depends to a large extent on the material that will be packaged in the barrel. In any case, the wood must not produce undesirable characteristics, such as odours, in the product.

Tight barrels are frequently lined or sized. Lining consists of

coating the interior of the barrel with such materials as glue, sodium silicate or paraffin. Slack barrels are sometimes lined with paper or plastic bags to make them suitable for packaging dusty products.

Some automatic operations are used in most barrel plants and many are used in the manufacture of whisky barrels. Only a few barrels were made by hand in the early 1960s. In a typical operation, the wood for staves and headings is air-dried for at least a year and is then kiln-dried for 10–20 days to reduce the moisture content to 10%–12%. The wood is then cut and planed to the proper size and finish. A most crucial operation is the jointing of the edges of the staves and giving them the proper bilge (middle bulge) and taper so that when the barrel is completed the joints will be tight and the circumference of the bilge uniform.

The most complex part of the operation is "raising" the barrel. Staves are set vertically into a head truss ring, and a temporary hoop is placed over the other end. In this arrangement, the staves are passed through a steam tunnel to soften them; while soft, they are drawn into their final shape and dried again. Whisky barrels are charred at this point to increase their ability to develop flavour in whisky while it is being aged. The barrel is then automatically conveyed to a crozer, a machine that trims the ends of the staves and cuts the croze, the groove near the end of the stave into which the head pieces will be fitted. The temporary end rings are pulled off, the head pieces fitted and the permanent head hoops put in place. Head pieces usually are made of two or more pieces jointed by wooden dowel pins. Finally, the temporary bilge hoops are removed and the rest of the permanent hoops, usually a quarter hoop and a bilge hoop on each end, are driven into place. The bunghole is bored and the barrel is tested for leaks with water under pressure. Both slack and tight barrels are shipped with the heads in place. Tight barrels are, of course, filled through the bunghole, but the heads must be removed from slack barrels for filling. Barrels are generally made near their point of use to avoid the expense of shipping empty barrels long distances.

Barrels are durable and relatively easy to handle because of their shape. However, they are heavy, are difficult to open without destroying the head pieces and are relatively expensive because of the time and labour required to make them. As a result, the use of wooden barrels declined substantially after World War II.

By far the major use for wooden barrels in the U.S. in the early 1960s was for aging whisky. When barrels are used for this purpose they may be used only once, according to U.S. law. Some tight wooden barrels are still used for shipping animal and vegetable oils and liquid chemical products, but they have been largely superseded by metal drums and by bulk tank transportation on special railroad cars and truck trailers. Slack barrels have been used in the past for packaging cement, dry chemical products, china, fresh and dried fruit, fish and numerous other products; this type of barrel has suffered from competition principally from multi-wall paper shipping sacks and corrugated paperboard cartons, which are not as durable as wood barrels but cost considerably less. Fibre drums made from multiple layers of paperboard, usually with a vapour barrier, also have competed effectively with wooden barrels. The outlook in the early 1960s regarding the future use of barrels was for a continuing decline except for the aging of whisky. (P. B. Ba.)

CO-OPERATIVES. Co-operative organizations founded for mutual economic aid exist in most countries of the world—in advanced as well as in underdeveloped countries and colonial possessions, and in urban as well as in rural areas. The co-operative way of doing business takes many forms, ranging from local to centralized and federated organizations, and from highly specialized to multipurpose societies.

Since earliest times people have worked together in large or small groups to attain social, religious, or economic objectives, but the modern co-operative movement is not much more than 00 years old. The underlying social philosophy was formulated during the first half of the 19th century by writers such as Robert Owen (*q.v.*) in Great Britain and Charles Fourier (*q.v.*) in France. The basic organizational structure can be said to date from 1844 with the establishment in England of the first successful consumers' co-operative, the Rochdale Society of Equitable Pioneers. The society created a set of organizational and working rules, popularly known as the Rochdale principles, that have been adopted, with modifications, in most countries and used for a wide variety of co-operative activities. Briefly, these principles call for democratic control, open membership, no religious or political discrimination, service at cost and education of the members. Members have a dual relationship to their association. They contribute its capital and are also customers or patrons. In many countries governmental or co-operative banks aid in financing new and old associations. Credit societies developed in Germany between 1860 and 1875 under the leadership of F. H. Schulze-Delitzsch and F. W. Raiffeisen. Modern credit unions (*q.v.*) are patterned largely on the German experience. (For agricultural co-operation *see* AGRICULTURAL ECONOMICS: *Agricultural Co-operation.*) (J. M. Ti.)

GREAT BRITAIN

Pre-Rochdale Co-operation.—As noted above, the British co-operative movement had its origins in the Owenite movements of the early 19th century. There were many earlier instances of joint purchase, production and sale, but these never constituted or originated a movement. Owen regarded the formation of human character as being of prime importance, for the happiness of each would depend upon the characters of all. Under the existing system, he observed, bad characters were formed because avarice was encouraged. All were trained to seek pecuniary gain and the best feelings of human nature were sacrificed to the love of accumulation. Competition and the pursuit of profit resulted in the exploitation of labour, unemployment, increasing poverty, misery and crime. He advocated as a remedy the establishment of co-operative communities. None that he founded was successful but the idea had a powerful appeal and generated a movement: in 1821 George Mudie founded the Co-operative and Economical society and published *The Economist*, which propagated Owenite views. Both the society and the journal came to an end in 1823. The London Co-operative society (1824) then became the main propagandist body, issuing *The Co-operative Magazine* (1826–30) and concentrating upon the desirability of mutual aid and equal distribution. It carried co-operative ideas into such working-class organizations as branches of trade unions, friendly societies and mechanics' institutes.

A branch of the latter in Brighton, Sussex, attracted the attention of Dr. William King and aroused his interest. Under his guidance two co-operative organizations were founded in Brighton in 1827, one to raise a fund by small weekly subscriptions to enable members to join co-operative communities, the other to accumulate profits out of co-operative trading to finance the establishment of a co-operative community. Between 1828 and 1830 he published a monthly magazine *The Co-operator*, which had a wide circulation and was keenly studied by working-class Owenites, who regarded it as something of a textbook on co-operation. It explained how workers could develop co-operative communities through co-operative trading and production. According to the theory, a small amount of capital could be raised by subscriptions and a store opened, the management of which would provide the experience and knowledge to engage in larger ventures. If credit were neither given nor taken and speculative ventures avoided, little risk would be involved. Profits were not to be divided but were to accumulate in a capital fund to finance further co-operative enterprise, thereby enabling the co-operators to build their own houses, provide their own schools, educate their children on co-operative lines, acquire their own fields and workshops, employ themselves and evolve a community. The practice of co-operation during this evolution would educate the members in co-operative living: "the very act of co-operation would improve the character and change the nature of man . . . the greatest and most beneficial effects of co-operation will be upon the moral character . . . this is the final end and consummation of the cause." The formation of producers' societies was also advocated; trade unions were advised to invest their funds in co-operative enterprises and to start enterprises of their own. Advice on the con-

duct of co-operative business was given—credit must be avoided, there must be accurate bookkeeping and members must be educated in the art of co-operation and democratic administration.

A vigorous movement quickly developed. King claimed in 1830 that over 300 societies had been established as a result of his *Co-operator*. Co-operative congresses were held in the early 1830s and a co-operative wholesale company was established. Model rules were drawn up and approved which not only revealed the influence of King's *Co-operator*, but had a resemblance to some of the later rules of the Rochdale Pioneers. This movement, however, was almost extinct by 1835. Its collapse was bound up with the failure of Owen's National Equitable Labour exchange involved in the crash of the Grand National Consolidated Trades' union of 1834. This was a catastrophe for the co-operative movement, for it discredited Owen and Owenism with the working classes, but Owenism continued, although its national organization changed its name several times. Its activities were mainly propagandist and educational, still directed toward the establishment of communities. By 1840 there were 62 branches and it was claimed that 50,000 persons attended its lectures each Sunday. Their activities were carried on in buildings that were acquired in some towns and named Halls of Science or Social institutions.

The Rochdale Pioneers.—One of these branches, no. 24, formed in 1837, was in Rochdale. It was a very active branch, having its Social institution, holding lectures by prominent Owenites (including Owen himself), running a day school and an evening school, engaging in public debates with the rival Chartist movement on the subject of socialism versus Chartism and raising funds for the Queenwood community.

It was this group of Owenites who founded the Rochdale Society of Equitable Pioneers, 1844, generally regarded as the beginning of the modern co-operative movement. The leading figures and 16 of the original 28 Pioneers were members of this branch. Most were not weavers, although the defeat of a weavers' strike and the subsequent intention to start a weavers' productive society provided the opportunity for the Owenites to persuade the weavers to join them in establishing a society on similar lines and with the same objective as that advocated by King. They had studied King's writings and one of the leaders of the branch, James Smithies, had all the issues of *The Co-operator* bound in one volume.

From their rules and practices what came to be known as the Rochdale principles were culled. There are differences in the lists of these principles given by various writers because the original Pioneers did not draw up a statement of principles. The principles were: open, voluntary membership; democratic control; limited interest; dividend on purchases; education; trade only in pure goods; true weight and measure; religious and political neutrality. The society overcame initial difficulties, including the severe depression of 1847, and achieved such success that it came to be regarded as the model for other societies not only in Great Britain but in other parts of the world. G. J. Holyoake's *Self-Help by the People: History of Co-operation in Rochdale* (1858) was translated into many languages and made the Rochdale system known the world over.

The success of the society is often ascribed to the attraction of dividend on purchases, which provided quick and tangible benefits from co-operation. Although undoubtedly important, it was by no means the sole reason for success. Dividend was not regarded as the end or purpose of the society and there was a grasp and understanding of its social ideals which promoted loyalty and secured a ready adherence to its principles. The early members were enthusiasts for education. As Owenites the formation of human character was more important to them than trading, and they engaged in educational activities, using the society's premises and making grants for education even when these were illegal. They desired a rule allocating 10% of profits to be used for educational purposes, but the registrar would not agree to more than 2½%. A fine library with news room was acquired, classes were held and lectures given. The society was the principal educational body in the town for many years and was something of a pioneer in adult education in conjunction with the universities.

Activities were not confined to the development of the society alone. In the first 25 years it assisted or took part in other co-operative enterprises in the town, *e.g.*, a co-operative corn mill, a sick and burial society, a building society and a cotton-manufacturing society, and had the leading part in establishing the Co-operative Wholesale society and the Co-operative Insurance company. The place of the Rochdale Pioneers in co-operative history does not rest alone upon the famous Rochdale principles, for there was actually little that was original in these, but also upon their work in founding the movement. They were active in developing co-operation outside their own society; many retail societies were inspired and advised by the Rochdale men. They drew up and published model rules to guide societies, convened conferences on matters of general concern, pioneered co-operative wholesaling and supplied some of the great leaders of the national movement, notably Abraham Greenwood and J. T. W. Mitchell.

The Christian Socialists.—In the 1850s a group of professional men known as the Christian Socialists (*see* CHRISTIAN SOCIALISM) attempted to establish self-governing societies as a solution to the conflict between capital and labour. Their ventures failed but some of them, notably E. V. Neale, Thomas Hughes and J. M. Ludlow, were drawn into the co-operative movement and continued to play leading parts in it during the 19th century. They were instrumental in obtaining more satisfactory laws relating to co-operative societies, especially the Industrial and Provident Societies act (1852). Hughes and Neale wrote a *Manual for Co-operators* (1881). Neale suggested several fruitful ideas of national development and eventually became general secretary of the co-operative union; Ludlow became the chief registrar of friendly societies.

National Organizations.—The need for a co-operative wholesale organization had been realized in the 1850s and both the Rochdale group and Neale had made unsuccessful efforts to meet it. A change in the law which permitted societies to hold shares in each other's enterprises made possible a federal organization for the purpose, and in 1863 the North of England Wholesale Industrial and Provident society, later known as Co-operative Wholesale society (C.W.S.), was established. Only 50 of the 454 societies then existing joined it at first, the membership of the Rochdale Pioneers constituting about one-quarter of the aggregate membership of the societies first affiliated to the wholesale society. In 1868 Lloyd Jones and William Pare, both leading figures in the Owenite movement, were still active in the movement and desired to revive the Co-operative congress. Their efforts, together with the support of H. Pitman's *Co-operator* (1860–71), brought about the Co-operative congress in 1869, the first of a series. Out of these congresses was developed the Co-operative union, an organization open to all co-operative societies, undertaking propaganda, educational, research and advisory work for them and representing them in dealings with the government and with trade unions.

During the 1870s the movement was shaken by the failure of a number of productive societies, mainly in textiles, coal mining and engineering. The C.W.S. had opened a banking department (1872) and commenced production in 1873. These steps were strongly opposed by Hughes and Neale and gave rise to great consumer-versus-producer debates in the 1870s and 1880s. Producer co-operation, however, revived in the 1880s partly because of recovery from the slump of the 1870s and of the efforts of the Co-operative Productive federation, set up in 1882. The trades entered were mainly printing, clothing and footwear. These had the advantage of co-operative markets and retail societies also invested in them. The strength of the case for producer co-operation was, however, largely destroyed by the publication of Beatrice Potter's (later Mrs. Sidney Webb) *The Co-operative Movement in Great Britain* (1891). She and Webb carried on a life-long attack on producers' co-operation and were strong and effective advocates of consumer co-operation.

The wholesale societies continued to extend their activities in the range of trade and production, uniting for joint enterprises in the English and Scottish Joint Co-operative Wholesale society

and the Co-operative Insurance society. Co-operative congresses generated various developments, among these being the formation of the North of England Co-operative Newspaper company (1870) which began to publish the *Co-operative News* in 1871, the oldest working-class newspaper in existence. Developments of the co-operative press continued, both in organization and in number and range of publications. The Co-operative union and the wholesale societies published books and periodicals, but the *Co-operative News, Scottish Co-operator* and *Reynolds News* (a Sunday paper) with various weeklies and quarterlies are published by the Co-operative Press, Ltd. This is an independent body, although its shareholders are co-operative societies.

Suggestions were made shortly after the passage of the Reform act (1867) that the co-operative movement should have some parliamentary representation, and efforts were made between 1892 and 1914 to persuade the Co-operative congresses to agree to take steps to that end and to form an alliance with the Labour party and the trade unions. These efforts were unsuccessful, until annoyance with government indifference to co-operative grievances during World War I resulted in a decision to seek political representation at a special congress in 1917. Resulting from this decision, the Co-operative party was formed and this found that, for practical purposes, an alliance with the Labour party was necessary. Agreements were made (1927, 1946, 1958) which made co-operative members of parliament and candidates subject to control by the Labour party. The Co-operative party, however, is subject to the Co-operative congress and is financed by the fees of societies affiliated to it. Societies are free to affiliate or not and every society affiliated with the Co-operative party has decided to do so by vote of its own members.

Retail Society Developments.—Steady although unspectacular growth was made by the consumer movement in the 20th century. Individual membership of retail societies more than doubled every 25 years between 1875 and 1950, and amounted to more than 12,500,000 in 1960. From 1938 to 1958 the volume of trade increased from £263,000,000 to £997,000,000, share and loan capital from £183,000,000 to £356,000,000 and reserves from £15,000,000 to £37,000,000. The greatest growth of membership occurred in the midlands and the south, although the northern parts of England and Scotland continued to grow faster in trade and capital per member. Co-operative growth after 1920 was also mainly in large towns and cities, in which it was generally weak before 1914. The combined membership of the metropolitan societies increased from 270,000 in 1920 to 2,148,000 in 1958. Societies also grew in size: whereas in 1920 no society had a membership of 100,000, in 1958 there were 18 such societies, with an aggregate membership amounting to 33% of the movement's total. In 1958 more than half the total membership was in societies with a membership of more than 50,000 each. Much of the increase in size was due to amalgamations which reduced the number of societies from 1,455 societies in 1903, 1,379 in 1920 to 918 in 1958. The increase in size presented problems of management, democratic control and the maintenance of the average member's interest and loyalty.

The general pattern of co-operative trade changed little: foodstuffs amounted to 75% of the total in 1958, almost the same proportion as in 1938. New methods of retailing were introduced and developed by co-operative societies in the 1940s and 1950s, mainly self-service shops, supermarkets and mobile shops. In 1950, 90% of self-service shops were co-operative and in 1958 there were still more co-operative self-service shops than any other (4,500 co-operative, 1,350 multiple, 550 other), and more than half the number of mobile shops were co-operative in 1957. The movement, however, was not engaged in mail-order trading or in that of the variety chain store. Although credit trading was common in co-operative societies before World War II, its trade was and is predominantly a cash trade: the proportion of members' indebtedness to its total trade in 1938 was 2.7%, in 1958 it was 2.5%.

The wholesale societies, dependent for capital, trade and directorial control upon the retail societies, have naturally a similar pattern of development. The business of the C.W.S. increased from £205,000,000 in 1946 to £463,000,000 in 1958, that of the S.C.W.S. from £44,000,000 to £90,000,000. The C.W.S. was Britain's largest business in 1958, excepting some nationalized industries. It had more than 200 factories and farms, 50,000 employees, and depots in many parts of the world. It was one of the largest farmers, with farms and estates amounting to 34,000 ac., an agricultural department with a trade of £34,000,000 and agricultural co-operatives from which it bought large quantities of produce. Current account turnover of its banking department increased from £1,334,595,000 in 1946 to £5,042,323,000 in 1958, that of the S.C.W.S. from £102,925,000 to £507,963,000. The Co-operative Insurance society, a joint venture of the C.W.S. and the S.C.W.S., increased its premium income from £9,058,000 in 1938 to £47,702,000 in 1958. Exclusive of overseas workers, the co-operative movement employed 395,657 workers in 1958.

Co-operative workers' productive societies remained mainly engaged in the printing, clothing and footwear industries. As these did not enjoy the general expansion of the 1950s, they did not grow at the rate of the co-operative movement in general. But little advance was made generally by this type of co-operation during the 1920–60 period. The number of societies changed little during this time, 44 societies being affiliated to the Co-operative Productive federation in 1923, 46 in 1955 and 41 in 1958. The number of employees is a fair measure of their growth: there were 5,217 employees of these societies in 1923, 5,481 in 1955 and 4,898 in 1958.

Organization.—The co-operative movement is organized from the bottom upward. At the base are the individual members of the primary societies, in Great Britain mainly retail societies. Members are in no way subject to their societies but the societies are subject to the members, whose interests they exist to serve and to whom they are responsible. These societies associate in federal societies, local and national, yet the same relations exist. The federal societies exist to serve the purposes of the member societies, to whom they are responsible, but the member societies surrender none of their independence and are autonomous bodies. Each higher organization is created by and controlled by those below it, not by those above it. If there is any sovereign authority in the co-operative movement, it is to be found in the basic units, the individual members of the primary societies.

The principal national organizations are those mentioned above —the C.W.S., the S.C.W.S., the C.P.F., the Co-operative press, the Co-operative party and the Co-operative union. This latter includes most co-operative societies and is generally regarded as representing the co-operative movement as a whole. It is organized on sectional lines, Great Britain being divided into eight sections for the purpose and there is also an Irish section. Each section has a board elected by the societies in its section, which is concerned with the affairs of the movement in its section but which also expresses the voice of the section in national affairs and also exercises some control over them. The central executive of the Co-operative union consists of two representatives of each sectional board, except the Irish, which has one, and representatives of the C.W.S., the S.C.W.S., C.P.F., Co-operative press and Co-operative party. Sectional representatives number 17, those of the national organizations number 10. The central executive is responsible for managing the affairs of the Co-operative union and determining co-operative policy between congresses. Although the central executive is ultimately responsible for management and policy decisions it effects its work through four main subcommittees, General Purposes (concerned with finances and management of the C.U.), Parliamentary, National Policy and Economic. Each section is represented on the General Purposes committee which is the main committee, and so is each national organization with the exception of the Co-operative party. A similar pattern exists with other C.U. organizations: the National Wages board (which negotiates on a national level with the trade unions) has two representatives from each section and two from the central executive. The trade associations have generally one from each section and representatives of the central executive and the wholesale societies. By this organizational structure each sectional board and national organization is kept well informed of the conduct of all affairs by the Co-operative union and is able to voice its opin-

ions and share in control. A Co-operative congress is held annually, attended by delegates from all Co-operative union member societies. Its principal business is consideration of the report of the central executive, which is a statement of all the work of the Co-operative union in the preceding year. Resolutions on matters of the Co-operative union, on those of the retail societies, the national organizations and international questions are moved and discussed. But the only effective resolutions are those referring to the Co-operative union itself. Congress has no constitutional power over the individual societies or the national organizations excepting the Co-operative union and the Co-operative party. Nevertheless resolutions which refer to co-operative affairs have often given a lead and exercised considerable influence.

Agricultural Co-operation.—The agricultural societies have not been willing to enter into the main stream of the British co-operative movement, although most are members of the C.W.S. and relations are amicable. Circumstances and the inspiration and leadership of Sir Horace Plunkett (*q.v.*) enabled a successful agricultural co-operative movement to develop earlier and more rapidly in Ireland than in Great Britain. The English movement grew slowly and almost suffered catastrophe in 1924 with the collapse of the Agricultural Organization society (established 1901) and the Agricultural Wholesale society (established 1918), victims of the postwar slump. The C.W.S. did much to keep some of the societies alive, but although the National Farmers' union took the affairs of the movement into its hands, agricultural co-operation was handicapped by lack of zealous organization to further it. The formation of the Agricultural Co-operative Managers' association in 1936, the Agricultural Co-operative association in 1945 and the Agricultural Central Co-operative association in 1956 helped to remove this handicap. There are separate agricultural organizations in Wales and Scotland. During and after World War II, agricultural co-operation grew rapidly. Membership in England increased from 108,000 in 1946 to 230,687 in 1958, trade from £25,000,000 in 1946 to £129,189,000 in 1958. Requisite societies have always been and are the strongest, accounting for £80,000,000 of this turnover. (A. Bo.)

UNITED STATES

Co-operatives in the United States may be classified by specific function as: (1) farmer-owned marketing, processing and purchasing associations; (2) retailer-owned wholesale co-operatives; (3) credit and banking co-operatives (including credit unions and the nationwide farm credit system); (4) mutual insurance companies; (5) rural electric co-operatives; (6) consumer goods stores; (7) group health and medical plans. In addition, there are co-operatives performing miscellaneous farm services (*e.g.*, artificial breeding, cotton-ginning), housing co-operatives, student co-operatives (dwellings, bookstores and other facilities), rural telephone co-operatives and burial associations.

The first seven types are listed in the approximate declining order of their annual business volume. Of an estimated annual total co-operative business of $24,000,000,000, farmer-owned marketing, purchasing and service associations accounted for nearly half the dollar volume in the early 1960s.

History.—Co-operative endeavour in the United States was started by workers' groups. An early example was the establishment of a short-lived co-operative boot and shoe factory by the Journeymen Cordwainers' union of Baltimore, Md., in 1794. Two groups of workers launched co-operative stores in 1829, one in Philadelphia and the other in New York. Two years later, co-operative trading was discussed at the first annual convention of the New England Association of Farmers, Mechanics and other Workingmen, and co-operative stores were soon established. A member of this association took a leading part in organizing the Workingmen's Protective union, which sought to accomplish "broad social amelioration" through "cooperation, mercantile and fraternal." By 1857 membership in the union extended to the six New England states and New York. Distrust and dissatisfaction caused some members to break away and form the American Protective union in 1853, which did not share the social aims of the original union. Both agencies were weakened by internal problems. They were also the targets of competing merchants, and suffered from the financial panic of 1857 and pre-Civil War economic dislocations. The majority of local stores disbanded without loss to their members; some distributed sizable accumulated earnings. Their experience illustrated elements of weakness and strength in co-operative endeavour.

The first recorded co-operative effort among farmers in the U.S. was a "dairy" (presumably a creamery) established at Goshen, Conn., in 1810. By 1867, there were over 400 co-operatives processing dairy products in the eastern United States. In 1820 a group of Welsh farmers at Granville, O., began marketing hogs co-operatively. Wool pools were established during the 1840s and Wisconsin grain farmers erected an elevator at Madison in 1857. Co-operative purchasing of farm supplies began on Long Island in 1863 with the formation of an association to buy fertilizer in wholesale lots.

Meanwhile the success of the Rochdale Pioneers in England in the middle of the 19th century (*see* above) was widely publicized. More than a century later, true co-operatives throughout the world still acknowledged and respected the Rochdale principles, regardless of their degree of adherence to them. Although they were promulgated for consumer co-operative stores, they were also applied to agricultural producers' co-operatives.

The founding of the National Grange in 1867 gave impetus to co-operative activity in the U.S. (*see* GRANGE, THE). A sponsor of "cooperation in all things," the Grange declared that its objective was to bring "producers and consumers, farmers and manufacturers, into the most direct and friendly relations possible." It grew slowly at first but later had 24,000 local organizations. It exerted political influence at the national level and emphasized economic activities locally. It established state and county agencies for marketing farm commodities, purchasing farm supplies, operating stores, manufacturing farm equipment, and for banking and insurance. Without co-ordination at the national level, the state and local operating methods were divergent and not conservative.

In 1874 the Grange sent a representative to England to study the Rochdale system and soon thereafter operating rules and directions for organizing co-operatives on Rochdale principles were developed and distributed by the National Grange headquarters. Although the Grange movement was largely spent by 1885, Grange-sponsored or Grange-organized co-operatives continued to function throughout the nation. In later decades, Farmers union and Farm Bureau organizations in many states encouraged and assisted in the formation of co-operatives—principally farmers' marketing and purchasing associations—some of which attained imposing size.

This glimpse of co-operative history reveals two streams of endeavour—one directed toward savings in cost of consumer goods, the other directed toward higher net farm incomes through increased returns and stabilized markets or savings in costs of production. Both are stronger in rural areas than in urban communities, although co-operative supermarkets and co-operative apartments are found in and near metropolitan centres. There has been no confluence of these streams because of strong and basic differences in viewpoint. Proponents of across-the-board co-operative effort, with emphasis on consumer services, have been more zealous in their adherence to a co-operative philosophy and ideology. They stress the high motives and ethical values of mutual endeavour. Farmer co-operatives, on the other hand, underscore business objectives: higher prices for their commodities when marketed, increased savings on co-operative purchases and interest on invested capital. Although these differences are only in degree, and monetary savings gained through patronage of consumer stores and services are a prime determinant of their longevity and success, the differences are evident in the teachings and publications of the two types of organizations and there is a lack of rapport between the two groups in some areas of the United States.

Characteristics of Co-operatives.—In their operating technique and organizational structure, co-operatives closely resemble other types of business, and have similar motives. Distinguishing

characteristics of co-operatives are their ownership by patrons (rather than by investors who may or may not be patrons), their distribution or allocation of all net earnings annually among member-owners in proportion to their patronage, and their control by directors who are themselves members, owners and patrons. Moreover, co-operatives stress service to members to a degree that shapes their policies.

Because co-operatives are voluntary associations of patrons who may withdraw from membership in any year, they are peculiarly dependent upon members' active participation and loyalty. Some co-operatives (*e.g.*, processing associations) require large sums of capital for plant and equipment which must be provided by members in proportion to their patronage. This capital may be obtained through revolving capital funds derived from the proceeds of marketing, through a surcharge added to the cost of supplies purchased, through a capital allowance in service fees or through stock subscriptions. Although this capital is seldom retained for a period in excess of 10 years (since it is accumulated annually and rotated accordingly), it often involves large investments by member-patrons at a given time. Thus, member relations are a vital aspect of co-operative affairs. Research studies disclose a positive correlation between members' knowledge of their co-operative and their loyalty and patronage. In those co-operatives with membership numbering tens of thousands, information and education become massive responsibilities.

In general, co-operatives in the U.S. are decreasing in numbers and increasing in size and membership. In the face of powerful competition, some co-operatives have been eliminated and others have merged. Some local associations are part of nationwide organizations such as the Farm Credit system and the Rural Electrification administration. Many regional and federated associations have members in several states.

A common ethnic background, similarity of interests and employment, and comparable income levels all contribute to harmony of interests among members. In predominantly Scandinavian communities, support and patronage of co-operatives are firmly established. This is probably the principal reason why the greatest concentration of co-operative organizations and membership in the United States is in the north central region lying west and south of the Great Lakes, where the large Scandinavian population favoured the formation and early growth of co-operatives with success that has been self-perpetuating. For quite different reasons, California is the state in which annual dollar volume of business through farmer co-operatives is greatest. California co-operatives, primarily engaged in processing, packing and marketing farm commodities, were organized in the early decades of the 20th century and gained national recognition for their rigid standardization of product grade and quality, their promotion of brand names and their consistent efforts toward orderly marketing. These organizations are constantly exposed to keen business competition and the critical appraisal of their members.

With the growth of chain stores in the retail grocery and drug business there has been a marked expansion of wholesale buying co-operatives. These are owned and patronized by supermarkets and proprietary grocery stores seeking bargaining power commensurate with their chain store competitors and savings derived from quantity purchases.

In contrast to those of many other countries, co-operatives in the U.S. have been encouraged, but not financially supported, by the federal government. In general, farmer co-operatives have received more assistance than those of other types. Marketing associations organized and operating in accordance with the provisions of the Capper-Volstead act of 1922 receive specific consideration under antitrust laws; the Co-operative Marketing act of 1926 established a division under the U.S. department of agriculture to render services to associations of agricultural producers engaged in co-operative activities. Those co-operatives which distribute all net earnings among their patrons annually and adhere to special stipulations of the internal revenue code (relative to the identity and equitable treatment of patrons, rate of returns on invested capital, accumulation of reserves and record-keeping) may qualify for a "letter of exemption" from federal income taxes. Since the co-operative thus retains no net income, its earnings are taxed as income to the individual patrons who receive it. Other types of co-operatives pay federal income taxes. All co-operatives are subject to all other types of taxation.

The federal government has facilitated the growth of two major types of co-operatives through loans: (1) rural electric associations, which may borrow from the Rural Electrification administration; (2) land bank and production credit associations, which were initially provided with funds through the component banks of the Farm Credit administration. The latter include district federal land banks, intermediate credit banks and banks for co-operatives, which lend directly to farmer co-operatives. The federal funds that originally implemented this nationwide farm credit system were gradually replaced by borrower stock subscriptions. By the early 1960s all three types of lending institutions under the Farm Credit administration were approaching borrower ownership in the co-operative tradition. The 1,000 rural electric co-operatives that function in 45 states have played a major role in electrification of more than 90% of all farms in the U.S.

Several national organizations serve co-operatives. The American Institute of Cooperation in Washington, D.C. promotes co-operative research and serves as a source and clearinghouse for co-operative information. The Cooperative League of the U.S.A. in Chicago, Ill., a federation of co-operatives dealing with consumer goods and farm supplies and services, functions as an educational and training agency and as a spokesman for co-operative principles. The National Council of Farmer Cooperatives in Washington, D.C. represents co-operatives before congress and before executive agencies of the federal government and assists in co-ordinating co-operative views on matters of national policy. State co-operative councils perform parallel functions within their respective boundaries. In addition, there are several nationwide associations that follow specific commodity or service lines, including the National Milk Producers federation, the National Federation of Grain Cooperatives and the National Rural Electric Cooperative association. (A. W. L.)

OTHER COUNTRIES

Africa and Near East.—The co-operative movement grew rapidly in Africa after World War II, aiding the technical advancement of primitive agricultural economies by making available farm machinery, credit, a marketing system and training in new methods. The co-operatives generally followed the pattern established by the mother country. In the British territories the government actively encouraged the co-operative movement and appointed registrars to assist in organizing and supervising the new co-operatives. In Nigeria, cocoa marketing co-operatives began in 1922 and were followed by other marketing, credit and consumer co-operatives. In other sections of British West Africa produce-marketing co-operatives were introduced. After World War II membership in co-operatives in British East and Central Africa was extended from Europeans to the African population. Marketing societies added processing functions and began to operate cotton gins and coffee-processing plants. In Kenya, new African co-operatives were patterned after the existing European and Asian societies.

In French West Africa the government's attempt to convert native provident societies into co-operatives resulted in some failures. The authorities then set up pilot marketing co-operatives and rural producers' mutual societies to promote co-operative development. In Belgian territories there was a slower development and some failures due to inadequate preparation. Ghana had an early history of co-operatives in the production and marketing of cocoa, but consumer co-operatives declined because of the competition of credit stores. South Africa had the most advanced development of co-operatives on the continent, chiefly in consumer and agricultural marketing co-operatives for Europeans. The Cooperative Winegrowers' Association of South Africa controlled the entire wine industry.

In north Africa many societies were founded by Europeans and were later extended to include Africans. The Algerian agricultural co-operatives included wine cellars and agricultural equipment

societies. Morocco's co-operatives were primarily in agricultural marketing, production and handicraft societies. In Tunisia, craftsmen were encouraged to pool their effort in co-operative workshops and marketing societies.

In the Arab League countries consumer co-operatives were weak because people preferred to shop in the bazaars. Agricultural co-operatives were developed through government action to improve land utilization and reduce the traditional indebtedness of farmers. Credit and housing co-operatives appeared in Turkey, Jordan, Egypt and Iraq. Government co-operative departments were established in most of these countries to encourage the growth of the movement.

In Israel co-operatives flourished under a distinctive association with the labour movement. "Hevrat Ovdim," the General Cooperative of Jewish Labor, was a subsidiary of "Histadrut," the General Federation of Labor. Co-operative agricultural communities accounting for 50% of the total rural population, were of the following types: the "Kibbutz" and "Kvutza," where all property is collectively owned and work is organized collectively; the "Moshav" and "Moshav Ovdim," co-operative settlements where all farms are of equal size; and "Moshav Shitufi," a co-operative settlement where all property, except individual farms, is owned collectively.

Canada.—The earliest co-operative developments in Canada were in agricultural marketing. The United Grain Growers', Ltd. was founded in 1906, the United Fruit Companies of Nova Scotia in 1912, and the Associated Growers of British Columbia in 1923. The Canadian Cooperative Wheat Producers, Ltd. was organized in 1924 as the central selling agency for the wheat pools. Other important marketing societies were for honey products, forage, livestock, poultry and maple sugar. Altogether more than 30% of all Canadian farm products were marketed through co-operatives in the late 1950s. Consumer co-operatives in retail trade were organized chiefly in rural areas and mining towns. Canada had a strong credit movement, serving chiefly the rural areas and filling gaps in the banking system. The 5,000 co-operative credit unions were grouped into 26 central banks, which were affiliated with the National Federation of Cooperative Credit, which was in turn affiliated with the corresponding organization in the United States. The French-speaking area was represented by Le Conseil canadian de la cooperation, which comprised 6 provincial unions, including the Federation of Quebec with 1½ million members.

Australia and New Zealand.—The first co-operatives in Australia were organized in 1868. By the time the Cooperative Federation of Australia was founded in 1943 the membership of individual societies had reached 500,000, mainly in New South Wales. Among the most important organizations were the Co-operative Dairy association of New South Wales, the Poultry Farmers' Cooperative society of Queensland and the Trustees of the Wheat Pool of Western Australia. In New Zealand more than 300 co-operative cheese and butter factories dominated the co-operative movement.

Latin America.—The co-operative movement in Latin America was launched by European immigrants as early as 1900, and was later fostered by state action in connection with agrarian reform. The chief co-operatives are agricultural, credit, housing and consumer types. By the early 1960s there were about 15,000 co-operatives with about 5,000,000 members. The Union of Argentine Cooperative societies was founded in 1922, and in Brazil the Central Cooperative of Rural People's Banks of Rio Grande do Sul was established in 1925. Consumer co-operatives were strong in Argentina, Brazil and Chile. Many were established by business firms or government departments for their own employees, and usually received tax exemptions. Agricultural co-operatives were established in every Latin-American country. By the middle of the 20th century Argentina had six federations of general agricultural marketing co-operatives, including the "Sancor" Butter factories founded in 1938. Brazil had 1,300 agricultural production co-operatives for such products as sugar cane, cocoa, bananas, coffee, maté, timber, wine and rice. Chile had agricultural co-operatives for dairy products, poultry, fruit, cattle and forestry. Among the agricultural co-operatives in Uruguay were those for livestock, cereals and rice, dairies, fruit and flowers.

Credit and insurance co-operatives were also firmly established. The Association of Argentine Mutual Insurance cooperatives was founded in 1940, and had 88,000 members by 1960. The Federation of Argentine Credit cooperatives, founded in 1950, included 50 societies and 35,000 members. Brazil had 444 credit unions. The Chilean Federation of Savings cooperatives, founded in 1951, included 98 credit co-operatives. The Cooperative Union of the Dominican Republic functioned mainly in credit, and represented 100 credit and insurance societies.

In Mexico the *ejidos* (land-owning villages) provided a system of co-operative farming and community improvement. There were also production co-operatives in forestry, fishing, transportation, mining and services. A major consumer co-operative was organized and managed by the trade unions. The Mexican National Bank for the Development of Cooperation was founded in 1944 to provide credit to co-operatives and small businesses.

Asia.—In Communist China co-operatives are defined as a form of collective ownership by the workers. The first-five year plan called for the collectivization of agriculture through the intermediate stages associated with the Communist bloc in eastern Europe, and for the gradual organization of individual handicraft workers and private merchants into co-operatives. Wholesale trade in industrial products was to be handled by state trading companies; handicraft products and other retail trade were to be handled by the co-operatives. By the end of 1956, 92% of all handicraftsmen had been drawn into co-operatives; most of the operators of wagons, wheelbarrows and junks became members of transport co-operatives; and the majority of fishermen, salt miners, peddlers and human carriers were organized into other co-operatives. By the end of 1958 the socialization of agriculture was declared to be complete, without having gone through the scheduled intermediate stages. Communist party workers were in charge of co-operatives and collectives.

The co-operative movement in Indonesia had advanced steadily before World War II, but lost ground under Japanese occupation. The first constitution of the republic in 1945 specifically provided for co-operative organization. With the authoritarian government established in 1960, it was anticipated that the co-operatives would become subservient to a state-controlled economic plan.

In India the plan to establish a co-operative in every village embodied the national policy to assign a major role to co-operatives in achieving economic development. The second five-year plan called for an expansion of the multipurpose village societies from 5,000,000 to 15,000,000 members. A government training program was established with a staff of technical advisers to work through the local co-operatives and the village schoolmasters. The Reserve Bank of India was instrumental in distributing agricultural credit, organizing training programs, and otherwise assisting co-operative development. Short-term credit was available through 180,000 credit societies. Production and marketing co-operatives were widely organized for handloom weavers, sugar cane growers, spinners and cottage industries.

In Pakistan at the end of 1957 there were 21,000 co-operatives with a membership of 1,000,000, chiefly in agricultural credit societies. The co-operative movement was also actively promoted in Ceylon, Burma, Malaya and the Philippines. Consumer co-operatives were particularly active in Ceylon, in addition to agricultural credit societies.

In Japan, co-operatives were first established in the 1870s and by the end of the century had 65,000 members, chiefly in the farm villages. With government encouragement the number increased to 380,000 by 1909. After World War I the farm co-operatives were used to carry out the government's economic recovery plan. Fishermen's and workers' production co-operatives also developed rapidly in this period. By World War II, all of these co-operatives had become state agencies and had lost their independence. After the war, co-operatives were reorganized under new laws. Agriculture and fishing were almost completely organized into co-operatives by the early 1960s. Industrial, commercial and consumer co-operatives were growing less rapidly.

U.S.S.R.—Consumer co-operation began in Russia with the

abolition of serfdom in 1865, and by the end of the century total membership was about 250,000. The revolution of 1905 resulted in the promotion of co-operatives as a means of social improvement, and by 1914 membership had grown to over 1,000,000. During World War II the government controlled distribution through co-operatives, and in the postwar era their scope was determined by political exigencies. In 1958 the Central Union of Consumer cooperatives had a membership of 34,000,000 and accounted for 29% of the total retail trade of the U.S.S.R. When producer co-operatives were included in the state planning system most private handicraft workers were induced to join by means of discriminatory taxes or benefits. The "artel" was the main type of co-operative; under this arrangement the shop and equipment were communally owned, each member received a wage, and the annual surplus was distributed in proportion to individual output. The formation of farm co-operatives was advocated by Lenin as a practical method of introducing agricultural collectivization. The complete collectivization drive of the 1930s was later modified because of peasant resistance, and each family was permitted to have a farmstead for its personal use, consisting of about half an acre, a few livestock and some tools.

Eastern Europe.—Co-operatives had attained a considerable growth in this area before World War II; at least 15% of the population belonged to some type of co-operative. As the Soviet Union gained control of each country the basic pattern of socialization was to establish direct state control of large industries and to promote gradual collectivization of the rest of the economy. Collectives were represented as an advanced form of the traditional co-operative. Agriculture was to be reorganized in four stages: (1) machinery was to be used collectively; (2) fields were to be worked in common but still owned individually; (3) all property was to be pooled except the small private farmstead; (4) all land was to be pooled and all income was to be distributed in proportion to the work performed. After fulfilling the quota set for each collective according to its fertility, making deposits in established funds, and paying other expenses, the surplus was distributed in proportion to the number of workday units contributed. Any surplus from the farmstead could be sold in a free market. State farms were directly owned and managed by the state, and the employees were paid regular wages.

The typical organization of trade was through a pattern of state stores in urban centres and co-operatives in rural areas. In either case, the operation was in the hands of the political party, which determined quotas and prices in consonance with the national economic plan. Distribution of the surplus was made according to labour contribution rather than to sales and purchases. Producer co-operatives in the cottage or handicraft industries were encouraged because they could provide additional consumer goods at low cost by using local raw materials and local markets, and because skilled workers were thus gradually brought under socialism.

In Albania, the government was reported in the early 1960s to be relying heavily on the co-operatives in its attempt to develop commerce and agriculture. In Bulgaria many of the economic functions carried out by co-operatives were assigned to state organizations, especially the distribution of food products, the sale of agricultural supplies, agricultural marketing, credit and insurance.

In Czechoslovakia, both consumer and agricultural co-operatives were strong before the German invasion of 1938. There was a rapid revival after World War II, when many private businesses were transformed into co-operatives. Retail trade was socialized between 1946 and 1952. The consumer co-operatives during the late 1950s operated 42,000 stores, 15,000 restaurants and 282 training schools.

In Hungary, the government established a close relationship with co-operatives under the Horthy regime. After the war, co-operatives were extended but were dominated by the state and linked with state-owned businesses.

The agricultural circle was revived in Poland as an alternative to the collective farm; it provided for co-operative use of new machinery, irrigation systems and local processing plants, but retained private ownership of property. Producer co-operatives provided 11% of total production; in retail trade 64% of the stores were co-operatives and 30% were state stores.

When industries were nationalized in Rumania in 1948, individual producers were organized into state-controlled co-operatives affiliated with a federation under close government supervision. In the late 1950s they accounted for the production of 30% of clothing, 34% of furniture and a high proportion of small metal goods.

In Yugoslavia the government liberalized its policy of agricultural collectivization and encouraged the spread of privately-owned co-operatives. Individual holdings were limited to 25 ac. each and personal control was maintained.

Western Europe.—The co-operative movement in western Europe underwent major changes after World War II. Consumer co-operatives introduced self-service stores and merged some of their units to reduce costs. Agricultural co-operatives developed marketing and processing facilities to provide more complete vertical integration.

Co-operatives had been formed in Germany in the middle of the 19th century. The system of rural credit originated by F. W. Raiffeisen was later copied throughout the world. At the same time, F. H. Schulze-Delitzsch pioneered in establishing banks for small business loans. These were revived in the Federal Republic of Germany after World War II, and within a decade claimed 5,000,000 members. Consumer co-operatives also recovered quickly after the war, claiming over 2,000,000 members.

In France the first consumers' store was founded in 1835, but the main early development was in producers' societies. By 1960 consumer co-operatives had 3,000,000 members and agricultural co-operatives had more than 1,000,000 members. It was estimated that 82% of all grain and 60% of all oil-producing crops were marketed through co-operatives. The 600 workers' production co-operative societies were found mostly in building, quarrying, books, paper, metallurgy and electricity.

The Scandinavian countries are strongly organized for both consumers' and agricultural co-operation. In rural areas purchasing and marketing co-operatives are common; in urban areas the consumer co-operatives have food stores, department stores, bakeries and apartments. A Cooperative Union and Wholesale society in each country provides goods and miscellaneous services to the affiliated consumer co-operatives, and may also operate productive enterprises. By 1960 the percentage of the population belonging to co-operatives was 24% in Finland, 21% in Iceland, 14% in Sweden, 11% in Denmark and 8% in Norway.

In Sweden there were over 1,000,000 members of farm co-operatives in 1960. Consumer co-operatives handled 12% of all retail trade; housing co-operatives represented 100,000 members and worked with municipal authorities to build low-cost housing. In Norway the sale of fish is handled exclusively by the co-operatives. Dairying co-operatives are also particularly strong. Denmark has a long record of agricultural and consumer co-operatives, including a co-operative theatre with 115 affiliated societies.

In Italy, the co-operative movement lost its freedom with the rise of Mussolini in the early 1920s. In the expansion that followed World War II the co-operatives split into two major federations, each representing 10,000 co-operatives and more than 2,000,000 members. Agricultural and consumers' co-operatives were the most numerous.

Among the 5,000 agricultural co-operatives in Spain, the most important groups were wine cellars, oil factories, mills, dairies and rural credit banks.

Austrian co-operatives lost their autonomy during the German occupation but were re-established in 1947. By 1957, agricultural marketing co-operatives had 1,000,000 members. In urban areas, credit co-operatives claimed 750,000 members and consumer co-operatives had 355,000 members.

Before World War II, consumer co-operatives in Belgium handled 10% of all retail trade and served 25% of the population. The postwar revival retained the compartmentalized organization which had developed. The Belgian Farmers' league represented

marketing and credit co-operatives, with a membership of 250,000. The National Federation of Christian cooperatives operated 1,200 stores for its 145,000 members. "L'Économic populaire" operated 320 stores for 60,000 members. The Federal Cooperative society had 217,000 members, and the General Cooperative society served 340,000.

In the Netherlands agricultural marketing and supply co-operatives were divided along religious lines. Consumer co-operatives serve about 15% of the population, chiefly in urban areas.

In Switzerland, the most important wholesale co-operative started a wartime movement to intensify land cultivation. By the end of 1946, 42% of Swiss families were members of consumer co-operatives. These were extended after the war to the production of flour, furniture, shoes and miscellaneous consumer goods. Agricultural co-operatives came to be particularly active in the dairy industry.

See also references under "Co-operatives" in the Index volume.

(J. M. McCr.)

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COOPERSTOWN, a village of eastern New York, U.S., seat of Otsego county, about 60 mi. W. of Albany at the foot of Otsego lake where the Susquehanna river emerges.

In 1779 an army of American patriots under Gen. James Clinton assembled at the present site of Cooperstown where a dam had been built to raise the level of the lake. Breaking the dam, Clinton floated his supplies down the swollen Susquehanna as he moved his force to join Gen. John Sullivan for their successful campaign against the Iroquois and their Loyalist allies. Judge William Cooper of Burlington, N.J., the father of the novelist James Fenimore Cooper, founded the village in the spring of 1786. His policy of selling land outright and accepting mortgages in payment attracted many settlers and probably influenced other great landholders to follow his example. Incorporated in 1807, Cooperstown became a thriving commercial and transportation centre.

James Fenimore Cooper spent his boyhood in his father's mansion which overlooked Otsego lake. The scenes and stories of his childhood are reflected in his Leatherstocking Tales. Otsego lake is the Glimmerglass of his novels.

Cooperstown was the home of Erastus F. Beadle, who originated the dime novel, and of Samuel Nelson, a justice of the U.S. supreme court. Abner Doubleday (later a general in the U.S. army) was said to have devised the modern game of baseball in Cooperstown in 1839 and the National Baseball Hall of Fame and Museum are located there. (*See* Baseball: *History of Baseball.*) Cooperstown is the headquarters of the New York State Historical association which operates Fenimore house and the Farmer's museum in the village. The Historical association has one of the nation's best collections of American folk art. Mary Imogene Bassett hospital in Cooperstown is a notable centre of medical research. Every summer thousands visit Cooperstown to enjoy its museums and beautiful scenery. (J. A. Fr.)

COOPER UNION, an educational institution at Cooper square, New York city, founded by Peter Cooper in 1859. In endowing the school, Cooper stipulated that it be "forever devoted to the advancement of science and art." The Hewitt and Carnegie families and others later increased the Union's financial resources.

Green Camp, a 1,000-ac. tract from the ancestral estate at Ringwood, N.J., given by Norvin H. Green, Cooper's great-grandson, was opened in 1941 as a year-round educational and recreational facility. In 1955 the institution acquired the historic Bible house property adjacent to its original site and in 1960 a new school of engineering building was constructed there.

All instruction is tuition-free and open to all who meet the entrance requirements, regardless of race, creed or colour. Day and evening students are selected from among many applicants on the basis of rigorous intelligence and aptitude tests. The school of engineering confers the degrees of bachelor of chemical, civil, electrical and mechanical engineering; the art school awards degrees and certificates in the fine and graphic arts and in architecture. In 1939 a department of humanities and social studies was established to function as an integral part of undergraduate professional education.

The adult education division conducts evening courses. Free lectures and programs of music, dance and drama are given in the Great hall, where on Feb. 27, 1860, Abraham Lincoln gave his famous Cooper Union address in which he championed the right of the federal government to prohibit slavery in the territories. Many national agencies for social uplift and welfare were founded there, and a number of United States presidents have spoken in the hall.

The Museum for the Arts of Decoration, opened in 1897, provides important resources for designers in the decorative arts. Its collections include original drawings and designs, textiles, woodwork, furniture, metalwork, glass, ceramics and wallpaper. Free exhibitions are offered frequently.

The library, first free public reading room in New York, has nearly 100,000 volumes, as well as extensive holdings of current journals, magazines and trade catalogues. The reference library is supplemented by an encyclopaedic picture reference collection of classified photographs and clippings.

(E. S. Bl.; F. A. Cu.)

CO-OPTATION, the election to vacancies on a legislative, administrative or other body by the votes of the existing members of the body, as opposed to election by an outside constituency. Such bodies may be purely co-optative, like the governing boards of most private U.S. universities, or elective with power to add to the numbers by co-optation. An example of the latter is the municipal corporations in England, which have statutory authority to co-opt persons who are not elected members of the councils to serve on certain of their committees. (C. H. P.)

CO-ORDINATES, real numerical quantities, specified with respect to some frame of reference, that determine the position of a point on a plane or in space. To each set of co-ordinates in a given co-ordinate system there corresponds one and only one point. For a detailed discussion of the important types of co-ordinate systems used by mathematicians, *see* ANALYTIC GEOMETRY.

See also references under "Co-ordinates" in the Index volume.

CO-ORDINATION COMPOUNDS are chemical compounds the atoms or groups of which are united by bonds or valences supplementary to those assigned by the classical theory of valence to the substances of which they are composed. The term was coined by Alfred Werner, who announced the *Co-ordination Theory* in 1893 in order to explain the existence of addition compounds and double salts, such as ammines, hydrates and the double cyanides. The classical theory of valence (*q.v.*) did not explain, for example, the fact that copper chloride, $CuCl_2$, combines with ammonia, NH_3. Werner postulated that the ions of metals such as copper have not only the usual or "primary" valence bonds, which hold the atoms of chlorine in $CuCl_2$, but also "secondary" or "co-ordinate" valence bonds, by which they may attach themselves to other molecules or negative ions. Werner called the resulting substances "compounds of the higher order" or "co-ordination compounds." Werner's theory, restated in electronic terms by both Nevil V. Sidgwick and Thomas M. Lowry in the 1920s, has become one of the foundation stones of the knowledge of molecular structure. Positive ions, especially those which are small and highly charged, share electrons from adjacent negative ions or neutral molecules which have unshared electrons. The metal ion is referred to as the "acceptor" and the other group the "donor" of electron pairs. Thus, when platinic chloride is treated with an excess of ammonia, the hexammine platinic ion is formed:

$$PtCl_4 + 6\,{:}\ddot{N}{:}H \longrightarrow \left[Pt\left(:\ddot{N}:H\right)_6\right]Cl_4$$

That chemical union has taken place is indicated by changes in colour, solubility and other properties, and by the fact that the material does not respond to the usual chemical tests for either the platinic ion or ammonia. Other molecules having unshared pairs of electrons may be substituted for the ammonia; *e.g.*, water, $H:\ddot{O}:H$, organic amines, $R:\ddot{N}:H$, organic sulfides, $R:\ddot{S}:R$, and many others. Similarly, negative ions such as chloride, $:\ddot{Cl}:$, and cyanide, $:C:::N:$, often enter the co-ordination sphere; chloroplatinic acid is a typical co-ordination compound:

$$PtCl_4 + 2HCl \longrightarrow H_2[Pt(:\ddot{Cl}:)_6]$$

or simply H_2PtCl_6.

Two or more different donor groups may be present in the complex simultaneously. Between the hexammine and the hexachloroplatinic ions there are the chloropentammine ion, $[Pt(NH_3)_5Cl]^{3+}$, the dichlorotetrammine ion, $[Pt(NH_3)_4Cl_2]^{2+}$, the trichlorotriammine ion, $[Pt(NH_3)_3Cl_3]^{+}$, tetrachlorodiammine platinum, $[Pt(NH_3)_2Cl_4]$, and the pentachloromonoammine ion, $[Pt(NH_3)Cl_5]^{-}$.

Chloro-aquotetrammine cobaltic ion, $[Co(NH_3)_4(H_2O)Cl]^{2+}$, is a more complex type, in which three different donor groups are co-ordinated to the central ion.

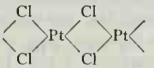
The number of donor groups with which the central ion can combine is more or less fixed for each metallic ion, and is called the co-ordination number. According to Sidgwick, the maximum co-ordination number of any ion depends upon the atomic number of the element; for hydrogen, it is 2; for elements 3 to 9, it is 4; for elements 11 to 35, it is 6; for the heavier elements, it is 8. Usually these maxima are not reached, but in a few examples, such as $CaCl_2.8NH_3$, they appear to be exceeded.

A donor atom having more than one pair of unshared electrons may combine with two metallic ions, thus binding them into a dinuclear complex.

There are often two or three "bridge groups" as:

$$\left[(NH_3)_4Co\begin{matrix}H\\:\ddot{O}:\\H\end{matrix}Co(NH_3)_4\right]^{4+}$$

Many polynuclear complexes are known. Among these are the highly polymeric prussian blue, $K\{Fe[Fe(CN)_6]\}$ and the polymeric, insoluble hydroxides of metals. Thus, ferric hydroxide, the formula of which is usually written $Fe(OH)_3$, is actually a three dimensional polymer $[Fe_n(OH)_{3n}(H_2O)_x]$, the ferric ions being held together by mutual sharing of electrons from the OH "bridges." This substance may lose hydrogen ions, either from the hydroxo bridges, or from the water molecules. In the first case, "oxo" bridges result; in the second, new hydroxy groups are generated and these may form additional bridges with other ferric ions. Platinous chloride is a linear, doubly bridged polymer:



If two donor atoms are present in the same molecule, but separated by at least one other atom, they may both co-ordinate with the same metallic ion, forming a "chelate" ring. The stability of co-ordination is greatly enhanced by this chelation effect if the ring is of suitable size; five-membered rings are the most stable, if only single bonds are present in the ring structure. In rings containing double bonds, six members give the greatest stability, but those containing four or six members are easily prepared. This effect may be illustrated by the organic amines. Monoamines such as methylamine, $CH_3\ddot{N}H_2$, co-ordinate poorly, but ethylenediamine, $\ddot{N}H_2CH_2CH_2\ddot{N}H_2$, does so readily, forming compounds of great stability. The tris-ethylenediamine cobaltic ion, for example, is not decomposed by hot concentrated hydrochloric acid.

Simple secondary organic amines will co-ordinate scarcely at all, but diethylenetriamine, $\ddot{N}H_2CH_2CH_2\ddot{N}HCH_2CH_2\ddot{N}H_2$, attaches itself to cobaltic, platinum and other heavy metal ions through all three of its nitrogen atoms because of the formation of very stable double chelate rings:

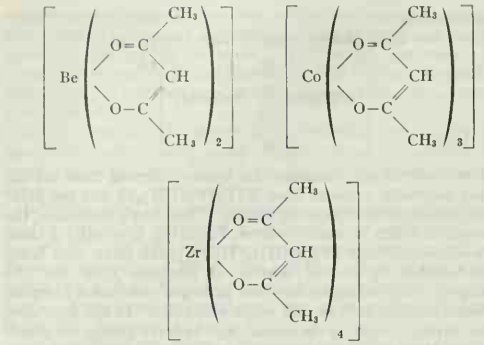
$$M\begin{matrix}:NH_2\\:NH\\:NH_2\end{matrix}\!\!>C_2H_4\!\!>C_2H_4$$

Donor groups which attach themselves to a single metal ion through two atoms (*e.g.*, ethylenediamine) are referred to as bidentate, those which attach themselves through three atoms, as tridentate, and so on. The number of atoms in a chelate ring is most important in determining its stability. Thus, the cupric complexes of α-amino acids (five-membered rings) are extremely stable, those of β-amino acids (six-membered rings) are much less stable, and those of γ, δ, and ϵ amino acids show no tendency to ring formation at all. They are simple salts.

Among the important bidentate groups are ethylenediamine, 1, 3 diketones, and the anions of α-amino acids. Since ethylenediamine is a neutral molecule, compounds formed with salts have saltlike character:

$$MCl_2 + NH_2CH_2CH_2NH_2 \rightarrow \left[M\begin{matrix}:NH_2CH_2\\|\\:NH_2CH_2\end{matrix}\right]_2Cl_2$$

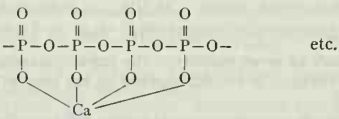
When a β-diketone forms a co-ordinated molecule, however, it loses a hydrogen ion and becomes a negative ion. If the charge on the metal ion balances the charges on the negative diketone ions and if the co-ordination number of the metal ion is twice its charge, a neutral molecule (not a salt) is formed. Many such substances are soluble in nonpolar solvents and are volatile. Among the "inner complexes" formed by β-diketones are the following:



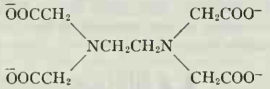
Many of the amino acid compounds are inner complexes, but they are not volatile or soluble in nonpolar solvents. The α-amino acid inner complexes have the type formula

where x is the charge on the metal ion.

Tridentate donor groups form more stable complexes than do analogous bidentate groups; tetradentate groups form still more stable complexes, and so on. In many types of chemical work, polydentate chelating agents are used to combine with metal ions that have undesirable properties, converting them to stable complexes which are not deleterious. Thus, the polyphosphate ion is used in water treatment to "sequester" calcium ions:



The hexidentate anion of ethylenediaminetetraacetic acid



is one of the most powerful co-ordinating agents known, and is used to tie up undesired metal ions in soaps, cosmetics, electroplating baths, food products and a host of other materials. It can also be used to remove rust and scale from metal surfaces, and its iron compound has found application in supplying iron to growing plants.

Many metal ions catalyze unwanted oxidations, so their conversion to noncatalytic forms is most important. Chelating agents are used to effect this in petroleum products, rubber, foods and other organic materials.

Isomerism.—The co-ordination compounds exhibit many types of isomerism (*q.v.*). The most important of these are illustrated as follows:

1. *Polymerism.*—Hexammine cobaltic hexanitro cobaltate $[Co(NH_3)_6]\ [Co(NO_2)_6]$, which consists of two co-ordinate ions, is a polymer of the nonionic trinitrotriammine cobalt, $[Co(NH_3)_3(NO_2)_3]$.

2. *Structural Isomerism.*—The nitrite ion has unshared electrons on both the nitrogen and the oxygen atoms, and can, therefore, attach itself to the cobaltic ion in two different ways. In the bright red nitrito ammines, such as $[Co(NH_3)_5ONO]^{2+}$, the linkage is through oxygen. These compounds rearrange to the more stable brown nitro ammines, $[Co(NH_3)_5NO_2]^{2+}$.

3. *Co-ordination isomerism,* in which groups from the positive and negative ions are interchanged, is illustrated by $[Co(NH_3)_6]\ [Co(NO_2)_6]$ and $[Co(NH_3)_4(NO_2)_2]\ [Co(NH_3)_2(NO_2)_4]$ and by $[Co(NH_3)_6]\ [Cr(CN)_6]$ and $[Cr(NH_3)_6]\ [Co(CN)_6]$.

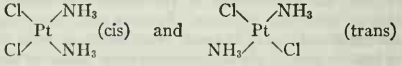
4. *Ionization isomerism,* which is closely related to co-ordination isomerism, is shown by $[Co(NH_3)_5SO_4]\ Br$ and $[Co(NH_3)_5\ Br]SO_4$. The first gives the usual analytical tests for bromide ion, but not for sulfate, while in the second the reverse is true.

5. Another type which is related to co-ordination isomerism is illustrated by $[Co(NH_3)_5NO_3]^{2+}$ and $[Co(NH_3)_4NH_2OHNO_2]^{2+}$.

6. *Hydrate isomerism* is exhibited by the hexahydrates of chromic chloride, $[Cr(H_2O)_6]Cl_3$ (gray-violet), $[Cr(H_2O)_5Cl]Cl_2.H_2O$ (green) and $[Cr(H_2O)_4Cl_2]Cl.2H_2O$ (green). The water molecules which are not part of the complex ion are probably held in the crystal lattice by mechanical or semichemical forces. Silver nitrate precipitates all the chlorine from solutions of the gray-violet isomer immediately, two-thirds of it from the first-mentioned green isomer and one-third from the other green isomer.

7. *Isomerism of Donor Groups.*—Either isopropylamine or normal propylamine can enter into the formation of $[Co(ethylenediamine)_2(propylamine)\ Cl]^{2+}$.

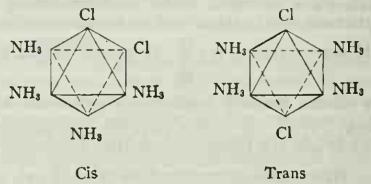
8. *Stereoisomerism.*—Co-ordinate bonds are directional, so that the co-ordinated groups occupy fixed positions about the central metal ion. The four covalences of platinous ion lie in a plane, so that compounds such as $[Pt(NH_3)_2Cl_2]$ exist in the two forms



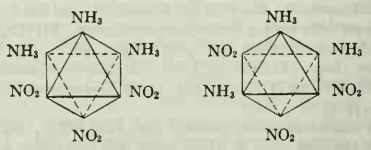
These differ in solubility and in chemical behaviour. Many such examples are known, not only for platinum, but also for palladium, nickel and many other metals.

On the other hand, many complex ions and molecules containing four donor groups have been shown to have a tetrahedral configuration. Nickel carbonyl, $[Ni(CO)_4]$, and the complex cyanides of zinc, cadmium and mercury, $[M(CN)_4]^{2-}$, belong in this class.

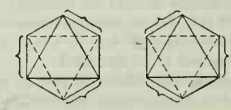
When there are six co-ordinated groups, they occupy the corners of an octahedron, and if two of the groups are different from the other four, cis-trans isomerism is possible. The cis form of $[Co(NH_3)_4Cl_2]^+$ is violet, while the trans form is green:



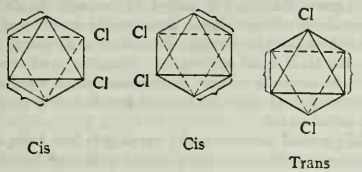
If three of the co-ordinated groups are alike, but different from the other three, isomerism is again possible:



9. *Optical isomerism* is shown when the co-ordinated groups (either four, six or more) are asymmetrically disposed about the central metallic ion. This is easily achieved if the complex ion contains chelate rings. Thus, tris-ethylenediamine cobaltic ion exists in mirror image forms which cannot be superimposed:



The same is true of the cis form of the dichloro-bis-ethylenediamine cobaltic ion, but not of the trans form:



Optical activity might be achieved by proper arrangement of nonchelating groups, but apparently only one attempt has been made to study such a case. I. I. Chernaev prepared the ion $[Pt(NH_3)(pyridine)(NH_2OH)(NO_2)]^+$, which should be resolvable into optically active forms if the valences of the platinum are tetrahedral, but which should exist in three isomers of the cis-trans type if the valences lie in a plane. He discovered the latter to be the case. An octahedral ion containing six different groups should exist in 30 different forms—15 pairs of mirror-image isomers.

The stereochemistry of co-ordination numbers 2, 3, 5, 7 and 8 is much less well developed than that of co-ordination numbers 4 and 6, and few cases of isomerism have been discovered for these co-ordination numbers. The stereochemistry of these less familiar co-ordination numbers has been studied by physical means, such as X-ray crystal analysis, and by measurements of the spectra, dipole moments and magnetic properties.

Some Important Types of Co-ordination Compounds.—Aside from the ammines and the hydrates, there are many important types of co-ordination compounds. The complex cyanides of the heavy metals find wide application in electroplating baths. Ferric ferrocyanide, or prussian blue, and many other highly coloured co-ordination compounds, such as the metal derivatives of the azo dyes, also find application as pigments. Hemoglobin and chlorophyll are naturally occurring co-ordination pigments; they find a counterpart in the synthetic phthalocyanine pigments, which are deep blue or green in colour.

The metal carbonyls (*q.v.*) constitute an interesting group of co-ordination compounds in which the classical rules of valence would indicate a valence of zero for the metal. Many of these substances are volatile. Nickel carbonyl, $[Ni(CO)_4]$, for example, is a highly refractive volatile liquid which is readily formed by the action of carbon monoxide on finely divided metallic nickel. This reaction has been utilized in the metallurgical separation of nickel from cobalt, copper and other metals. Nickel carbonyl is also used in the preparation of nickel powder for catalytic purposes. Iron carbonyl, $[Fe(CO)_5]$, is used in the preparation of pure iron powder. At one time it also found limited use as an antiknock in gasoline, but it was superseded for this purpose by lead tetraethyl. In some of the carbonyls, part or all of the carbon monoxide may be replaced by nitric oxide, giving carbonyl nitrosyls, such as $[Fe(CO)_2(NO)_2]$.

Unsaturated hydrocarbons co-ordinate with many metals through the double bond. This type of co-ordinate bond is of great importance in many reactions involving unsaturated hydrocarbons; such reactions are common in the paint, rubber and petroleum industries.

The ability of α-amino acids to form stable co-ordinate links, to which reference has already been made, is shared by many derivatives of these acids, and the chrome tanning of leather is sometimes explained on the assumption that the chromic ion forms stable inner salts with the polypeptides of the hide. The formation of insoluble inner salts is often used to test for the presence of specific metallic ions, and to determine their amount.

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COORG, a district of the state of Mysore (*q.v.*), India, after 1956, was formerly an independent kingdom and later a small province of British India. It lies at the southern end of the Western Ghats. Pop. (1961) 321,516. Area 1,591 sq.mi. The district is divided into three talukas, Mercara, Virajpet (Virarajendrapet) and Somwarpet. The name Coorg is probably a corruption of Kodagu, meaning "steepness" wherefore under the British regime, it was sometimes called the Wales of India. It is a rugged mountainous district with a high rainfall and the climate is pleasantly tempered by the altitude. Some of the hills (which rise from the general Mysore plateau surface) reach more than 5,000 ft. (Pushpagiri, 5,627 ft.; Kottebetta, 5,375 ft.). Their summits are covered with grass while their slopes are thickly forested. The valley bottoms, cleared of forest, are devoted to the cultivation of rice, which is the staple food crop of the people. Coffee plantations, dating from 1854, occupy considerable hillside clearings. One of the principal sources of the Cauvery river is in Coorg. In legend the rivers of Coorg have something of the life-giving properties of the Ganges (*q.v.*).

From the 9th century onward the mountain kingdom of Coorg remained independent, though under various rulers such as the Gangas, Cholas and Hoysalas. In 1780 it was conquered by Haidar Ali. The people rose in rebellion and freed themselves of Muslim rule, but later Tipu Sahib (*q.v.*) plundered the territory. The raja entered into a treaty with the English and after the final defeat of Tipu (1799) the territory was restored to him. It enjoyed complete freedom during the reign of Virarajendra (Vira Raja). Later troubles resulted in the pensioning of the raja and Coorg became a British Indian province.

The chief centre (the old capital of the kingdom of Coorg) is Mercara (Madhu-keri), situated at an elevation of 3,800 ft. Pop. (1951) 10,117. The site was selected by Mudda Raja in 1681 because of its central yet inaccessible situation and the capital was transferred there from Haleri. Linge Raja built the fort in 1812; to the south of it is the picturesque little garden known as Raja's Seat, commanding a magnificent panoramic view. Other tourist attractions include the Onkeshwara temple, a curious blend of Hindu and Islamic architectural styles. The degree-granting college, founded in 1957, is affiliated to the university of Mysore. Mercara is on the main highway from Mysore to Mangalore, 75 mi. from Mysore city. (L. D. S.)

COOSA, a river of northwestern Georgia and eastern Alabama, 286 miles long, is formed by the confluence of the Etowah and Oostanaula rivers at Rome, Ga. It flows southward through the Appalachian ridge and valley province onto the gulf coastal plain at Wetumpka, Ala. Its course is southwesterly into Cherokee county, where it receives the Chattooga river, then southwest past Gadsden, Childersburg, and Talladega Springs. Four miles southwest of Wetumpka and ten miles north of Montgomery, it joins the Tallapoosa river to form the Alabama river. Locks and power dams make navigation possible for barges to Rome. These power dams are the Lay, Mitchell and Jordan, located between Wetumpka and Talladega Springs. (M. C. P.)

COOT, an inland water-dwelling bird of the genus *Fulica*, belonging to the rail family, Rallidae. About ten species are found throughout the world in larger inland waters and streams, where they swim and bob frequently for food, which consists of water plants, seeds, mollusks and worms; occasionally, when the bird forages on land, small reptiles and mice are pursued.

Members of the genus have greenish or bluish-gray feet, the toes of which are fringed by a lobed membrane that facilitates swimming and walking over plant-choked marshes and ooze.

The European coot (*F. atra*) breeds abundantly in many northern parts of the old world, in winter resorting to river mouths or shallow bays of the sea. About 18 in. in length and sometimes more than 2 lb. in weight, the seemingly short-winged coot appears to rise with difficulty from the water, pattering along the surface with its feet. However, it is capable of long-sustained and rapid flight.

Although it is not considered a game bird, it is hunted in winter when it is most gregarious. When wounded it is said to clutch the weeds at the bottom. The coot nests in masses of water plants where it lays as many as ten speckled eggs. The young are beautifully clothed in jet-black down, with heads of a bright orange-

JOHN MARKHAM

EUROPEAN COOT (FULICA ATRA)

scarlet, varied with purplish-blue. This brilliant colouring is soon lost, and they assume the sooty black plumage which is worn for the rest of their lives; a characteristic of the adult is a bare white patch or callosity on the forehead.

An African species (*F. cristata*) is distinguished by two red knobs on its forehead. The North American mud hen (*F. americana*) closely resembles the European bird. In South America about six species are found, one (*F. gigantea*) being of considerable size; a species (*F. caribaea*) occurs also in the West Indies. The remains of a large extinct form (*F. newtoni*) were discovered in Mauritius.

See also RAIL.

COOTE, SIR EYRE (1726–1783), British soldier, who served as commander in chief in India under Warren Hastings, was born near Limerick, in Ireland, the sixth son of a clergyman. He saw active service in the Jacobite rising of 1745 and a few years later obtained a captaincy in the 39th regiment, which was the first British regiment sent to India. In 1756 a part of the regiment, then quartered at Madras, was sent forward to join Clive in his operations against Calcutta. After the battle of Plassey Coote led a detachment in pursuit of a French force for 400 mi. under extraordinary difficulties. His conduct won him the rank of lieutenant colonel and command of the 84th regiment. In Oct. 1759 Coote's regiment arrived to take part in the decisive struggle between French and English in the Carnatic; in 1760 he led them in the decisive victory of Wandiwash (Jan. 22). Coote supported Col. William Monson in the siege and capture of Pondicherry and soon afterward (1761) was given command of the East India company's forces in Bengal. In 1762 he returned to England, receiving from the company rewards for his services. In 1769 he proceeded to India as commander in chief but quarreled with the governor and again returned to England. He was knighted in 1771. In 1779 he returned to India as lieutenant general and commander in chief. Following generally the policy of Warren Hastings (*q.v.*), he nevertheless refused to take sides in the quarrels between the governor general and his council and made a firm stand in all matters affecting the army. Haidar Ali's progress in southern India called him again into the field, but his difficulties were great and it was not until June 1, 1781, that the decisive defeat of Porto Novo struck the first heavy blow at Haidar's schemes. The battle was won under unfavourable conditions and was followed by another hard-fought battle at Pollilur and by the rout of the Mysore troops at Sholingarh a month later. His last service was the arduous campaign of 1782. He died at Madras on April 28, 1783.

See H. C. Wylly, *Life of Sir Eyre Coote* (1922); E. W. Sheppard, *Coote Bahadur* (1956). (T. G. P. S.)

COPAIBA (COPAIVA), an oleoresin (sometimes termed a balsam) obtained from the trunk of several species of *Copaifera* (family Leguminosae; *q.v.*), native to tropical South America. It is a viscous transparent liquid, occasionally fluorescent and light yellow to pale golden in colour. The odour is aromatic and characteristic, the taste acrid and bitter. Copaiba, insoluble in water but soluble in absolute alcohol, ether and oils, is used in making varnishes and photographic paper, and was formerly used in medicine as a disinfectant.

COPAL, a hard lustrous resin, varying in hue from an almost colourless transparent mass to a bright yellowish-brown. When dissolved in alcohol, spirit of turpentine or other suitable solvent, it forms a valuable varnish. Copal is obtained from a variety of sources; the term is vaguely used for resins that, though similar in physical properties, differ in their constitution and are altogether distinct as to their source. In Brazil and other South American countries, copal is obtained from the tree *Hymenaea courbaril*, and other species. By far the most important from a commercial point of view is the Zanzibar or East African copal, yielded by *Trachylobium verrucosum*. The resin is found in two distinct conditions; (1) raw or recent ("jackass" copal) and (2) ripe or true copal. The raw copal obtained directly from the trees, or found at their roots or near the surface of the ground, does not enter into European commerce. It is sent to India and China, where it is manufactured into a coarse varnish. The true or fossil copal is found embedded in the earth over a wide belt of the mainland coast of Zanzibar, on tracts where not a single tree is now visible. It is not found at a depth greater than four feet, and occurs in pieces varying from the size of small pebbles up to masses of several ounces in weight; occasionally lumps weighing four or five pounds have been obtained.

Kauri copal is found in New Zealand, which exports large quantities. It is derived from the kauri pine (*Agathis australis*), and, like the East African copal, is found in the earth often far from living trees of this pine.

The dammar resins and the piney varnish of India are occasionally spoken of as copal.

See also RESINS.

COPALITE (COPALINE), also termed "fossil resin" and "Highgate resin," a naturally occurring organic substance found as irregular pieces of pale-yellow colour in the London clay at Highgate hill.

It has a resinous aromatic odour when freshly broken, volatilizes at a moderate temperature and burns readily with a yellow, smoky flame, leaving scarcely any ash.

COPÁN, the name of a small department in western Honduras, adjacent to Guatemala, and an ancient Maya ruined city. Population of department, mainly rural, was 126,191 in 1960; area 1,237 sq.mi. Despite much hilly to rough land, agriculture is significant and the department produces tobacco amounting to 65% of the national output. It is a relatively important producer of corn, sugar, beans, rice, coffee, swine and poultry. The departmental capital, Santa Rosa de Copán (pop. 7,963), in the eastern part of the department, is the centre of several agricultural districts. The small town of Copán (pop. 1,832), on the Copán river, is near the Guatemalan boundary and the ancient Maya city.

The Maya city of Copán was built during the old empire of the Mayas, which reached its height between A.D. 400 and 600. Excavation of Copán has been carried on especially by the Peabody museum of Harvard university and the Carnegie institution of Washington, D.C. The latter uncovered and restored the beautiful hieroglyphic stairway, two large pyramids serving as bases for temples, spacious courts, carved stone pillars or steles (calendars), and the gigantic sundial, on two hills to the east and west of the city. (C. F. J.)

COPE, EDWARD DRINKER (1840–1897), U.S. zoologist and naturalist known for his work in vertebrate paleontology, was born at Philadelphia, Pa., July 28, 1840, of Quaker parentage. After a brief professorship at Haverford college (1864–67) Cope devoted the rest of his life to exploration, research, writing and editorship. By 1871 he was embarked on his major work, the discovery and description of the extinct fishes, reptiles and mammals

of the western U.S., from Texas to Wyoming. He was one of the last of the zoological explorers of the American west to collect among hostile Indians with a rifle at his side. Even more exciting was the race for priority of discovery of fossil dinosaurs and titanotheres, which led to controversies with colleagues, notably O. C. Marsh (*q.v.*). Cope's interest in living fishes, amphibians, reptiles and mammals was second only to his special attention to the extinct forms. He was naturally drawn into evolutionary thinking, holding the Lamarckian views then widespread among paleontologists. As editor of the *American Naturalist* he commented and often engaged in controversy on almost every topic of scientific interest of his time. His bibliography includes more than 1,200 published books and papers, ranging from great quarto volumes to half-page editorials. He died at Philadelphia on April 12, 1897.

See H. F. Osborn and H. A. Warren, *Cope: Master Naturalist* (1931). (K. P. S.)

COPE (Pluviale), a liturgical vestment, a full-length cloak, worn at certain functions in place of the chasuble. *See* Vestments, Ecclesiastical.

COPEAU, JACQUES (1879–1949), French actor, stage director and dramatic coach of widespread influence, was born in Paris on Feb. 4, 1879. After a brief career as an art dealer, he became drama critic for *L'Ermitage* (1904–06) and for the *Grande revue* (1907–10). In 1909, with André Gide, Paul Claudel and others, he founded *La Nouvelle Revue Française* and edited it until 1914. His adaptation of Dostoevski's *The Brothers Karamazov*, written in collaboration with Jean Croué, was staged in 1911. In 1913 he founded the Théâtre du Vieux Colombier, where he produced works from many periods, from Shakespeare and Molière to his contemporary Paul Claudel. Notable in the repertory company were Charles Dullin, Louis Jouvet and Valentine Tessier. His theatre was antinaturalist, and his reconstruction of the Elizabethan apron stage without proscenium arch, and with simple screens to suggest locale was influential both in Europe and in the United States. Emphasizing the play rather than its trappings, he also concentrated on training actors until his company ranked with the Moscow Art theatre of Stanislavski. In 1917 he took his company to New York.

In 1923 Copeau left the Vieux Colombier and moved his acting school to Burgundy. Later he toured Europe with a company of young actors. He was director of the Comédie Française, 1940–41. He died in Beaune on Oct. 20, 1949.

COPENHAGEN (Dan. København, "Merchant's Harbour"), the capital of Denmark, lies on the eastern coast of the island of Zealand (Sjaelland) and on the northern part of the small island of Amager at the southern end of the Sound (Öresund) opposite Malmö in Sweden. Pop. (1960) 721,381. Area 83 sq.km. (32 sq.mi.). Greater Copenhagen consists of 22 independent municipalities (Copenhagen, Frederiksberg, Gentofte and 19 suburban municipalities) covering 583 sq.km. (225.6 sq.mi.) and with a population of 1,321,805. After World War II the growth of population was concentrated in the suburban municipalities. The inner parts of the two central municipalities (Copenhagen and Frederiksberg) were becoming less and less residential. They were completely built up, and their population figures were declining as their inhabitants settled in the suburbs.

The nucleus of the city is on low-lying ground between the sea and the old ramparts and moats, partly incorporated into public parks and gardens and into the citadel. West of the ramparts is a series of small fresh-water lakes, St. Jörgens Sö, Peblinge Sö and Sortedams Sö. Around the original city there are extensive and densely crowded districts (Vesterbro, Nörrebro, Österbro and Amagerbro) built after the removal of the ramparts in 1872. At the beginning of the 20th century former independent municipalities (the districts of Valby, Vigerslev, Vanlöse, Brönshöj and Husum on the Zealand side and Sundby on the Amager side) were incorporated into the city so that its area was trebled, and the municipality of Frederiksberg was completely encircled by Copenhagen. Various parks outside the old ramparts cover 0.6 sq.km. (.23 sq.mi.), the largest being Utterslev Mose, Faelledparken and Valbyparken.

The fertile island of Amager produces a large proportion of the vegetables for the capital. It was founded by several Dutch colonists in 1516, and some of its villages, such as Dragör, have a distinctive architecture, costume and dialect. An excellent harbour is provided by the natural channel between the two islands, and communication from one to the other is afforded by three modern bridges, the Langebro, the Knippelsbro and the Sjaellandsbro.

The heart of the city's life is the Raadhuspladsen (Town Hall square) where stands the great town hall, built in 1894–1905. From the square an old crooked shopping street—colloquially called Ströget ("the Sweep")—leads northeast to the former centre of the city, Kongens Nytorv ("King's New square"). This great square, with trees in the centre encircling an equestrian statue of Christian V, was laid out in the 17th century. Buildings of that date include Thotts palace, now the French embassy, and the Charlottenborg palace, now the Academy of Arts, which holds its annual exhibition of painting and sculpture in the adjacent Kunstudstilling (1883). Other buildings in Kongens Nytorv are the Royal theatre (1874) and several great commercial houses. Ströget passes through the oldest parts of the city where the streets still follow the medieval layout. Besides Ströget, other main streets leading to Kongens Nytorv are Bredgade and Store Kongensgade from the north and Gothersgade from the west. A narrow arm of the harbour (Nyhavn) lined with picturesque old gabled houses leads to Kongens Nytorv from the sea. From the southern end of the square a street called Holmens Kanal winds past the National bank to the Holmens Kirke (the naval church), originally erected as an anchor smithy by Frederick II but consecrated by Christian IV, with a chapel containing the tombs of the great admirals Niels Juel and Peder Tordenskjold.

Holmens Kanal crosses a bridge to Slotsholmen ("Castle Islet"), which is divided from the mainland by a narrow strip of water. It contains the Christiansborg palace, originally built during 1737–45 by Christian VI on the site of an older castle founded by Bishop Absalon in 1167. Twice destroyed by fire, in 1794 and 1884, the royal palace was rebuilt after 1907 for use on state occasions. After 1918 it was occupied by parliament, the supreme court and the foreign office. The palace chapel (1826) is adorned with works by the Danish sculptors B. Thorvaldsen and H. V. Bissen. In adjacent buildings are the central government offices. The exchange (Börsen), on the quay to the east, is an ornate, gabled building erected during 1620–40 and surmounted by a remarkable spire formed of four entwined dragons' tails.

Southeast of Christiansborg is the arsenal (Töjhuset), with its collection of armour, and the Royal library (national library) in which are housed R. Rask's famous Persian manuscripts and a unique Mongolian and Tibetan collection. In an adjacent building is the Arnamagnean collection of old Norse-Icelandic documents. The Thorvaldsen museum (1839–48), on the northwest corner of Slotsholmen, has an open court containing the sculptor's tomb, and most of his original works are in this museum.

On the mainland, immediately west of Slotsholmen, is the Prinsens palace, the residence of Christian V and Frederick VI when they were crown princes, which is now the National museum. This consists of six sections: the prehistoric collections, the Danish historical and folk museums, the ethnographical and the numismatic collections and the collection of classical antiquities. The collection of prehistoric Danish finds, in particular those of the Bronze Age, is most remarkable. In Nytorv ("New Market") is the former town hall (1815), now the city court, to the north of which is Gammeltorv ("Old Market"), the main square of the medieval town. From there an old street leads to the Vor Frue Kirke ("Church of Our Lady"), the cathedral church of Copenhagen. This church, on a 12th-century site, was rebuilt after the bombardment of 1807 and is adorned with marble works by Thorvaldsen, the most famous of which is the colossal statue of Christ.

Just north of the Vor Frue Kirke is the university (until 1933 the only one in Denmark), founded by Christian I in 1479, although its constitution dates from 1788. The modern buildings date from 1836 and include the university library. This has a new section in the modern University park in the Österbro district where are also the departments of medicine, dental surgery and pharmacy,

among others. Opposite the old university is St. Petri church, built in quasi-Gothic style with a spire 251 ft. high and after 1585 used as a parish church for the German residents of the city. A short distance to the northeast, in Köbmagergade, is Trinity church whose round tower (117 ft.), considered to be unique in Europe, was formerly used as an observatory. Toward Slotsholmen, Köbmagergade opens into the Höjbro-plads which contains an equestrian statue of Bishop Absalon and from which a bridge goes across a narrow arm of the harbour to Slotsholmen.

The area from Kongens Nytorv and Gothersgade, northeast to the moated citadel (1662–63) which guards the harbour, includes the palace of Amalienborg, the castle and gardens of Rosenborg and the Frederikskirke or Marble church. The last named was begun in the reign of Frederick V (1749) but was left unfinished until 1874, when it was purchased by a wealthy banker, who added the conspicuous dome. The four rococo palaces, of uniform design, encircling the neighbouring Amalienborg-plads, have been the residence of the king and the royal family from 1794.

Southwest from the citadel extends the line of parks on the site of the former fortifications, skirted on the inner side by wide boulevards, Östervoldgade, Nörrevoldgade, Vestervoldgade and, close to and parallel with Vestervoldgade, H. C. Andersens boulevard. The botanical gardens (1874) contain an observatory with a statue of Tycho Brahe; and the Rosenborg park, on the opposite and inner side of Östervoldgade, contains the palace of Rosenborg (1610–34), an irregular building in Renaissance style with a high, pointed roof flanked by four unequal towers. It is now a museum with fine collections of furniture, Venetian glass, oriental carpets and silver, including the famous silver drinking horn of Oldenburg (1474) and the crown jewels. The Vestervoldgade and H. C. Andersens boulevard flank the Raadhuspladsen from where several main streets radiate to vast residential quarters. H. C. Andersens boulevard runs across the harbour on the Langebro bridge to residential quarters on the island of Amager, its extension leading to Kastrup, the Copenhagen airport. The boulevard skirts the Tivoli pleasure garden and passes the Ny-Carlsberg Glyptotek with its very fine collection of old and new art. The quarter of Christianshavn skirts the harbour to the south and lies within the fortifications. It contains the Vor Frelsers Kirke ("Church of Our Saviour"), dedicated in 1696, with a curious 284-ft. steeple. From the western end of the Raadhuspladsen, the Vesterbrogade leads to the Central station, where there is a modern business quarter with an air terminal and hotel 21 stories high as its central point.

The western quarter contains the Frederiksberg park, with its palace, erected in the reign of Frederick IV and used as a military school. The park also contains a zoological garden. From H. C. Andersens boulevard, main streets lead to the modern northwestern residential districts, Brönshöj, Husum and Bispebjerg with the impressive Grundtvig church built during 1921–40 to commemorate the founder of the Danish folk high schools.

Copenhagen is the centre of several important learned societies, including the following: the Royal Danish Academy of Sciences and Letters, founded in 1742; the Royal Society of Nordic Antiquaries (1825), which is concerned with northern and Icelandic archaeology; the Royal Academy of Fine Arts, founded by Frederick V in 1754; the two Carlsberg foundations, established in 1876 and 1902 by the brewers J. C. and C. Jacobsen, which promote research and foster art. Among educational institutions besides the university may be mentioned: the Royal Veterinary and Agricultural school established in 1773 and adopted by the state in 1776; the technical high school (1829); the Royal Academy of Music (1867); the dental college (1888); the high school of pharmacy (1892); the Technological institute (1908); and a high school of commerce (1924).

J. ALLAN CASH

CONCERT HALL (1956), IN TIVOLI GARDENS, COPENHAGEN, DEN.

Churches other than Lutheran include: the Reformed church, founded in 1688 and rebuilt in 1731; the Roman Catholic church of St. Ansgarius, consecrated in 1842; and the Jewish synagogue in Krystalgade, which dates from 1833. Of the monastic buildings of medieval Copenhagen, traces are preserved in the names of the streets. The Franciscan establishment gives its name to the Graabrödretorv or Grey Friars' market; and St. Clara's monastery, the largest of all, which was founded by Queen Christina, is still commemorated in the Klareboder or Clara buildings.

Commerce and Industry.—Copenhagen is by far the most important commercial town in Denmark. Most of the country's foreign trade passes through the capital, while the transit trade is considerable. Copenhagen is, moreover, the headquarters of nearly all the steamship companies of Denmark. The harbour is mainly contained in the narrow strait between the outer Sound and its inlet, the Kalvebod Strand. Trading facilities were improved by the construction in 1894 of the Frihavn ("free port") at the northern end of the town which contributed largely toward the position of Denmark as an emporium of Baltic trade. The area of the free port is 0.66 sq.km. (0.25 sq.mi.) and that of the customs ports, 2.76 sq.km. (1.07 sq.mi.). The harbour has a total water area of 13.15 sq.km. (5.08 sq.mi.). More than 30,000 ships arrive at Copenhagen annually with more than 15,000,000 net registered tonnage.

Copenhagen is connected by rail, including train ferry, with Oslo and Stockholm to the north, and by rail with practically all the principal cities to the south. The Copenhagen airport (6½ mi. from the city centre) is one of the most important in northern Europe. International and intercontinental routes include one to Los Angeles via Greenland and another to Tokyo via the north pole.

The chief imports are raw materials, machinery and other equipment. The principal exports are agricultural products, machinery (*e.g.*, marine engines, cranes, refrigerators, dairy machinery, cement-making apparatus, made in the city), iron and steel goods and chemicals. Nearly half the population of Copenhagen is engaged in industries and handicrafts including shipbuilding, the manufacture of diesel engines and machinery, canning and brewing (Carlsberg and Tuborg beer). Special mention may be made of the Royal Copenhagen porcelain factory, the Bing og Gröndahl china factory and the Georg Jensen hand-wrought-silver works.

History.—Excavations show that the site of the inner town of Copenhagen has been inhabited for 6,000 years. About the year 1000 the fishing hamlet Havn was known as a place of commercial and strategic significance because of its position near one of the best natural harbours in northern Europe on one of the principal European trade routes. In 1167 Bishop Absalon of Roskilde, the foster brother of King Valdemar I, built a castle to protect the citizens against hostile fleets. The ruins of this castle can be seen in the cellars of the castle of Christiansborg. In 1254 the first civic charter was granted by the bishop of Roskilde. The city played an important role in the wars with the Hanseatic league and was several times attacked. It remained in the possession of the bishops of Roskilde till 1417 when it passed to the crown, which, in 1443, granted the city a royal civic charter. Two years later the city became the residence of the king. In 1479 the university was founded, and soon after the naval base and naval shipyards were established.

During the years of the civil and religious wars between 1523 and 1536 the city was often attacked. In the reign of King Christian IV (1588–1648) foreign trade grew immensely and

magnificent castles and other buildings were erected. In the wars with Sweden (1657–60) the whole country with the exception of Copenhagen was occupied and for two years (1658–60) the city was besieged in vain by the Swedish king Charles X Gustavus. After the peace of Copenhagen (1660) the king yielded to the demands of the citizens for the abolition of the privileges of the nobility, and in 1661 he granted royal privileges to Copenhagen including the establishment of a city council of 32 men elected by the leading citizens.

Both in 1728 and in 1795 great fires reduced considerable parts of the city to ashes. To prevent an eventual Danish closing of the Baltic a British fleet attacked Copenhagen in 1801 under the command of Sir Hyde Parker and Lord Nelson (see *Battle of Copenhagen*, below). In 1807 the capital was bombarded for three nights by the British in order to force the Danes to give up the Royal Danish Navy to England. On March 21, 1848, the city council went to the king to demand a free constitution for the country and this constitution became law in 1849. It contained a clause which declared "the right of the local governments, under the supervision of the state, to manage their own affairs." This clause gave rise to the new city statutes of 1857, which attained their final form in 1938.

In World War II Copenhagen was occupied by German troops from April 9, 1940, to May 5, 1945. The Danish resistance movement grew up during 1941. The Royal Air Force bombed the main shipyards and completely destroyed the headquarters of the Gestapo in March 1945 and the capital was liberated by British troops in May. (Ed. H.)

Battle of Copenhagen.—On Dec. 16, 1800, Russia, Prussia, Denmark and Sweden, backed by France, formed a league to resist a British claim to the right of search at sea. Britain retaliated by sending a fleet to the Baltic on March 12, 1801, under Sir Hyde Parker, Lord Nelson being his second in command (*see* Nelson, Horatio Nelson, Viscount). Denmark was sent an ultimatum to withdraw from the league. In the event of refusal, Parker was ordered to destroy or neutralize the country's naval strength. Denmark was defiant, and Copenhagen was put into a state of defense. On hearing the news, Nelson urged an immediate attack, recommending as an alternative that part of the fleet should advance up the Baltic to attack the Russian fleet. Parker was unwilling to venture up the Baltic with Danish forces unsubdued behind him or to divide his force, and finally agreed to an immediate attack on Copenhagen.

After the fleet entered the Sound it was engaged by the batteries of Kronborg castle, ineffectively because the Swedes did not second their opposition from the eastern side. The fleet brought up under the shelter of Hven on March 30, and the operation was planned. Because of the shallow water in the approaches to Copenhagen, the heavier ships would take no part in the direct attack on the floating batteries and forts. This was entrusted to Nelson with 12 sail of the line and smaller vessels. The Danish position was particularly strong at the northern end where the heavy guns of the Trekroner battery were located. Nelson's plan was first to advance his force to the southern end of the Middle Ground, the great shoal opposite Copenhagen; then, when the wind changed, to move northward along the Danish line, blasting it as he went. Parker, with the heavier ships, would lie off the entrance to the harbour, ready to prevent any sortie from seagoing squadrons.

On April 1, 1801, Nelson successfully navigated his force from north to south of the Middle Ground. Early on April 2 the wind changed and he went into battle, advancing along the Danish line, the frigates leading under Capt. Edward Riou. Three ships went aground on the shoal and Riou was left to bombard the Trekroner with only a light squadron. For several hours fighting was severe, and so critical did Nelson's position seem that Parker signaled him to disengage. Nelson took no notice (this being the occasion when he put his telescope to his blind eye), but Riou with his frigates withdrew from his exposed position and was killed in the process. Early in the afternoon Danish fire slackened, and Nelson sent a flag of truce ashore to the crown prince, regent of Denmark. Firing ceased and negotiations were begun for a formal armistice, made easier for Denmark as a result of the assassination of the emperor Paul of Russia, the most forceful member of the league. Both sides had suffered; there were about 900 English and 1,700 Danish casualties. Nelson was in charge of negotiations and he officially replaced Parker on May 5. A convention was agreed in June, which ended the immediate campaign.

(O. M. W. W.)

See also references under "Copenhagen" in the Index volume.

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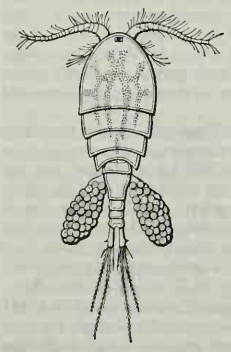
COPEPODA, one of the subclasses of the Crustacea (*q.v.*), the members of which, for the most part of microscopic size, are abundant in the sea and in fresh waters.

Importance.—They form one of the most important constituents of the plankton and it would be difficult to find a sample taken with the tow net in any part of the world that did not contain some representatives of the group. The bottom-living (benthic) species, which have been less studied, are not so numerous as individuals but probably include more species than the open-sea (pelagic) forms. A ten-quart pail of wash water from the sand of Katama bay, Martha's Vineyard, yielded 800 sand-dwelling copepods distributed among 25 species, with one exception (Cyclopoida) all Harpacticoida (*see* below). A large number of Copepoda are parasitic on other aquatic animals of all classes; these exhibit a wide range of modification in structure and life history. Copepods, in the economy of the sea, rank perhaps first as food for other marine animals because of their abundance; *Calanus* species, particularly *C. finmarchicus*, are an important link in many marine food chains. (*See* also Marine Biology; Plankton.)

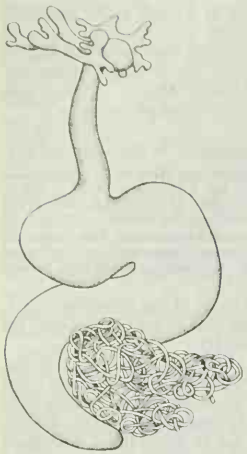
Structure and Natural History.—The typical free-swimming Copepoda have usually a somewhat pear-shaped body, divided into segments (somites) and narrowing behind to end in a caudal (tail) fork. There is no distinct carapace (a bony or horny dorsal shield), although one or two of the body somites are coalesced with the head. There are four or five pairs of two-branched, oarlike, swimming "feet." The unbranched antennules are generally large and many-jointed, the antennae smaller, sometimes two branched, and both are used in swimming. The mandibles are often of very primitive structure, the two-branched head appendage (palp) retaining the form and to some extent the function of a swimming "foot." The unpaired or larval (nauplius) eyespot is usually present (paired eyespots are not developed in the typical Copepoda). The eggs are usually carried by the female, cemented together into one or a pair of masses (ovisacs) attached to the genital openings. The young are hatched, as a rule, in the nauplius stage and attain the adult form by the successive addition of somites and appendages without any very sudden change. The antennules, antennae and mandibles may retain in the adult copepod, more nearly than in any other Crustacea, the form they have in the nauplius stage.



FROM SARS "CRUSTACEA OF NORWAY," BY PERMISSION OF THE BERGEN MUSEUM

FIG. 1.—CYCLOPS VULGARIS
Female, carrying a pair of egg masses

The parasitic habit has been acquired in the evolution of many unrelated families of Copepoda and the modifications of structure and of life history to which it has led are correspondingly diversified. In some parasites the power of swimming has been retained and the general form does not differ greatly from that of free-living species, the mouth parts only becoming modified for suck-



BY COURTESY OF THE RAY SOCIETY FROM SCOTT "BRITISH PARASITIC COPEPODA"

FIG. 2.—LERNAEA BRANCHIALIS
One of the Lernaeopodoida, a parasite found on the gills of the cod and other fishes. Above are the branched root-like processes of the head region, which are buried in the tissue of the host, and below the body proper are the two intertwined tubular egg masses

ing the juices of the host. In many other cases the male remains free swimming and little modified while the adult female has a wormlike or distorted body and loses most of the appendages. In others, again, the minute and degenerate male is attached, like a secondary parasite, to the body of the much larger female. In all cases, probably, the earliest stages are free swimming while the adults may be sedentary parasites. Some life histories are more complicated, as in the family Monstrillidae, in which only the later larval stages are endoparasitic, living in annelid worms, while the early larvae and the adults are free swimming. The latter do not feed, neither mouth parts nor alimentary tract being developed; like the May flies, they exist only for reproduction.

In the Lernaeidae there are in the female two parasitic phases, passed on two different species of fishes, with a temporary free-swimming phase intervening. Some of the parasitic Copepoda are much larger than any of the free-living species. The largest are species of *Pennella*, parasitic on whales, that sometimes exceed a foot in length.

Branchiurans, Problematical Relatives.—A small group of Crustacea ectoparasitic (parasites on the outside) on fish, both fresh-water and marine, and heretofore considered an order of Copepoda, the Branchiura (carp or fish lice), have been elevated to the rank of subclass, comprising an order Arguloida, named after the typical genus *Argulus*. Branchiurans differ from copepods in having paired compound eyespots, which, although characteristic of many Crustacea are not possessed by copepods; in lacking an ovisac in the female, the eggs being deposited on some suitable surface (a few copepods shed their eggs directly into the water); and in having the larvae, which much resemble a partly developed *Caligus*, well developed when hatched. Generally speaking, the broad, flat, oval body of branchiurans is not unlike that of some copepods. The segmentation of their body corresponds closely to that of the copepods; the appendages also are similar in number and grouping, but differ in having on some of the legs of some species an inward extension of the exopodite (the lateral branch of the two-branched appendage) not found in the Copepoda. On the underside of the head there is, in most of the species, a pair of suckers which are shown by their development to be modified maxillae (jawlike mouth parts). In front of the mouth in the genus *Argulus* is a sharp protrusible spine connected with a supposed poison gland.

Classification.—As the parasitic Copepoda do not constitute a single order and the details of the distribution of many of them among the free-living families have still to be worked out, the classification of the Copepoda is not yet settled. A working classification, however, recognizes seven orders: the Calanoida, almost exclusively planktonic; the Harpacticoida, for the most part bottom living; the Cyclopoida, both free swimming and parasitic; and the Notodelphyoida, Monstrilloida, Caligoida and Lernaeopodoida, exclusively parasitic. (W. T. C.; W. L. Sr.; X.)

COPERARIO, JOHN (real name, COOPER) (*c.* 1575–1626), English violist, lutenist and composer, especially of music for viols. Sometime before 1604 he went to Italy and, as a result, Italianized his surname and became influenced by the Italian manner of playing and composition. After returning to England he became musical tutor to the children of James I and to Henry and William Lawes. He was later appointed royal lutenist and composer. He died in London in 1626.

Coperario composed songs and music for masques but is most famous for his fantasias for viols. These fantasias are more sectionalized than those of his contemporaries and show great contrapuntal ingenuity. Some are scored for "violins," an almost unique requirement in English music of this period. He published two collections of compositions (1606 and 1613) and contributed two anthems to Sir William Leighton's *Tears or Lamentations of a Sorrowful Soul* (1614). (A. D. F.)

COPERNICUS, NICOLAUS (MIKOLAJ KOPERNIK) (1473–1543), Polish astronomer, propounded the Copernican theory which revolutionized planetary astronomy and laid the foundation stone for modern developments. He was born on Feb. 14, 1473, at Torun on the Vistula river where his father was a merchant of some social standing. In 1491 Copernicus went to the University of Cracow. There he came under the influence of the mathematician Wojciech Brudzewski (1445–97), a supporter of the geocentric system of Ptolemy, who is believed to have awakened his genius. Copernicus probably returned home in 1494, and his maternal uncle Lucas Waczenrode, elected bishop of Ermeland (Warmia) the same year, wished to confer on his nephew a canonry of Frauenburg (Frombork). He thus sent him for further training in Italy and in 1497 Copernicus became a student at the Natio Germinorum at Bologna. For three and a half years he studied Greek, became acquainted with the writings of Plato, and in due course was closely associated as friend and assistant with the astronomer Domenico Novarra of Ferrara (1454–1504) in spite of their disparity of age. Copernicus was thus encouraged to observe the heavens and his first recorded observation (an occultation of Aldebaran) was made on March 9, 1497. Copernicus went to Rome in the spring of 1500, the year of the great jubilee, and there he gave a course of lectures in mathematics. He had been elected (by proxy) a canon of Frauenburg in 1497 and in 1501 he returned to take his seat on the cathedral chapter. This year saw him return again to Italy, under special leave of absence, to continue his studies. He entered the University of Padua where, enrolled in the register of Polish students, he studied both law and medicine and, except for a short break in 1503 when he was granted the degree of doctor of canon law at Ferrara on May 31, he spent almost four years in Padua. Copernicus returned to Poland in 1503 and, after his stay in both Bologna and Padua, can be said to have been in possession of all the knowledge of the day in mathematics, astronomy, medicine and theology. On his return he revisited Cracow and later acted as adviser to his uncle, the powerful bishop of Ermeland, until the latter's death in 1512. Copernicus remained at Frauenburg acting as representative of the cathedral chapter, his medical skill being used especially for the poor. His fame as an earnest student of astronomy spread and in 1514 he was invited to give his opinion on reform of the calendar which was then being considered by the Lateran council, but he refused to express any firm views for he was of the opinion that the positions of the sun and moon were not known with sufficient accuracy to permit of a proper reassessment of the position.

Soon after his return from Italy, Copernicus appears to have planned a program of astronomical work. Although he carried out no extensive program of observations, he made such measurements as would enable him to redetermine the elements of the orbits of the sun, moon and planets. He published 27 such observations made over the years 1497–1529 and a few others have been found entered in books from his private library.

After settling in Frauenburg Copernicus became increasingly dissatisfied with the Ptolemaic system of astronomy. He was not alone in this dissatisfaction; indeed he himself said that the many divergent views prevalent in his day gave him cause for profound thought. These difficulties had arisen as the accumulated observations on the position of the sun, moon and planets had made it necessary to elaborate the arrangement of deferents and epicycles which the Ptolemaic system contained. It was therefore an increasingly laborious task to compute the future positions of these bodies and, of course, much of the elegance of the Ptolemaic hypothesis was lost. Ptolemy's system contained not only some

original work but also a synthesis of the views of previous Greek philosophers and was based on a purely geocentric basis. By the 16th century this geocentric idea had become not only firmly entrenched in astronomical thought but also had the virtual standing of an article of faith. Although certain Greek philosophers had, as far back as the third century B.C., suggested that the sun and not the Earth was the centre of the universe, their ideas had not been developed. However Copernicus concluded that, in view of the plethora of epicycles necessitated by the Ptolemaic system so that it might still account for the observed motions of heavenly bodies, it must contain some basic error. In consequence he read many original Greek authors and discovered that heliocentric hypotheses had been suggested. The idea of a moving Earth seemed absurd at first but when Copernicus used this assumption he found that a much simpler and aesthetically superior system resulted even though, as might be expected, he still believed that the planets moved with uniform circular motion. After many years of labour he became convinced of the truth of his new ideas, but made no attempt to publish them. It was only the efforts of his friends and, more particularly, those of his pupil and disciple Georg Joachim Rhäticus (1514–76), who studied with him for two years, that finally resulted in the publication in 1543 of the great *De revolutionibus orbium coelestium*. Although not widely accepted at once, the heliocentric views of Copernicus, as expounded in this work, in due course exerted a vital influence on astronomy. Thomas Digges (?–1595) appears to have been the first English supporter of the Copernican teachings, and the work of Kepler and Galileo helped, of course, to bring general acceptance.

However in 1530 Copernicus circulated a manuscript, the *Commentariolus*. This was, in effect, a summary of his ideas but it contained no diagrams or calculations. Lectures on the principles which the manuscript expounded were given in Rome by Johann Albrecht Widmanstadt, Pope Clement VII approved and a formal demand for publication was made. In 1540 Rhäticus, who himself had published an exposition entitled *Narratio prima de libris revolutionum*, was permitted to take the complete manuscripts to Nürnberg for printing. Because of opposition from Luther, Melanchthon and others, Rhäticus left Nürnberg and went to Leipzig. He passed on the task of publication to Johannes Schöner and Andreas Osiander. The latter corresponded with Copernicus but, apparently fearing severe criticism of views which considered the Earth as having an annual motion around a stationary sun, Osiander inserted on his own responsibility a preface which emphasized that the heliocentric hypothesis was only a convenient means for simplifying planetary computation. A careful examination of the text makes it clear, however, that Copernicus himself really believed that the heliocentric theory, which originally he had viewed with disfavour, was a true picture of the system of the sun and planets. He placed the orbits of Mercury and Venus next to the sun, the Earth followed with the moon circling around it, then came the orbits of Mars, Jupiter and Saturn with the sphere of fixed stars outside. The *De revolutionibus* was written in six sections or books, the first proving that the earth is spherical and moving, as well as containing some remarks on spherical trigonometry and a catalogue of stars. In the second the ecliptic is discussed; the third deals with precession and the apparent motion of the sun. The fourth book concerns the moon and in the fifth and sixth the planets are discussed. The whole work was not completed until 1543 and is believed to have been brought to Copernicus on his deathbed. Copernicus died at Frauenburg on May 24, 1543.

Copernicus also published, in 1509, a Latin version of Greek epistles by Theophylact (fl. A.D. 610–629), and an exposition of principles of currency reform for certain Polish provinces was written in 1525 but not published until 1816 at Warsaw.

See ASTRONOMY: *History of Astronomy; see* also references under "Copernicus, Nicolaus" in the Index volume.

BIBLIOGRAPHY.—The only contemporary biography of Copernicus, which was written by Rhäticus, has perished. Various biographies have been published, especially in connection with the quatercentenary of 1943. These are: A. Armitage, *Copernicus, Founder of Modern Astronomy* (1939); S. P. Mizwa, *Nicholas Copernicus,* Kosciuszko Foundation (1943); Victoria University College, Wellington, N.Z., *Quadricentennial Addresses* (1943); J. Rudnicki, *Nicholas Copernicus,* Copernicus Quatercentenary Celebration Committee (1943). Other works are: L. Prowe, *Nicholas Copernicus,* 3 vol. (1883–85); E. Rosen (ed.), *Three Copernican Texts: Commentariolus, Letter Against Werner* and *Narratio prima of Rhäticus* (1939). A facsimile text of *De Revolutionibus* and a reprinted text (Latin) with notes were prepared by F. Kubach (1944). (CN. A. R.)

COPIAPÓ, capital of the north Chilean province of Atacama (*q.v.*), is located about 35 mi. from the coast in the fertile Copiapó river valley, an irrigated oasis which has been farmed at least since the Inca period. Pop. (1960) 37,224 (mun.). It is perhaps the most attractive of the northern cities with architecture that retains the provincial 19th-century style; the buildings are not original but were rebuilt after destruction by the serious earthquakes of 1819, 1822, 1851, 1918, 1922 and 1939. Settled about 1540 on orders of Pedro de Valdivia, the community was elevated to *villa* status in 1744, at which time it became San Francisco de la Selva de Copiapó. The settlers of Copiapó explored much of the nearby Atacama desert (*q.v.*). Their discovery and development of copper deposits and Juan Godoy's discovery in 1832 of the rich silver lode near Chañarcillo resulted in the town becoming a significant mining and political centre. Its position and wealth were also exemplified by the Caldera and Copiapó railway (one of the first in South America), built in 1850–51 by the American William Wheelwright (*q.v.*).

Local power and prestige, which had gradually eclipsed between 1875 and 1925, was fostered anew by copper mining. A local boon has been the construction and operation (1951) of the government's Paipote copper smelter, where there is a good mining school.

Railway and all-weather roads connect the city to the port and bathing resort of Caldera and to the adjacent provinces and Santiago. A road also connects with Tinogasta, Arg. The city has an airport. (J. T.)

COPING, in architecture, a capping or covering for the top of a wall to prevent the entrance of water. In those countries and times in which parapets were common, coping design became of great importance, especially in Gothic work, where copings were usually of stone with a steeply sloped, and sometimes molded, profile. Copings may be made of stone, brick, tile, slate, metal, wood or thatch. They are usually sloped so as not to hold water, and projected beyond the face of the wall they cover in order to prevent the wall below from becoming saturated.

COPLAND, AARON (1900–), U.S. composer whose great achievement is a distinctive musical characterization of American subjects in an expressive modern style, was born in Brooklyn, N.Y., Nov. 14, 1900. He studied harmony and counterpoint in New York with Rubin Goldmark (1917–21), and free composition and orchestration with Nadia Boulanger (1921–24) in Paris. His first published work, *The Cat and the Mouse* for piano (1919), is impressionistic in style. Upon his return to America, he wrote a symphony for organ and orchestra (1924). Much more advanced was his *Music for the Theater* for small orchestra (1925), employing asymmetric rhythms with striking effect. On Jan. 28, 1927, Copland was soloist in his piano concerto with the Boston Symphony orchestra under S. Koussevitsky, which produced a sensation because of its outspoken jazz idiom.

Then followed works of distinct American connotations. *Lincoln Portrait* for speaker and orchestra (1942) embodied thematic materials from contemporary songs; the ballet *Appalachian Spring* (1944) also utilized American tunes. Mexican folksongs form the materials of the tone poem *El Salón México* (1936), and Cuban rhythms permeate the *Danzón Cubano* for two pianos (1942). The ballets *Billy the Kid* (1938) and *Rodeo* (1942) make use of western cowboy tunes. In all these pieces the folksong materials are reworked in a highly individual manner. His operas *The Second Hurricane* (1937) and *The Tender Land* (1954) are also based on American subjects.

Much more austere are Copland's instrumental works: of these, the most important are *Symphonic Ode* (1929; revised in 1955); *Short Symphony* (1933; also arranged as a sextet for clarinet, piano and string quartet); and *Third Symphony* (1946), in which a quasi-atonal tension is enhanced by extremely mobile rhythms. In his *Quartet for Piano and Strings* (1950) Copland applies a

thematic series of 12 different notes. His *Piano Variations* (1930) and *Piano Sonata* (1941) are significant as examples of pure constructivism. The song cycle *Twelve Poems by Emily Dickinson* (1950) introduces a vocal line in widely disjunct intervals sustained in a framework of inherent tonality.

Copland wrote incidental music for the play *Quiet City* (1939) and for the films *Of Mice and Men* (1939), *Our Town* (1940), *The Red Pony* (1948) and *The Heiress* (1949); he also is the author of *What to Listen for in Music* (1939), *Our New Music* (1941), *Music and Imagination* (1952) and *Copland on Music* (1960). He traveled widely as conductor and lecturer in America, Europe, Russia and the far east.

See A. Berger, *Aaron Copland* (1953); J. F. Smith, *Aaron Copland* (1955). (N. Sy.)

COPLEY, JOHN SINGLETON (1738–1815), American-British painter, best among the pre-Revolutionary painters, was born (probably in Boston) on July 3, 1738. In 1748 his widowed mother married Peter Pelham, the limner and engraver, and Copley thereby had direct contact with painting, engraving and music. At 15 Copley signed an oil portrait and his only known engraving. He soon mastered miniature painting and pastel, with admirable results. His final decade in America (1764–74) was filled with portrait commissions and marked by two events important for him. In 1766 he sent "The Boy With the Squirrel" (privately owned) to London, where it received discriminating praise. In 1769 he married Susannah Clarke, daughter of a rich Boston merchant. His mature American style, exemplified in "Jacob Hurd" (Cleveland museum) and "Mrs. Thomas Boylston" (Harvard university), manifests strong drawing and rich colour in impressive designs.

A stay in Italy (1774–75) broadened his style. Settling in London, he succeeded (1778) in transcending portraiture with the notable "Watson and the Shark" (Boston museum). Elected to full membership in the Royal Academy (1779), he had a decade of fame and prosperity, in spite of several quarrels, from "The Death of Chatham" (National gallery, London) to "The Siege of Gibraltar" (Guildhall, London). His earlier painstaking technique was now lightened by considerable fluency. Thereafter skill and fortune declined; in his last years he experienced financial difficulties and suffered ill-health.

Copley died in London, Sept. 9, 1815.

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COPPÉE, FRANÇOIS (1842–1908), French author, achieved success with his play, *Le Passant* (1869), and as a poet of the Parnassian school, but later became known as the *poète des humbles*. He was born in Paris, Jan. 26, 1842; held a number of posts, including that of archivist of the Comédie Française (1878–84); was elected to the Académie Française (1884); and died in Paris, May 23, 1908. From 1867 he published poems, plays, contes and novels, and achieved popularity by expressing commonplace emotions memorably. His reconversion to Roman Catholicism, described in *La Bonne Soufrance* (1898), and the part he played with the extreme nationalists in the Dreyfus case, added to his fame, which has not, however, been sustained.

Coppée also wrote *Oeuvres completes*, 4 vol. (1890–1900).

See biographies by M. F. A. de Lescure (1889) and L. Le Meur (1932).

COPPER, one of the most useful of the nonferrous metallic elements, was discovered and first used by Neolithic man during the late Stone Age. The exact time of this discovery will probably never be known, but it is believed to have been about 8000 B.C. Copper is found in the free metallic state in nature and this native copper is the material which Neolithic man used as a substitute for stone. From it he fashioned crude hammers and knives and, later, other utensils. The malleability of the material made it relatively simple to shape implements by beating the metal into the desired shape. Pounding hardened the copper so that keener and more durable edges resulted and the bright reddish colour of the metal and its everlasting qualities made it highly prized.

The search for copper during this early period led to the discovery and the working of deposits of native copper. Sometime after 6000 B.C. the discovery was made that the metal could be melted in the campfire and cast into the desired shape. Then followed the discovery of the relation of metallic copper to copper-bearing rock, and the possibility of reducing ores to the metal by the use of fire and charcoal. This was the dawn of the metallic age and the birth of metallurgy. (*See* Metallurgy: *History.*)

The early age of copper probably had its greatest development in Egypt. As early as 5000 B.C. weapons and implements left in graves for the use of the dead were of copper. Definite records have been found of the working of copper mines on the Sinai peninsula by King Snefru about 3800 B.C., and the discovery of crucibles at these mines indicates that the art of extracting the metal included some refining. The art had also developed to the point where copper was hammered into thin sheets and the sheets in turn formed into pipes and other objects. During this period bronze made its first appearance. The oldest piece of this material known is a bronze rod found in the pyramid of Medum, the date of origin being generally accepted as about 3700 B.C.

Bronze, an alloy of copper and tin, possesses qualities of hardness and toughness superior to copper. This alloy was generally used as a material from which to fashion weapons and objects of art. The period of its extensive and characteristic use has been designated as the Bronze Age. From Egypt the use of bronze rapidly spread over the Mediterranean area; to Crete in 3000 B.C., to Sicily in 2500 B.C., to France and other parts of Europe in 2000 B.C. and to Britain and the Scandinavian area in 1800 B.C.

About 3000 B.C. copper was produced extensively on the island of Cyprus. These copper deposits were so great and so highly prized that control of the island passed successively to the Egyptians, Assyrians, Phoenicians, Greeks, Persians and the Romans. The Roman supply of the metal came almost entirely from that island, and the material was known as *aes cyprium* ("ore of Cyprus"), which was shortened to *cyprium* and later corrupted to *cuprum*. From this name comes the English name copper. The first two letters of the Latin name constitute the chemical symbol Cu.

When copper and bronze were first used in Asia is not known. The epics of *Shu Ching* mention the use of copper in China as early as 2500 B.C. but nothing is known of the state of the art at that time or of the use of the metal prior to that time. Bronze vessels of great beauty made during the Shang dynasty, 1765–1122 B.C., have been found, indicating an advanced art. The secret of the source of the metals, however, is probably forever locked in the sacred graves of the early Chinese.

The copper age in the Americas probably dawned between A.D. 100 and A.D. 200. Although native copper was mined and used extensively, some bronze made its appearance in South America, and the art developed slowly until after the arrival of Columbus and other explorers. Both North and South America passed more or less directly into the Iron Age.

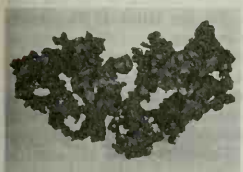
As man learned to fashion his weapons from iron and steel, copper began to assume another role. Being a durable metal and possessed of great beauty, it was used extensively for household utensils, for marine uses, water pipes and other purposes where resistance to corrosion was important. The unusual ability of this metal to conduct electric current accounts for its greatest use during the 20th century.

OCCURRENCE

Copper in nature occurs widely distributed and in many unusual places. It is found in many rocks and soils as well as in oceanic clays and river silts, in the ashes of seaweeds and many other plants, in the human liver and in many Mollusca and Arthropoda such as snails and spiders. It is believed that in plant life the metal is present because of mechanical storage, but that in Mollusca it forms the nucleus of a respiratory protein, and that in Arthropoda it is the nucleus of hemocyanin, which plays the same role as ferruginous hemoglobin in the red-blooded animals. Copper is also reported present in the sun and in many corals of the sea.

Ores.—The ores of copper are in general classified into three groups: the native coppers, the sulfide ores and the oxide ores.

Although commercial deposits of copper ores occur in every continent, four general areas contain about 90% of the world's known reserve. These areas are: (1) the Rocky mountain and Great Basin area of the United States; (2) the west slope of the Andes mountains in Chile and Peru; (3) the central plateau of Africa in the Republic of the (former Belgian) Congo and Northern Rhodesia; (4) the Pre-Cambrian shield area of central Canada and its extension into northern Michigan. These areas have been listed in the order of their importance, based on past production tonnages. The greatest known reserve of copper ore in one body is the deposit at Chuquicamata, Chile. Many lesser deposits are being economically exploited. These deposits occur widely dispersed, in Alaska, China, the U.S.S.R., Australia, Europe and other portions of North and South America and Africa. Collectively, they represent large reserves ensuring the world's copper supply for many years.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

SPRAY OF NATIVE COPPER FROM THE LAKE SUPERIOR REGION, UPPER PENINSULA, MICHIGAN

Of the major producing areas of the world, the porphyry copper deposits account for the greatest tonnage of metal. These are disseminated deposits in which the copper minerals are more or less uniformly scattered through a large body of rock. The copper minerals in the upper portion of the deposits are in general oxides, but are sulfides in the lower levels. The host rock is porphyry, schist or other rock; but since the first deposits discovered were in porphyry, the deposits have been named "the porphyry coppers." One of the largest deposits in the world is located at Bingham Canyon, Utah.

The great deposits of the Republic of the Congo and Northern Rhodesia are second in importance only to the porphyry coppers. These deposits are also disseminated, but are characterized by sharp delimitations by barren wall rock. The copper content of the ore is higher than the porphyry coppers, and in general the oxidized zones have been extensive.

The mines at Butte, Mont., had produced by the second half of the 20th century more copper than any other single area in the world. The copper minerals in these mines occur in well-defined veins and are chiefly chalcocite, bornite and enargite.

The large copper-ore deposits in eastern Canada are complex and

BY COURTESY OF KENNECOTT COPPER CORPORATION

ELECTRIC SHOVEL, USED IN STRIP MINING, WITH AN EIGHT-CUBIC YARD DIPPER CAPABLE OF LOADING 20 TONS EACH TIME THE BUCKET IS FILLED

TABLE I.—*General Classification of the Ores of Copper*

Name	Formula	% Copper (approximate)
Native copper ore:		
Native copper	Cu	99.9
Sulfide ores:		
Chalcocite	Cu_2S	79.9
Covellite	CuS	66.5
Chalcopyrite	$CuFeS_2$	34.6
Bornite	Cu_5FeS_4	63.3
Enargite	Cu_3AsS_4	48.4
Tetrahedrite	Cu_3SbS_3	46.7
Oxide ores:		
Cuprite	Cu_2O	88.8
Tenorite	CuO	79.9
Malachite	$CuCO_3 \cdot Cu(OH)_2$	57.5
Azurite	$2CuCO_3 \cdot Cu(OH)_2$	55.3
Chalcanthite	$CuSO_4 \cdot 5H_2O$	25.5
Brochantite	$CuSO_4 \cdot 3Cu(OH)_2$	56.2

are either copper-nickel or copper-zinc-lead ores. The copper-nickel ores are the most abundant and occur as the sulfides. These ores produce large tonnages of copper and the majority of the world's supply of nickel and platinum as a by-product. Other deposits contain many complex ores. Copper frequently occurs in the ores of zinc and lead and may be produced as a by-product of operations for the recovery of these metals. Deposits of native copper as small grains in amygdaloid or conglomerate rock occur in the state of Michigan. Chalcopyrite is found in massive pyrite in the Riotinto deposits in the province of Huelva, Spain, and also in the state of Tennessee.

COMMERCIAL PRODUCTION PROCESSES

The commercial production of copper is mainly by pyrometallurgical (smelting) methods or by hydrometallurgical (leaching) methods, usually followed by electrolytic refining or recovery. In general, the sulfide ores are treated pyrometallurgically, after flotation, and the oxide ores are treated hydrometallurgically. Most of the new copper produced by the latter 1950s was from sulfide ores. The sulfide minerals are usually found admixed with relatively large amounts of worthless rock or gangue. It is therefore economical to concentrate the valuable minerals into the smallest possible tonnage prior to smelting.

By the 1950s selective flotation was almost universally used on sulfide minerals for concentration, although gravity methods had been popular in the past. In selective flotation the finely ground ore mixed with water and selected reagents is subjected to violent agitation with air to produce a heavy froth. The reagents are so selected that great attraction exists between the surface of the valuable mineral particles and the air bubbles and only a small attraction between the gangue particles, which are readily wetted by the water, and the air. As a result the mineral particles cling to the bubbles of the froth and are carried to the surface while the gangue particles sink to the bottom of the container. It is necessary only to remove the froth from the container to separate roughly the minerals from the gangue material. Perfect separations are of course impossible, but with constant supervision, repeated treatment and exacting controls it is possible to concentrate 95% or more of the copper into 10% to 20% of the original weight, and to eliminate most of the gangue and much of the worthless sulfide.

The resulting concentrate containing the copper sulfides, some sulfides of other metals and a residue of gangue minerals if smelted in a reducing or neutral atmosphere with suitable fluxes will form two liquid layers. The upper layer is the slag which contains the gangue minerals and the fluxes, while the lower layer is a mixture of molten sulfides known as a matte (*see* below).

Some copper smelters continued to roast the concentrate before smelting, usually for the purpose of eliminating some of the sulfur from the concentrate by changing some of the sulfides into oxides and expelling the sulfur in the form of sulfur dioxide gas. The other purpose of roasting is to eliminate by volatilization as much as possible of the arsenic and antimony that may occur as impurities in the concentrate.

The partial elimination of sulfur from the concentrate will control the composition of the matte obtained upon smelting. When fusion takes place, all of the copper combines with sulfur to form

Cu_2S; the remaining sulfur combines with iron to form FeS. Thus, if some sulfur has been eliminated by previous roasting, only a part of the iron can go into the matte as FeS and the remainder will be rejected to the slag. At one time all smelters roasted the concentrates in order to get upon smelting a matte high in copper and low in iron, about 45% copper being considered optimum. By the latter 1950s most new plants charged the concentrates directly to the smelting furnace with the thought that it is preferable to accept a lower grade of matte in order to avoid the cost and inconvenience of roasting.

Roasting.—Roasting is generally carried out in multiple-hearth furnaces. These furnaces consist of a refractory-lined vertical shell from 14 to 25 ft. in diameter with a central vertical shaft. The furnace is divided into a suitable number of horizontal hearths through which centre or outside drop holes are provided. The charge is fed to the top hearth, and is slowly raked across the hearth from the centre to the outside by a system of arms and rakes fastened to the central revolving shaft. The movement on each hearth alternates from centre to outside so that the material travels across each hearth before dropping to the hearth below. The material leaves the furnace from the bottom hearth. Suitable ducts connect the upper portion of the furnace with a flue system for the evacuation of the gases and to supply a draft to draw air into the furnace. Air is admitted to the furnace through doors on the various hearths.

Ores of high sulfur content will usually roast autogenously; that is, once the furnace has been brought to roasting temperature the heat liberated by the burning of the sulfur will maintain the temperature without the use of extraneous fuel. Ores with a low sulfur content must have fuel burners located on suitable hearths. The temperature of the roast is maintained below the temperature of coalescence of the charge.

The reactions in the roasting furnace are oxidizing. Sulfur is oxidized to the dioxide and eliminated as such. Metallic sulfides, primarily those of iron but also some copper, on losing sulfur are left in the solid charge as the oxides. The resulting material, known as calcine, is a fine mixture of the sulfides and oxides of iron and copper, gangue material and nonvolatile impurities. The total sulfur content has been reduced to that desired for the subsequent smelting operation.

Matte Smelting.—The object of the first step in smelting is to produce a molten artificial sulfide of copper and iron. This material is known as matte and should contain all the copper, the desired amount of iron, and must have a specific gravity sufficiently high to ensure a clean separation from the gangue material, other undesirable compounds and the balance of the iron. Metallic oxides in igneous fusion react as bases and will combine with acid anhydrides to form stable compounds of relatively low specific gravity. These compounds, known as slags, are usually formed by the use of silica, SiO_2, as the acid anhydride. The formation temperature and the fluidity of the slag is a function of its composition. The action of the slag on the furnace lining is a function of its acidity. It is necessary then to balance the composition of the slag to secure the desired results. This is done by the addition to the furnace of selected materials to give a slag of the desired composition and properties. These materials are known as fluxes, and the most common are limestone, $CaCO_3$, or silica, SiO_2.

Matte is generally smelted in reverberatory furnaces. These are large oblong furnaces from 20 to 30 ft. in width and from 90 to 130 ft. in length. They are usually constructed with heavy silica brick side walls reinforced with steel buckstays and tie rods, and with a low roof of the sprung-arch type if of silica brick or of the suspended-arch type if of magnesite brick. The furnace is equipped with from four to eight fuel burners at one end and flue connections at the other end. The charge is fed through the roof near the burner end and the molten material flows toward the flue end, where it collects in a large pool. The slag, being the lighter material, rises to the top, where it is drawn from the furnace through a hole in the wall. The slag is usually discarded. The matte collects in the bottom of the pool and is held until needed in the subsequent operation, when it is drawn out through a tap hole near the bottom of the pool. Large quantities of fuel are used in these furnaces, and the temperature of the exhaust gases is high. Waste heat boilers are usually installed in the flue systems to recover a portion of this heat.

Matte may also be smelted in blast furnaces, but their use is restricted to a few locations. Although extensively used in the past, they are not easily adaptable to the smelting of the fine feed resulting from selective flotation. By the latter 1950s electric furnaces also were used for matte smelting.

Matte Converting.—Copper has a lower affinity for oxygen than has iron or sulfur. This, and the fact that the oxidation of iron and sulfur liberates large quantities of heat, is the basis of matte converting. Molten matte can be oxidized by introducing into it a stream of air. At the point where the air enters, iron, sulfur and copper will be oxidized. The copper oxide will immediately react with any iron sulfide still present to reform the sulfide of copper and form the oxide of iron. As air continues to flow through the molten mass, a time would arrive when all the iron would be present as the oxide, the copper as the sulfide, and the sulfur originally with the iron would have left the charge as sulfur dioxide. Since iron oxide will form a fusible slag with silica, it is necessary only to add to the molten mass sufficient silica to form the desired slag, and all the iron may be removed as an iron silicate slag while the heavy copper sulfide remains behind. The oxidation of the iron and its sulfur liberates sufficient heat to keep the material molten and melt the necessary silica and any other solid charge which it may be necessary to add. If air continues to enter the charge after the removal of the slag, the oxidation of the sulfur and the copper will continue and the copper oxide so formed will at once react with the copper sulfide remaining in the charge to form sulfur dioxide and metallic copper. These reactions liberate just sufficient heat to keep the charge molten. Ultimately a time will come when all sulfur has been oxidized, and metallic copper and a small amount of copper oxide will be present in the charge. Small amounts of minor impurities will also be present.

These reactions are carried out in the copper converter, usually of the Peirce-Smith type. These furnaces are a revolving refractory-lined horizontal drum about 13 ft. in diameter and about 30 ft. long. They are fitted with an opening at the top through which the furnace is charged and through which the gases escape when the furnace is in operation. Along one side is a large pipe which delivers compressed air to the furnace through a number of small pipes which enter the furnace through the side. These air ports are known as tuyères and are about $1\frac{1}{4}$ in. in diameter and located from 12 to 18 in. apart along the entire length of the furnace. Air enters the tuyères at about 14-lb. pressure per square inch. The tuyères are so located that when the furnace is revolved to allow charging, they are above the level of the molten material in the furnace, and when the furnace returns to operating position, they are below the level of the molten charge. This introduces the air into the molten charge in a number of fine streams.

The matte is charged to the converting furnace directly from the reverberatory furnace and the blow begins at once. Silica as a solid flux is added as the temperature rises, and the slag is poured from the furnace as necessary. More matte is added as slag is removed, and ultimately the furnace is nearly full of molten copper sulfide. At this time slagging is complete and the final blow begins. Oxidation continues until all the sulfur has been removed and molten copper remains. If this metal is cast and solidified the surface will take on a rough blistered appearance caused by the liberation of dissolved gases as the metal cools. For this reason the material is known as blister copper. Blister copper can be cast and shipped to refining plants or it can be charged molten to refining furnaces adjacent to the converting plant. The latter is the more common practice.

The slag formed in the converting operation will carry an appreciable amount of copper. To avoid loss of this copper, the converter slag is returned to the reverberatory furnace, where much of the metal is converted to the sulfide and joins the matte, and the balance of the slag leaves with the reverberatory slag.

Fire Refining.—Blister copper, in addition to copper oxide, contains small quantities of other impurities. These impurities are best removed by fire refining. The furnaces used for this pur-

pose are either small reverberatory-type furnaces or revolving furnaces similar to the copper converter. They are equipped with fuel burners which melt the charge, if necessary, and maintain it in a molten condition throughout the refining operation. Air is forced through the molten material to ensure complete oxidation of all impurities, and then the oxides are allowed to rise to the surface of the quiet pool from which they are skimmed and returned to the converter. The oxidizing treatment is followed by a reducing treatment known as poling. This is done by forcing the ends of green logs into the pool of molten metal. The highly reducing gases resulting from the destructive distillation of the green logs reduce most of the copper oxide present in the metal. During this operation frequent samples are taken from the bath, cast and examined to determine the degree of deoxidation. When the proper stage has been reached, the sample has a distinctive metallic rose colour. This metal is called tough pitch, and may be readily cast into dense slabs.

Commercial tough-pitch copper is usable in this form. It will, however, contain any gold and silver recoverable from the original ore and traces of other impurities which are detrimental in many uses. The gold and silver often make their recovery economically attractive, and the removal of other impurities to produce a pure metal adaptable to all uses accounts for the final state of purification.

Electrolytic Refining.—When an impure copper anode and a copper cathode are immersed in a solution of copper sulfate and an electric current is imposed across the cell, copper ions from the solution will migrate to the cathode and be deposited as metallic copper, and copper from the anode will enter the solution. For each ion deposited on the cathode, an ion will enter the solution from the anode. Impurities in the anode will be liberated and will settle to the bottom of the cell as a slime. The net result will be the ultimate transfer of copper from the anode to the cathode, resulting in a deposit of pure copper and the formation of a cell slime which contains the gold, silver and other insoluble impurities. The rate of the transfer of the metal will be proportional to the quantity of electricity passing through the cell in unit time, and the total weight of copper deposited on the cathode will be proportional to the total quantity of electricity in accordance with Faraday's law.

This principle of purifying or refining is extensively used, and the molten copper from the fire-refining furnaces is usually cast into suitable shapes and sizes to be used as anodes in electrolytic refining cells. The size and weight of these anodes vary greatly in different plants, usually from 350 to 700 lb. in weight, 30 to 40 in. long and 24 to 36 in. wide.

Two general systems of electrolytic refining are in use, the multiple system and the series system. Economic factors dictate the system which will be employed. In the multiple system separate anodes and cathodes are used, the cathodes consisting of thin sheets of high-purity copper known as starting sheets. In an individual cell all of the anodes are connected in one parallel group and all of the cathodes in another. In the series system no starting sheets are used, the electrodes of impure copper being in series in a single cell and serving as both anode and cathode. This allows the impure copper to be corroded from the face of an electrode while pure copper is deposited on the back. The multiple system is the most widely used.

Starting sheets for use in the multiple system are prepared in special electrolytic cells known as stripping tanks. In these tanks regular anodes are used, but the cathodes are smooth rolled copper sheets with lightly oiled surfaces. The pure copper deposit is stripped from the sheets when of the proper thickness, straightened and used as cathodes in the regular cells. The current density, the intensity of the current per unit area, influences the physical characteristics of the deposit. In general, the lower the current density, the finer the grain and the greater the strength of the deposit. Stripper tanks operate on relatively low current density, usually from 14 to 18 amp. per square foot. Starting sheets are stripped when about $\frac{1}{16}$ in. in thickness, and before insertion in the cells are fitted with copper strips at the top through which the bar serving as the electrical connection is passed.

The cells in the multiple system are connected in series. The number of cells in a single series is determined by the voltage drop across each individual cell and the total voltage at which the direct current is supplied to the system. The current passing through an individual cell amounts to several thousand amperes, and heavy conductors are required to carry it without overheating. These conductors, which lie along each side of the cell, are known as bus bars and are arranged so that the anodes contact the positive bus bar and the cathodes contact the negative bus bar. They are made of cast copper and are rectangular in cross section.

In operating the cells, the anodes are placed in position by an overhead crane; the starting sheets are placed by hand. The electrolyte is continually circulated through the system to prevent segregation of salts and to allow control of the composition of the solution and the removal of soluble impurities. Current density is usually between 18 and 24 amp. per square foot and is maintained until the cathode is about one-half inch in thickness. At this time the cathode is removed and a new starting sheet inserted. About four starting sheets are usually used for each anode and from 10 to 15 days are required for each cathode. When the anode has completely corroded, the remaining contact lugs and other scrap are remelted and recast into new anodes. The cell slimes are removed for treatment and the recovery of valuable materials.

The series system of refining usually employs electrodes smaller in size than those used for the multiple system, usually weighing about 100 lb. each. These electrodes are carefully cast and are sometimes rolled in order to make them as smooth as possible. The cells are larger than those used in the multiple system, and only the first and last of the electrodes are connected electrically. The current entering the tank at one end through the copper electrode passes through the electrolyte from electrode to electrode, corroding copper from the face of one and depositing it on the back of the next. This operation is allowed to proceed until nearly all the impure copper has been corroded, at which time the electrodes are withdrawn, and the small amount of impure copper remaining is scraped from the deposit of pure copper.

Electrolytic refineries are usually large plants consisting of several hundred cells, each using 25–35 anodes or electrodes. Large purification plants are often needed to maintain the proper analysis and specific gravity of the electrolyte.

After electrolytic refining, the cathodes are melted in furnaces similar to those used for fire refining or in electric furnaces, and are cast into the desired shapes for market. The most common forms are wire bars, cakes and ingots. This material is known as electrolytic copper and is suitable for practically all commercial uses. Special treatments can be used during the melting process for the production of oxygen-free copper. This involves the use of special apparatus to allow the melting and casting of the cathodes without any oxygen entering the copper:

Hydrometallurgy.—This involves the treatment of the ore with a suitable solvent which will take the copper into solution and leave all or a major part of the undesirable material unaltered. The copper must then be recovered in a relatively pure form from the solution.

The oxide ores of copper lend themselves to the foregoing treatment. Sulfuric acid readily dissolves the oxides of copper and has little effect on the common gangue materials, excepting some of the salts of iron. Many of the oxide ores are not amenable to concentration and it is necessary to treat or leach the ore as mined. The material is agitated or soaked with the leach solution. Elaborate systems of washing and filtering or settling are necessary to recover the optimum amount of copper.

The leach solutions are usually subjected to some type of purification for the removal of the soluble iron and other objectionable impurities. This often involves neutralization and oxidation followed by the removal of the precipitated ferric salts.

Direct leaching of sulfide concentrates can be achieved by the use of elevated temperatures and high pressures such as are attained in autoclaves. These procedures are usually limited because of cost to mixed nickel-cobalt-copper concentrates with high value; both acid and basic solutions are used.

Two systems of recovering the copper from the leach solutions are in general use: precipitation and electrolytic recovery.

Precipitation.—Since copper lies below iron in the electromotive series of the elements, iron will displace copper from the solutions of its salts. Metallic iron in any form if added to a solution of copper sulfate will enter the solution and displace metallic copper. This system of copper recovery is used where relatively small tonnages of copper are to be recovered and the smelting of the recovered copper is feasible. It is used extensively for the recovery of copper from mine waters.

The operation involves leading the solutions to be treated through suitable tanks or agitators in the presence of metallic iron. Scrap iron or detinned scrap from the manufacture of tin cans is most commonly used. Traps to collect precipitated copper are installed in the system. The spent solutions are usually discarded. The copper so produced is a fine brown powder and contains an appreciable amount of entrained iron and other impurities. Relatively high recoveries are made and the material lends itself readily to smelting with normal smelter feed.

In plants using pressure leaching techniques it is also quite feasible to precipitate copper from solution in the form of a granular powder by introducing hydrogen gas under high pressures.

Electrolytic Recovery.—When an insoluble anode and a copper cathode are immersed in a solution of copper sulfate and an electric current is imposed across the cell, copper will deposit on the cathode in the same manner as when a soluble copper anode is used. At the anode, however, a different reaction takes place. The hydroxyl ion (OH^-) of the water is oxidized with the liberation of oxygen leaving a surplus of hydrogen ions (H^+). The net cell reaction is the sum of the anodic and cathodic reactions and is the decomposition of copper sulfate and water and the formation of metallic copper, sulfuric acid and oxygen. This reaction is endothermic, absorbing heat. This heat, or its equivalent, is supplied by electrical energy theoretically amounting to 1.195 v. and is called the decomposition voltage of copper sulfate. It is necessary then to supply current to each cell at this voltage plus the necessary voltage to overcome the resistance of the electrolyte, contact losses and overvoltages. In practice this amounts to about two volts. The process requires large quantities of electrical energy.

Cathodes for these electrolytic cells are starting sheets prepared in a similar manner to those used in the multiple system of refining. Anodes vary greatly at different plants, the alloys of antimony and lead and the copper silicates being the most common. The electrolyte is continually circulated between the cells and the leaching plant in order to utilize the regenerated sulfuric acid, to allow purification of the solution and to avoid the electrolysis of solutions too depleted in copper sulfate. The cathode copper produced is of high purity and is melted and cast in the same manner as cathode copper from electrolytic refining.

Hydrometallurgical and electrolytic recovery plants are widespread over the world, the largest individual plants being located in Chile, Republic of the Congo and the state of Arizona. Most plants must adopt special methods and techniques to meet their individual problems and often combine in one plant many or all of the various methods for the winning of copper from its ores. (*See* also HYDROMETALLURGY.)

Secondary Copper.—As a result of its durability, large tonnages of scrap or reclaimed copper become available each year from obsolete or discarded machinery and equipment. This material is readily converted into usable metal by its addition to smelter feed, or by remelting and refining at secondary plants. *See* ALLOYS; BRASS; BRONZE. (J. P. SP.; A. W. S.)

MANUFACTURE, USES, ALLOYS AND PRODUCTION

Manufacturing Uses.—The major portion of the world's production of copper is utilized by the electrical industries; of the remainder the greater part is combined with other metals to form alloys. This leaves a comparatively small portion of the total production to be absorbed for general purposes.

The division of copper, including copper contained in alloys, among the principal industries using it is as follows in the U.S., the figures in parentheses indicating the approximate percentage of the total consumption used for that purpose:

Electrical manufactures, including generators, motors, electric locomotives, switchboards, light bulbs, etc. (22%); telephones and telegraphs, light and power lines (13%); other rod and wire (9%); automobiles, not including starting, generator and ignition equipment (10%); buildings, excluding electrical work (10%); manufactures for export (11%); other uses (25%). Uses of copper included in the last item, stated approximately in the order of tonnage consumed, are ammunition, radio and television, air conditioning, refrigerators, railroads, shipbuilding, screening, copper-bearing steels, radiators and heating, clocks and watches and numerous others.

Standard Electrolytic Copper.—Typical samples of electrolytic copper contain from 99.92% to 99.96% copper. About 0.03% oxygen is purposely left in the copper, since this amount will slightly improve the density and the conductivity. Copper in this condition is known as tough pitch. Its conductivity is 100% to 102% of the International Annealed Copper Standard (I.A.C.S.). On this standard, 100% denotes a resistance of 0.15328 ohm for a length of 1 m. weighing 1 g., at 20° C.; the I.A.C.S. was universally adopted for industrial purposes.

A relatively small but increasing amount of copper is manufactured free from oxygen, because this type has sufficiently greater ductility to make it better for severe working operations, and because it can be annealed in reducing atmosphere without developing porosity and brittleness. Removal of oxygen may be accomplished with a deoxidizing agent, such as phosphorus contained in a phosphor-copper alloy; this method leaves a little of the deoxidizing element in the copper, which in the commonest product lowers its conductivity enough to make it unfit for electrical conductors.

Other methods were developed of making copper free of oxygen with approximately the same conductivity as tough-pitch copper.

Copper Wire, Sheet and Strip.—For making copper wire, electrolytic copper is first cast into wire bars, which are made in several standard sizes varying in weight from 135 to 500 lb. The wire bars are then reheated to 700° to 850° C. and are rolled without further reheating to rods approximately $\frac{3}{8}$ in. in diameter. The rod is drawn cold into wire, through dies of successively smaller diameters until the desired size is reached. The dies are usually of tungsten carbide; for the finer wires diamond dies are often used.

Great advances have been made in the machinery used for wire drawing and multiple-die machines are in common use. In order to minimize oxidation and scaling, special types of furnaces are employed for annealing the coils between the drawing operations. A typical example is a gas-fired furnace chamber, the ends of which pass beneath water seals.

Much of the copper wire is marketed in the form of bare coils in the half-hard condition, but there is also a considerable tonnage which is subsequently covered with paper, fabric, rubber, plastic or other insulating material for use in the form of covered conductors. Much of the wire is also supplied stranded, and all these operations are carried out on special machines which are largely automatic in operation.

Copper cables, in many cases, have to undergo a special process to render them as resistant as possible to moisture, and at a later stage they may receive an outer protective covering, lead being the final protection in many instances. Lead covering is extruded onto the outside of the cable by means of a special extrusion apparatus. For immersion under water an additional protection sometimes has to be given in the form of hemp or metal armouring. Various designs of multiple-cored and other special types of cable are manufactured and supplied for various purposes. The electrical industries also use large quantities of bare copper strip for incorporation in electrical machinery. In the narrow widths and thicker gauges this form of the metal is produced mainly from wire bars which are rolled in a mill of a type similar to that used for the production of wire. In addition, copper strip of greater width and much thinner gauge is

produced in long lengths, and is usually supplied in the form of coils.

The term copper strip as distinct from copper sheet is usually assumed to apply to material less than 24 in. wide which is supplied in long lengths. The majority of the strip used is less than 12 in. wide. In the preliminary stages of manufacture, the copper castings are rolled hot, but in the later stages of manufacture all the rolling is carried out cold, the material being coiled on coiling drums on each side of the rolling mills. Material produced by this method is of very even gauge and possesses an exceptionally good surface finish. The coils can be handled easily and are in general use for the manufacture of stampings, both in the electrical and other industries. Copper strip is supplied in various degrees of hardness according to the rolling it has received subsequent to the last annealing. The usual grades of hardness or temper are termed soft, quarter-hard, half-hard, three-quarters-hard and hard. These various tempers are selected according to the amount of subsequent mechanical deformation to which they will be subjected. Copper sheets are produced by somewhat similar methods of manufacture; in the United States especially, the majority of copper sheets are made from electrolytic copper, but in Europe fire-refined arsenical copper is used frequently in the manufacture of sheets and plates.

U.S. and British practice is to use relatively small cast cakes of from 100 to 400 lb., which are rolled out and cut to size. Both hot-rolling and cold-rolling are practised, depending on the surface of the sheet required, but U.S. practice tended more and more to use cold-rolling for the final stages in sheet production, irrespective of the surface finish required. In Europe several finishes are marketed: the hot-rolled and descaled sheet is known as ordinary quality and has a distinct colour which is greatly valued in certain parts of the world. The red coloration is caused by a thin film of cuprous oxide, which is easily removed by immersion in dilute acid.

Cold-Rolling.—Cold-rolling is an operation carried out subsequent to hot-rolling, and gives a sheet with an exceptionally smooth, bright finish, suitable for working up into highly polished articles. Cold-rolled sheets are manufactured in a variety of tempers similar to those already quoted for strip copper. In Europe methods were developed to allow the use of large castings up to several tons in weight for sheet manufacture, and progress was also made in the manufacture by strip-rolling methods of much greater widths than had previously been attempted. In this method of manufacture the greater part of the rolling is a modified form of cold-rolling, and the resultant sheets show a surface finish which is smoother than that obtained by the ordinary methods of hot-rolling. In the thicker gauges, copper sheets find application in many industries, and are manufactured into pans and vessels of all kinds.

The high heat conductivity of copper is of great value for such purposes, in addition to which the malleable nature of the metal allows it to be worked into very intricate shapes. Where the metal is subjected to furnace gases and relatively high temperatures, it is generally considered that pure copper is not as satisfactory as arsenical copper containing approximately .5% arsenic. This applies also to the use of copper in locomotive fireboxes.

Extrusion.—Extrusion is commonly used as a method of manufacture of copper bus bars and similar elongated shapes of large or small cross section; also rods, either round, hexagonal or square, and some complex structural shapes of copper and copper alloys. In this process a billet is heated and then forced ahead, by the application of pressure, through a die, thus obtaining in one operation a cross section determined by the size and shape of the die.

Alloys of Copper.—In variety of uses these surpass all other nonferrous alloys and comprise mixtures of copper with zinc, tin, nickel, aluminum, lead, manganese and other elements. In some instances they consist simply of binary alloys formed by the addition of one other metal to copper, but in many cases two or more metals may be added in order to impart certain special properties. The most important series of alloys in which copper forms the chief constituent are the brasses (copper-zinc), bronzes (copper-tin) and nickel silvers (copper-zinc-nickel). For these alloys *see* BRASS and BRONZE.

In addition to these better known alloys, there are many others which found application in industry as their properties became more widely recognized. Those of copper and nickel are important examples; their manufacture increased greatly during the 20th century. Because copper and nickel are completely miscible in the solid state, forming a complete series of solid solutions, the useful range of alloys is not confined within any definite limits of composition, although certain compositions came into general use. Additions of 2%–45% nickel to copper provide a series of alloys which are considerably stronger and more resistant to oxidation at high temperatures than is copper. Of these "cupronickels," that containing 30% nickel is the most important; it is widely used for condenser tubes. The U.S. five-cent coin, popularly called a "nickel," is 75% copper, 25% nickel.

The alloy formed of 20% nickel with the remainder copper is one of the most ductile of commercial alloys, and may be subjected to the most severe cold-working without the need of any intermediate annealing. It is also readily forged and rolled at a temperature above 800° C. These properties make it a very suitable alloy for drop forgings and cold stamping and pressing, and it found a variety of uses in automobile construction for exposed fittings, as it takes a high polish and is resistant to atmospheric tarnishing. Other uses include bullet sheathing, for which purpose it was used by many nations including Great Britain and France. In the form of tubes its use was rapidly extended for steam condensers, although the alloys containing 25% nickel and 30% nickel were stated by some authorities to give better results as condenser tubing than the softer and less resistant alloys of lower nickel content. Another alloy in this series containing either 45% or 40% nickel became widely known under the name constantan. It has a high electrical resistance which remains almost constant over an appreciable range of temperature.

Monel metal is a so-called natural alloy prepared by the reduction of a copper-nickel ore and containing 65%–70% nickel. In addition to copper and nickel it contains iron and manganese in small amounts, together with other impurities which influence its properties to some extent. It has been widely used for various engineering and ornamental purposes, and possesses exceptionally high strength at both normal and elevated temperatures. Alloys of similar nickel content are also manufactured by melting nickel and copper together.

Copper also forms an important series of alloys with aluminum which are classed under the general term aluminum bronzes. The properties of these alloys were the subject of numerous scientific investigations which showed that the useful alloys rich in copper contain up to 11% aluminum. They may be classified into two main groups: those containing up to 7.5% aluminum are extremely ductile, while those containing 8%–11% possess high tensile strength in the cast state. The ductile alloys containing less than 7.5% are especially useful for deep stamping, spinning and severe cold-working of all kinds, and found application as a substitute for brass, compared with which they possess greater strength and resistance to atmospheric corrosion. Bronze coinage such as that used in France contains 8.25% aluminum together with a little manganese, and this mixture approaches very nearly the upper limit for satisfactory cold-working. The alloys with 8%–11% aluminum usually contain in addition 1%–3% iron and are in general use for die castings, for which their high tensile strength and clean casting properties are a great advantage. They are resistant to corrosion by mineral acids and also resist oxidation at relatively high temperatures.

Copper alloys are often classified as those used for making castings and those used for wrought materials. Castings usually require machining, but the toughness of copper and most of its alloys make them difficult to machine. Machinability can be greatly improved by addition of lead, which is often a component of the casting alloys. Leaded brass, bronze and other alloys, which may be wrought if the lead content is low, often carry from .5% to 10% lead.

Silicon bronze usually contains about 96% copper. The remainder may be silicon alone, but more often a little manganese, tin, iron or zinc is also added. These alloys were developed originally for the chemical industry because of their exceptional resistance to corrosion in many liquids. Their application later extended far beyond this field, chiefly because of their good casting qualities, satisfactory strength and hardness and ease of welding in addition to corrosion resistance.

Unlike many kinds of steel, most copper alloys are not susceptible to improvements of hardness and strength by processes of heat treatment. One useful exception is the heat-treatable alloy beryllium copper. This consists of copper with addition of about 2% of beryllium, with or without a smaller addition of nickel or cobalt.

When beryllium copper is heated to about 800° C., quenched in cold water and then reheated to 275° C., it develops a tensile strength up to 200,000 lb. per square inch, comparable with some of the stronger varieties of steel.

Manganese bronze is made in several varieties, exhibiting a range of compositions and properties. One type is in reality a brass to which a very little manganese has been added as a deoxidizer, less than .5% manganese remaining in the alloy. Another kind contains 2%–5% manganese together with 2%–4% iron and 3%–7.5% aluminum. It has exceptionally high strength, and is called high-tensile manganese bronze or manganese-aluminum bronze. Phosphor bronze is a true copper-tin bronze to which a little phosphorus is added as a deoxidizer and strengthener.

There are numerous other variations of the different copper alloys, and their development is an example of the progress of metallurgical science in providing materials to meet modern industrial requirements.

Output.—Ever since there has been any knowledge of the world production of metals, copper has exceeded all other metals except iron. During and after World War II, however, the production of aluminum grew more rapidly than that of copper, and by the mid-1950s aluminum had closely approached copper in world tonnage. A principal reason for this was the reversal in price position whereby copper, formerly cheaper than aluminum, became more costly. Though the output of aluminum increased more rapidly, copper also grew in production and use.

Just before World War I the annual production of copper in the world was about 1,000,000 metric tons. In 1939 it reached more than 2,000,000 tons, and in 1943, under the stimulus of demand for war purposes, it rose to almost 3,000,000 tons. It declined after World War II and then began rising to a new peak, reaching about 4,000,000 metric tons by 1960.

Before World War I considerably more than half of the world's copper came from the United States, but this proportion declined to one-third by mid-century. In order to meet the demand for copper, it became necessary to use ores of lower and lower grade, which accounted in large part for the increase in price.

See Brass; Bronze; Alloys; Zinc; Aluminum; etc.

(Al. Bu.)

CHEMICAL AND PHYSICAL PROPERTIES

Copper lies between nickel and zinc and is in subgroup Ib (copper, silver, gold) in the periodic classification of the elements. It is the ninth of the ten transition elements occurring between calcium and gallium and is the first element in which the atom has a complete third shell of 18 electrons. The electron arrangement indicates that the natural valence of copper is 1 and that the properties of its compounds in which the oxidation state is 1+ (cuprous) should resemble those of silver and to a lesser degree those of gold. This is true, since the cuprous salts resemble to a great degree those of silver, and some of the naturally occurring compounds of the two metals resemble each other and frequently occur together.

Copper lies below hydrogen in the electromotive series of the elements and consequently does not replace hydrogen from solutions. It lies below iron, zinc and lead, and these metals will displace copper from solutions of its salts. Platinum, gold, silver and mercury lie below copper and are displaced from solutions of their salts by copper.

TABLE II.—*Properties of Copper*

Physical constants:	
Atomic number	29
Atomic weight	63.54
Atomic volume	7.10
Stable isotopes (mass numbers)	63, 65
Radioactive isotopes (mass numbers)	58, 59, 60, 61, 62, 64, 66, 67, 68
Density, 20° C.	8.95 g./ml.
Melting point	1,083.0° C.
Boiling point	2,595° C.
Specific heat, 20° C.	0.0919 cal./g./° C.
Thermal conduction, 20° C.	0.941 cal.
Latent heat of fusion	50.6 cal./g.
Hardness (Mohs' scale)	3.0
Specific resistance	1.682 microhm
Coefficient of linear expansion	16.5×10^{-6}
Crystal structure	Face centred cubic
Electron structure	$1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^{10}, 4s^1$
Reflectivity	$\lambda=6{,}500$ Å 80%
	$\lambda=4{,}500$ Å 37%
Valence	1 or 2
Periodic classification	Group 1, series 5, period 4

Although copper is not soluble in acids with the evolution of hydrogen, it is readily soluble in oxidizing acids or in acids in the presence of other oxidizing agents; for example, nitric acid, hot concentrated sulfuric acid, or sulfuric acid and ferric sulfate. Copper is also soluble in ammonia and ammonium salts in the presence of air and in sodium and potassium cyanide.

Copper resists the action of the atmosphere and sea water to a high degree. Exposure to the atmosphere for long periods results in the formation of a thin coating of green basic copper carbonate known as patina. This beautiful green colour characterizes copper objects such as roofs and statuary, especially in the vicinity of the sea.

Physical Properties.—Many of the common gases such as oxygen, nitrogen, carbon dioxide and sulfur dioxide are soluble in molten copper. The degree of this solubility has a profound bearing on the mechanical properties of the solidified metal but presents a problem difficult to investigate.

Copper is one of the most ductile of the metals, and although not especially strong or hard, both strength and hardness are appreciably increased by cold-working. Soft commercial copper will vary in tensile strength from 30,000 to 36,000 lb. per square inch. This may be increased by severe cold-working to a maximum of about 70,000 lb. per square inch. Cold-working reduces ductility but annealing after cold-working will restore it.

Copper has no allotropic forms and therefore has no critical temperature at which changes take place in the crystalline pattern. The softening effect of annealing is simply the formation of a new crop of equiaxed crystals in place of the elongated crystals formed by cold-working. The lowest recrystallization temperatures lie between 200° and 400° C. The metal may be hot-rolled or formed at any temperature above the recrystallization temperature and below the melting point without work hardening.

Copper may be welded, brazed or soldered either with the electric arc or the oxyacetylene torch. The metal, however, cannot be cut with the oxygen lance in the manner of steel.

CHEMICAL COMPOUNDS

Copper forms two series of compounds in which its oxidation state is 1+ (cuprous) and 2+ (cupric); several unstable compounds of the 3+ state are also known. Since the cuprous ion is unstable in aqueous solution, its salts readily decompose to form the metal and cupric salts:

$$2Cu^+ \rightarrow Cu + Cu^{2+}.$$

The cuprous state is therefore maintained only in insoluble salts as CuI or in complex ions as $CuCl_2^-$ and $Cu(CN)_3^{2-}$. The cupric ion in dilute water solution is hydrated $Cu(H_2O)_4^{2+}$ and is blue in colour. With ammonia it forms the deep blue complex $Cu(NH_3)_4^{2+}$.

Oxides.—Copper forms two oxides in accordance with its two valences: cuprous oxide, Cu_2O, and cupric oxide, CuO. Cuprous oxide, a red crystalline material, can be produced by electrolytic or furnace methods. It is reduced readily by hydrogen, carbon monoxide, charcoal or iron to metallic copper. It imparts a red

colour to glass and is used for antifouling paints. It is soluble in mineral acids to form colourless cuprous salts, most of which rapidly oxidize to the cupric state. Cupric oxide, a black powder, can be prepared by the ignition of suitable salts such as the carbonate, hydroxide or the nitrate of copper, or by heating of cuprous oxide. This compound will oxidize carbon compounds and finds a wide laboratory and commercial use for this purpose. Since it imparts a green colour to glass, it is used extensively for that purpose. It is soluble in mineral acids and forms with them blue or green solutions.

Halides.—Cuprous chloride, CuCl, can be prepared by treating metallic copper and cuprous oxide with hydrochloric acid, or by treating metallic copper and cupric chloride with hydrochloric acid. The hydrochloric acid solution of cuprous chloride readily absorbs carbon monoxide and acetylene and is used for this purpose in gas analysis. Cupric chloride, $CuCl_2$, can be prepared by dissolving cupric oxide in hydrochloric acid. This material finds some use as the base salt for the manufacture of pigments. Cuprous iodide, CuI, is prepared by the direct combination of copper and iodine. Cupric iodide, CuI_2, exists only in combination with ammonium salts or in complex organic compounds.

Sulfides and Sulfates.—Cuprous sulfide, Cu_2S, occurs in nature as the mineral chalcocite. The compound may be prepared by the direct combination of copper and sulfur at high temperatures. Cupric sulfide, CuS, occurs in nature as the mineral covellite and can be prepared in the laboratory by treating the solution of a copper salt with hydrogen sulfide. Both compounds are insoluble in mineral acids.

Cupric sulfate, $CuSO_4$, commonly known as blue vitriol, is the most important salt of copper. It usually crystallizes as $CuSO_4 \cdot 5H_2O$ and has a bright blue colour. It is prepared by the treatment of copper oxides with sulfuric acid. While readily soluble in water it is insoluble in alcohol. The anhydrous salt is hygroscopic and is useful as a desiccating agent. Copper is readily displaced from aqueous solutions of the salt by metallic iron. Copper sulfate is the basic salt in the electrolytic refining of copper and it also finds a wide use in the preparation of pigments.

Carbonates.—Basic copper carbonates are formed when an alkaline carbonate is added to the solution of a copper salt. These compounds, which have a bright blue or green colour and are used in the preparation of pigments, occur in nature as the minerals azurite and malachite.

Miscellaneous Compounds.—Copper forms a series of salts with arsenic; all are bright green in colour and poisonous. Wide use has been made of these compounds in insecticides. Cupric nitrate, $Cu(NO_3)_2$, can be prepared by dissolving metallic copper in nitric acid. The hydrated crystals are deep blue in colour. Copper silicates occur in nature and impart a blue colour to many minerals.

Detection.—Solutions of copper salts take a characteristic deep blue colour when treated with an excess of ammonia. They impart a bright green colour to the flame of a Bunsen burner, and in dilute solutions produce a brown colour when treated with potassium ferrocyanide. The presence of minute quantities of the metal is readily detected with the spectrograph. For the quantitative estimation the electrolytic method and the potassium iodide method are widely used.

Medical Uses.—All salts of copper are poisonous and readily attack the mucous membrane even in low concentrations. They have limited uses, mainly as superficial antiseptics.

See also references under "Copper" in the Index volume.

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COPPERAS (Fr. *couperose;* Lat. *cupri rosa*, "the flower of copper"), a term formerly synonymous with vitriol and applied to the sulfates of copper, iron (ferrous) and zinc as blue, green and white copperas respectively. It is now applied exclusively to ferrous sulfate, $FeSO_4 \cdot 7H_2O$, a light green solid which has an astringent, inky and somewhat sweetish taste and which is used in medicine, in dyeing and tanning, and in the manufacture of ink. *See* IRON: *Compounds of Iron.* (J. B. PS.)

COPPERHEAD (*Agkistrodon contortrix*), a venomous snake of the pit viper family (Crotalidae). It occurs in the eastern and southern United States from Connecticut west to southeastern Nebraska, and south to northern Florida and western Texas. Four regional races (or subspecies) having different colour patterns are recognized. It is a small snake; although occasionally exceeding 4 ft., most adults are less than 3 ft. long.

BY COURTESY OF SAN DIEGO ZOO

NORTHERN COPPERHEAD (AGKISTRODON CONTORTRIX MOKESON)

Like its relative the water moccasin (*see* MOCCASIN), the copperhead (sometimes called the highland moccasin) bears living young, often four to eight at a birth. Mice comprise its preferred diet, but it eats other small mammals and lizards, frogs and insects. It favours rocky or woody habitats. In winter copperheads congregate for hibernation deep in ground fissures or rock crevices, often joined there by other snakes, including rattlesnakes.

In most areas copperheads are brightly coloured, with reddish head and body marked by brownish crossbands that are narrower along the back than along the sides. While usually mild-mannered, copperheads bite quickly if injured or frightened. Although rarely fatal, the bite should receive immediate medical attention, especially if the victim is a child. In Australia the name copperhead is applied to a quite different and far more dangerous snake, *Denisonia superba*, a species allied to the cobras and kraits. (L. M. KR.)

COPPERHEAD, a U.S. political epithet applied during the Civil War to those in the North who, deeming it impossible to conquer the Confederacy, were in favour of peace and therefore opposed the war policy of the president and of congress. The term "Copperhead" as one of opprobrium existed before the Civil War, but its first recorded use in the sense here described is believed to be in the *New York Tribune* of July 20, 1861. The name was adopted because of the alleged resemblance of the "peace democrats" to the venomous copperhead snake which does not rattle and strikes from concealment without warning, as: "A rattlesnake rattles, a viper hisses, an adder spits, a black snake whistles, a water-snake blows but a copperhead just sneaks!" Thus the antiwar Democrats were also called "sneak Democrats" and in the midwest, early in 1863, the terms "Copperhead" and "Democrat" had become virtually synonymous. Though applied opprobriously in this way, the term was willingly assumed by those upon whom it was bestowed, and some advocates of the peace policy, to emphasize it, wore Copperhead badges; these were generally made of one-cent copper pieces which had been cut away so that only the copper head remained, with Liberty written across the forehead. It is believed, however, that the badges did not appear until about six months after the term itself came into use.

The bases for antiwar sentiment were manifold, but differed in character and intensity with the region. In the midwest, there were factors such as an economic-based envy of industrial New England which was seen as fostering the war at the expense of the midwest; a continuing loyalty to the south, from which large segments of the midwest population had lately emigrated; a fear of growing centralization of government; and doubts about the possibly harmful consequences to themselves if slavery were abolished. In New England, it was largely a fear among merchants and manufacturers of losing a profitable commerce with the south should secession become a reality. In the middle eastern states, particularly New York and parts of New Jersey, there was the incentive among Democrats to make political capital out of the inevitable hardships of the war. And everywhere, of course, there were those who opposed civil strife under any circumstances.

In its organized aspect, the Copperhead movement was one of secrecy, quasi-military discipline, the taking of oaths, grandilo-

quent ritual, and, in its extremist form, terrorism and an arrogation of the law into private hands. It began in the middle west, where it also remained strongest, but in the third year of the war it had spread to the east. To a lesser extent it also spread to the west where it did not, however, exercise any serious influence on the outcome of the war.

For the first two years of the war, branches of the secret anti-war society known as the Knights of the Golden Circle were on the whole localized. Originally, they sprang up mainly as agencies of mutual protection against arbitrary arrests, and shared, in addition, a common sympathy with the southern cause. They were, and remained, strongest in Ohio, Indiana and Illinois. In 1863 they merged into the Order of American Knights and became more actively defeatist in character and aim. They opposed conscription, gave aid to deserters, hindered shipments of men and supplies, and terrorized Union sympathizers. A year later the name of the order was changed to Sons of Liberty, the name of the secret associations in the American colonies during the opposition to the British Stamp act of 1765.

Leaders of the Copperhead movement included Clement L. Vallandigham (*q.v.*), their chief spokesman; Alexander Long of Cincinnati, O.; and Fernando Wood in New York. There was no formal dissolution of these societies after the war, but the Democratic party continued to suffer for some time from the aftermath of its association with the Copperheads. Almost a century later, and shortly before World War II, Pres. Franklin D. Roosevelt revived the epithet by applying it to the noninterventionist stand taken by Charles A. Lindbergh in 1941; as a result of the president's comment, Lindbergh resigned his colonelcy in the U.S. army air corps reserve.

See also AMERICAN CIVIL WAR: *Politics, Economics and Foreign Affairs.*

COPPERMINE RIVER, in Mackenzie district, Northwest Territories, Can., rises in a small lake north of Great Slave lake. Flowing south through Lac de Gras and then northwestward, it joins a large number of irregular lakes to form Point lake. After flowing in rolling hill country, it breaks through the Coppermine and September mountains about 50 mi. from its shallow mouth on Coronation gulf, near which the settlement of Coppermine is located. The river is 525 mi. long and descends about 1,600 ft. Trees occur to within a few miles of the sea. Named by Samuel Hearne in 1771 who reached the mouth overland from Churchill while searching for copper, it was first traversed by Sir John Franklin in 1820. The lower 160 mi. is part of a formerly well-traveled route from Great Bear lake to the Arctic ocean. The largest lake drained by the Coppermine river is Takiyuak lake with an area of 400 sq.mi. (AN. KR.)

COPRA. Dried sections of the oil-bearing kernel of the fruit (nut) of the coconut palm (*Cocos nucifera*) are known in world commerce as copra. The less common drying of the intact whole nut kernel produces ball, edible or whole copra. Shredding of the fresh meat, followed by thorough drying, results in a food item, dessicated coconut, in which the moisture content is somewhat lower and the oil content higher than that of copra. Copra, as known in trade, is seldom used directly as human food, but is processed to extract the coconut oil of commerce, leaving a coconut oil cake, also called copra cake, poonac and *boengkil,* mostly utilized for livestock feed.

History.—The coconut tree in its several varieties has a long history as a "tree of life," a regular supplier of food and other necessities of man. Because fresh coconut supplies were generally available throughout all or most of the year for the indigenous population of producing areas, there was apparently little occasion to consider storage and overseas transport until northern Europe, faced with a shortage of dairy fats in the 1860s, began to experiment with copra as an economic source of cooking and table fats. As recently as 1910, though then widely used in western Europe, coconut oil was practically unknown in the U.S. In the second half of the 20th century, world production of copra and coconut oil, in oil equivalent, was in the range of 2,200,000 to 2,400,000 short tons, about 8% of total world production of all fats and oils. Of that amount 1,300,000 to 1,500,000 tons per year entered world trade, with western European countries and the United States the major importers.

Production.—Nuts gathered from naturally growing palms continue as the principal source of copra, though commercial coconut estates and smallholders' plantations provide significant fractions. The principal producing areas lie within 22° of the equator and below 900 m. altitude; temperatures must not fall below 20° C. (68° F.) and rainfall should exceed four feet per year. Cultivation of the coconut for copra is localized principally in the Philippines, India, Ceylon, Indonesia, Malaya and the Pacific islands. Under the most favourable practices, trees are spaced at 25-ft. intervals, with an expected harvest of 75 or more nuts per tree per year, or about 4,500 or more nuts per acre. Production begins in five to seven years after planting.

Nuts ripen throughout the year after they are about one year of age; they may be gathered as they fall, regardless of weather, in which case they must be processed promptly to obtain quality copra. The nuts also may be picked from the trees, in which case the greener nuts are seasoned for as much as four weeks in shallow piles. Eventually the nuts are husked by bringing them forcibly against a sharp point. This is in most areas hand work, though mechanical huskers are known. The shell is then cracked, normally into two halves, with a chopping knife, exposing the meat, which is about 28% by weight of the total nut and in its raw state is about 50% water and 30% to 40% oil. It requires about 30 nuts to provide meat for 10 lbs. of copra.

The earliest method of drying was to expose the kernels to the air and sun, a practice which is still extensively followed and gives a good quality white copra (sun-dried copra). A more rapid primitive process, adopted particularly in districts where the humidity of the air is excessive, is drying by fire (kiln drying). The kilns consist essentially of a fire pit overlaid with a grid on which the copra is placed. The drying copra is sheltered from the rain by a roof. Such kilns are used generally in the Philippines, which supply 50% of the world copra exports. Broken coconut shells, wood and to some extent coconut husks are used as fuel. The copra is deliberately smoked in order to sterilize the partially dried product and so modify the extent of self-heating and decomposition during subsequent natural drying in storage in the warehouse of the copra buyer. The copra does not remain on the kiln for more than two days. During this period the fire in the fire pit is kept going spasmodically.

Copra of better and more uniform quality is produced by another method—hot-air drying—first introduced in India and Samoa. The copra is drawn slowly through a heated tunnel, meeting a countercurrent of hot air. The method yields a fine, white copra of higher value than the sun-dried article. Well-dried copra as sold in world commerce contains 4% to 5% moisture. The proportion of oil in such copra ranges from 63% to 70%.

Processing Copra.—Coconut oil is obtained from copra chiefly by pressing in mechanical screw presses. In some areas hydraulic cage and box presses continue to be employed. Their use, however, is relatively limited, and the world production of coconut oil is largely obtained by use of continuous mechanical screw presses. In either instance, before processing the copra is passed through a cleaner which removes sand and trash. It is then passed through a crusher which breaks it into small pieces. The broken copra moves through a magnetic separator which disposes of any metallic debris. The material is then ground finely and treated.

Single Pressing.—The finely ground copra is cooked, or dried, in steam-jacketed kettles or compartments to a moisture content of about 1.5%. The meat passes from the driers into continuous mechanical screw presses which consist essentially of a cylinder, or barrel, in which an impelling worm turns and continuously forces the tempered copra through a small terminal orifice. The barrel is composed of a series of rectangular steel bars, separated by spaces to form slots. Pressure and heat of friction release the oil which escapes through the slots of the barrel. Continuous mechanical screw presses may have a vertical and a horizontal pressing barrel, each operated by a separate motor. In the single type the horizontal barrel performs the entire copra-pressing operation. Continuous mechanical screw presses have a capacity of

20–40 tons of copra per 24-hr. day. Before passing to the crude oil storage tanks the coconut oil is screened to remove fine particles of ground copra. It is then run through a filter press. The foots from the screening process and the filter press cake are returned to the screw presses for re-pressing.

Solvent Extraction.—In Europe and the United States some coconut oil is extracted by means of petroleum solvents (hexane type) from copra which has been prepressed through large continuous mechanical screw presses. These screw presses, with a capacity of 25–65 tons per day, reduce the oil in copra from 65% to 15%–20% before the cake is prepared for extraction. The oil-bearing material is treated continuously in a countercurrent flow with solvent until the oil left in the extracted meal has been reduced to .5% to 1%. The solvent is removed from the extracted meal by means of steam-jacketed, agitated conveyers. The solvent from the oil is recovered by distillation and the last traces of solvent are removed by steam distillation of the oil *in vacuo*.

Copra Meal.—The meal from pressed cake contains 21.3% protein on the average and 5% to 7% oil. Solvent-extracted cake contains less oil and a proportionately greater amount of protein. Copra meal is valued as a dairy feed. It is also satisfactory as a protein supplement for fattening cattle and lambs.

Coconut Oil.—The oil is colourless to yellowish in appearance and melts at about 74° F. Crude coconut oil has a characteristic coconut odour. The fatty acids of coconut oil possess a lower average molecular weight than those of most other fats. Thus the quick solubility of their sodium salts and the sulfated fatty alcohols derived from coconut fatty acids make coconut oil a highly desirable material for the manufacture of soaps and other detergents.

Edible coconut oil is the product of refining and deodorizing the crude oil to remove free fatty acids and flavours. An important food use of coconut oil arises from its high percentage of lauric acid (48%). The resistance of this saturated fatty acid to the development of rancidity caused by oxidation prompts confectioners and bakers to use refined coconut oil in coatings and fillings for baked goods and candy which may stand for a relatively long time between manufacture and consumption. Prior to World War II coconut oil had extensive use in margarine manufacture in the United States, but later it was largely displaced by domestic oils. Its use in margarine continues undiminished in Europe and other areas. Refined coconut oil is used in the manufacture of shortening and as a cooking fat.

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COPROLITE. The name was originally given by William Buckland to certain bodies in the Lias strata of Gloucestershire which formerly had been considered fossil fir cones (*see* JURASSIC SYSTEM). He showed that they possessed characters which could be best explained on the supposition that they were the fossilized excreta of reptiles (from Greek *kopros*, "dung," and *lithos*, "stone"). Chemical analysis showed that they were very rich in phosphatic minerals.

Coprolites are now known to be the fossilized excreta of a variety of organisms that differ greatly in size and habitat and include microscopic aquatic animals, fish, turtles, mammals and reptiles. In geologic age they range from Permian to Pleistocene and have been found in many parts of the world in beds of marine and fresh-water shale and limestone, in volcanic ash and in cave deposits.

Coprolites consist principally of tricalcium phosphate. Some contain extraordinarily well-preserved remnants of partially digested foods: muscle fibres and the tissues and seeds of identifiable plants. Others contain a profusion of silicified bacterial cells.

(W. B. R. K.; W. H. BY.)

COPTIC CHURCH (COPTIC ORTHODOX PATRIARCHATE OF ALEXANDRIA), the chief representative of the Christian church in predominantly Muslim Egypt. The Copts are a people, the descendants of the original inhabitants of Egypt, as their language is the direct descendant of the ancient Egyptian language. For the history of the language, which may be properly termed "dead" as a spoken language, and for the surviving Coptic literature, which is almost entirely religious, *see* COPTIC LANGUAGE and EGYPTIAN LANGUAGE.

The word Copt is the westernized form of Arabic *qubt*, Greek *aigyptios*, signifying the language and people of Egypt before the Arab conquest in the 7th century A.D. In later times the Muslims of Egypt ceased to call themselves *aigyptioi* and the word became the distinctive name of the Christian minority. From the 5th century onward this Christian minority belonged to the church which Eastern Orthodox and Roman Catholics term Monophysite (*see* MONOPHYSITES). The church never called itself Monophysite, however; to its members it is simply the Egyptian church, other churches being foreign. In the 19th and 20th centuries some Copts have become Roman Catholics and Protestants, so that the members of the Coptic Church have come to call themselves Coptic Orthodox, in order that they may be distinguished from these Christians and also from the Greek Orthodox of Egypt (for which *see* ALEXANDRIA, GREEK ORTHODOX PATRIARCHATE OF).

In the 4th and 5th centuries a conflict arose in Egypt between those who spoke Greek and those who spoke Coptic. The relationship between this conflict and the contemporary controversy concerning the person of Christ is very complex, but it is clear that in the 6th century, if not before, the Coptic speakers were all against the Council of Chalcedon (451) while the Greek speakers for the most part supported it. There is a tendency among modern writers to treat this conflict as a political one between nations; but the people involved in the controversy, while it was alive, regarded it as theological. Various attempts were made by the Byzantine emperors and their advisers to bring about a settlement through a compromise formula; but insofar as these attempts meant giving up the authority of the Council of Chalcedon they were opposed by the Greek Orthodox and by the see of Rome. After the Arab conquest of Egypt such attempts ceased. It was then in the interests of the Egyptian Christians that the majority of them should be able to say that their form of Christianity was not the same as the Christianity of the Byzantine empire. The emperors had sought to alter the doctrines of the Coptic Church and to coerce it into union with other Christian churches; the Arab caliphs, although they tended to favour those who adopted Islam, did not interfere so much in the internal affairs of the Christian Church.

The few Chalcedonians left in Egypt were Greeks and were described as Romans or Melchites ("emperor's men"). The theological controversy between the Copts and the Melchites may be thus summarized: The Monophysite (Gr. "one nature") Coptic, Syrian, Armenian and Greek opponents of the Council of Chalcedon believed that their Greek, Roman and other Melchite adversaries, who supported Chalcedon, were preaching two Christs, God and man, instead of one Christ, the God-man. The non-Chalcedonians insisted that, in no figurative sense but in reality, "God was born" and "God died," and they constantly suggested that the Chalcedonian formula of the "two natures" of Christ implied a denial of the reality of God's birth and death and thus undermined the essential doctrine of the incarnation. The Greek Orthodox, on the other hand, accused the Monophysites of denying that the humanity of Christ was true and real. After the Arab conquest of Egypt the Copts ceased to speak Greek, and the language barrier, in addition to the political conflict, gave a fixed form to the controversy, which slowly ceased to arouse interest. It has been described, with good reason, as a matter of phraseology rather than a matter of ideas in conflict, but it is still a barrier in the way of reunion between the Eastern churches. (For the 5th–6th century Christological controversy, *see* further COUNCIL; MONOPHYSITES; JESUS CHRIST: *The Dogma of Christ in the Ancient Councils*.)

Apart from the questions involved in this particular controversy, the Monophysite churches and the Orthodox Eastern Church agree in doctrinal matters. In modern times the Copts and the other non-Chalcedonians have been on the defensive against western influence, both Latin and Protestant, in the near east, and in this respect they have found the Greek Orthodox to be their allies.

Arabic is now used in the services of the Coptic Church for the lessons from the Bible and for many of the variable hymns. The part of the service which is not in Arabic consists largely of short refrains which churchgoing people all understand. The response "Lord have mercy" and the hymn "Holy God, holy and strong, holy and immortal, have mercy upon us" are sung in Greek. The Coptic Church uses the liturgies attributed to St. Mark, St. Cyril of Alexandria and St. Gregory of Nazianzus (*see* LITURGY). The service books are written in Coptic (the Bohairic dialect of Alexandria), with the Arabic text in parallel columns.

The Copts have shown little tendency to travel and carry their church with them. There is a Coptic church in Jerusalem and a few other Coptic churches were built in the Holy Land in the 19th and 20th centuries; there is also a Coptic bishopric in Khartoum for Copts living in Sudan. But no considerable body of Copts seems to have settled permanently in western Europe or the new world.

The Ethiopian Church is in full communion with the Coptic Church, having been founded by missionaries from Egypt, and until 1948 it had a Coptic archbishop as its sole bishop. Since 1948 it has had its own Ethiopian catholicos-patriarch, consecrated by and under the spiritual authority of the "pope and patriarch of Alexandria and of the preaching of St. Mark," who is the recognized head of the Coptic Church. The Armenian and Syrian Orthodox Churches also are in communion with the Copts.

The Coptic Church developed a democratic system of government after the 1890s. The finances of the churches and schools and the administration of the rules relating to marriage, inheritance and other matters of personal status among the Copts in Egypt are regulated by the patriarch and the diocesan bishops (of whom there are 12) with the assistance of community councils in which the laity is well represented. When the patriarch dies, an electoral college of which the great majority of members are laymen selects three duly qualified monks as candidates for the office of patriarch. Among these three the final choice is made by lot after prayer. Only a monk of many years' standing can be a candidate for the patriarchate or even become a bishop.

The patriarch resides in Cairo. The church has its own primary and secondary schools in many places in Egypt, as well as a strong Sunday school movement for education in Coptic Church tenets of children unable for any reason to go to Coptic schools. There is an Institute of Coptic Studies in Cairo, a theological college connected with that institute and a Coptic museum. Egypt appreciates the Copts as an important and thoroughly Egyptian element in the community, and the teaching of the Coptic Church has been the basis of the syllabus used in the religious instruction of Christian children in government schools. There are many Copts among government officials and professional men. Nevertheless Copts living in Muslim villages in Upper Egypt have shown a tendency to go over to Islam in the hope of getting work, and in some parts of the countryside the Coptic Church is struggling to keep alive.

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COPTIC LANGUAGE, the descendant of ancient Egyptian, is called in modern times after the Arabic *qubt* (*i.e.*, Egyptian); it is one of the Hamitic languages in origin. Its oldest documents belong to the 2nd and 3rd centuries A.D., being vernacular translations of the Scriptures by native scholars, who were well acquainted with Greek. They wrote their language not in their own current script (demotic) but in the Greek alphabet supplemented by seven symbols taken from demotic.

The vogue of this Coptic language and its dialects became progressively restricted after the Arab conquest of Egypt (A.D. 640). It was finally extinguished in the 17th century, apart from very scanty traces (19th century) in a few small localities in Upper Egypt (*Sa'id*), and except for its survival in the native Christian church of Upper Egypt in the Bohairic dialect (originally of lower Egypt). The Arabic writer Maqrizi (15th century) recorded that in his own day Copts in Upper Egypt spoke scarcely anything but Coptic; 200 years later a European traveler, P. Vansleb, found only a single family at the village Zeniya, a little north of Luxor, and one old man who spoke it.

Classification.—In word forms and sentence structure Coptic resembles the spoken Egyptian of the new kingdom from which it was derived and does not differ notably from literary demotic. A more popular demotic used Greek letters in which to write horoscopes and magical texts (usually omitting the vowels). The language of these, which has come to be known as Old Coptic, is different from Christian Coptic, being both more archaic and comparatively free from Greek loan words.

Coptic proper is classified into six dialects. Two are from Lower Egypt:

1. *Bashmuric* is unknown except in a few glosses. It appears to have been a pidgin language of mixed Coptic or Egyptian and Greek and was spoken along the eastern outlet of the Nile delta.

2. *Bohairic*, from Arabic *al-buhaira*, was spoken in the western part of Lower Egypt, including Alexandria, the Wâdi el-Natrun and Memphis. It was this that later became the churchly and upper-class dialect of the Coptic hierarchy at first at Cairo (in the 11th century) and eventually of Upper Egypt. For a time it must have been current side by side with Arabic in Lower Egypt.

The remaining four dialects are from Upper Egypt:

3. *Fayumic*, spoken along the Nile valley, chiefly on the west bank, was the Arsinoë of the Greco-Roman period; it is linguistically close to Bohairic. But some of the documents from the Fayum show intermixed Bohairic and Sahidic elements. It survived for popular use in private documents as late as the 8th century, having been abandoned for literary use.

4. *Asyûtic* (also called Sub-Akhmimic) in Upper Egypt (around Assiut), is closely akin to Sahidic and Akhmimic. It flourished in the 4th century. In it are preserved a text of the Fourth Gospel and of the Acts, important religious texts of Mani and his disciples, and a number of Gnostic documents, the last in a somewhat different, but related, dialect.

5. *Akhmimic* proper is known from the city Akhmim (Chemmis, Panopolis) of Upper Egypt and its vicinity. There are 4th-century documents in a dialect that must be descended from the same source as Sahidic, but from which its phonological system differs markedly.

6. *Sahidic* (from Arabic *al-sa'id* "Upper Egypt") was originally the dialect of Antinoë and Hermoupolis and the Thebaid, and after the 5th century was the standard Coptic of the whole of Upper Egypt. It was supplanted by Bohairic for religious use after the 11th century. It is richly documented; it has a well-known and extensive vocabulary; and its grammar is that of a pure and early Coptic, being in fact what is usually meant by "Coptic" without qualification.

Characteristics.—Notwithstanding Greek and Arabic influence the Egyptian origin of Coptic is clearly seen in its system of sounds, inflections, syntax and vocabulary. Both consonant and vowel systems are rich and varied. The parts of speech are the noun, adjective, pronoun and verb, all of which are inflected; the adverb, conjunction, and preposition are decayed noun forms. There are two genders and two numbers. Roots are preponderantly triconsonantal (*e.g.*, *wnš* "wolf"), exceptions being due to the loss of a laryngal, the failure to write semivowels (consonantal *i* and *u*), or other uncertainties of the interpretation of the writing. As for syntax, although the so-called "nominal" type of sentence lacking a finite verb, which is characteristic of Egyptian, survived into Coptic, there is an extensively developed system of tenses (as in Greek and Latin). Coptic is further characterized by an increased use of auxiliary verbs and a conjugation system that employs prefixes, a feature found in the Egyptian of the new kingdom.

Literature.—Coptic literature (apart from mere business documents and letters in Sahidic and Fayumic expressed in monkish language) is almost entirely religious and consists mainly of translations from Greek. Versions from the Old and New Testaments were made into Sahidic, Akhmimic and Fayumic before the Coun-

cil of Chalcedon (451). The Gnostic heresy, otherwise known only through the works of its opponents, is illustrated in some Coptic manuscripts of the 4th century, the so-called *Pistis Sophia*, and the Bruce Codex, respectively in the British museum and Bodleian libraries. They are believed to be translations dating from the 3rd century and belong to an ascetic sect of the Gnostics which rose in Egypt itself. There is abundance of apocryphal works, apocalypses, patristic writings from those of Athanasius to those of the Council of Chalcedon (451), homilies, lives of saints and anecdotes of holy men, acts of martyrs, extending from the persecution of Diocletian (reigned 284–305) to that of the Persians in the 7th century, and lives of later ascetics and martyrs, to the 14th century. Unless some of the Egyptian *acta sanctorum et martyrum* should prove to have been originally written in Coptic, almost the only original works in that language of any importance are the numerous sermons and letters of Shenute, the long-lived and now celebrated monk of Atrepe near Akhmim. These works were written in the Sahidic dialect in the 4th and 5th centuries. After the Arab conquest, as a defense to the threatened church language and nationality, versifications of the Proverbs, of Solomon's Song and of various legends were composed, with other religious songs. They are mostly antiphonal, the numbers of stresses in a line marking the rhythm. There is no musical notation in the manuscripts, but traditional church tunes are generally referred to or prescribed for the songs. Of secular literature strangely little existed or at least has survived; only a few magical texts and fragments of a medical treatise, of the story of Alexander and of a story of the conquest of Egypt by Cambyses are known. According to all evidence available, the Coptic portion of the great library in the monastery of St. Marcarius, made after its restoration in the 9th century, was bare of everything but religious books. *See* also EGYPTIAN LANGUAGE.

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(F. LL. G.; J. WH.)

COPTOS: *see* QIFT.

COPYHOLD, in early English law, a form of landholding defined as a "holding at the will of the lord according to the custom of the manor". This type of interest in land did not take root in the United States and was abolished in England in 1925. Its origin is to be found in the occupation by the villeins or nonfreemen of portions of land belonging to the manor of a feudal lord. The portion of the manor reserved for the lord as his demesne was cultivated by labourers who also were allowed to cultivate portions of the land for their own use. While at first this cultivation for his own use was at the pleasure of the lord, in the course of time it grew into an occupation by right. The labouring tenant would appear in the manorial court and solicit the succession to the land occupied by a deceased father or the admission of a new tenant who had purchased from him, or he would assert a customary right annexed to the land. The records of the manorial court constituted the title of the tenant; he held by copy of the court roll.

Among the vexatious incidents of this tenure which were abolished in the Law of Property act of 1925 was heriot, the right of the lord to seize the tenant's best beast or other chattel on the death of the tenant. Another form of this tenure was called customary freehold. *See* MANOR; SERFDOM AND VILLEINAGE.

(A. DM.)

COPYRIGHT is the term generally used to designate the rights secured by the laws of civilized countries to authors of literary, dramatic, musical and artistic works, to protect against unauthorized copying of their works. The growth of the law of copyright protection closely followed the development of means and media of reproduction, performance, exhibition, presentation and representation. Literary copyright received its great impetus from the invention in Europe of printing by movable type; artistic copyright from the expanded use of engravings and lithographs. Photography, sound recordings, motion pictures (silent and sound), radio and television have all affected copyright.

UNITED STATES

Prior to any copyright legislation, protection—known as "common-law copyright"—was afforded to authors on common-law and equitable principles. Such protection, although abolished by statute in Great Britain and the dominions, is preserved in the United States for unpublished works. Thus the United States has a dual copyright system, with prepublication protection dependent substantially on common-law principles and postpublication protection available only under federal statutory copyright.

At common law, protection accrues automatically upon the creation of the work, vests in the author regardless of his nationality or the place of the creation of the work and includes full control over all uses of the work prior to publication. Upon publication (meaning the sale or general distribution of copies and not public performances, presentations, broadcasts and the like), common-law copyright ends, and protection is available thereafter only under the federal copyright statute.

Statutes for the protection of copyright were among the earliest laws enacted in the United States. Noah Webster, interested in protecting his *American Spelling Book,* promoted copyright legislation and has been called the father of such legislation in the U.S. On May 2, 1783, congress, which under the Articles of Confederation had no power over copyright, recommended to the states that they enact legislation to protect the authors or publishers of new books. From 1783 to 1786, all of the 13 original states except Delaware adopted copyright statutes patterned after the English statute of Anne of 1710. The federal constitution ratified in 1788 empowered congress "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." In 1790 congress enacted the first federal copyright statute, giving protection to books, maps and charts, by authors who were citizens or residents of the United States, for a term of 14 years with the right of renewal for 14 years more. The author or his assigns were given the sole right to print, reprint, publish and vend the copyrighted work.

Gradually, during the 19th century, federal statutory copyright was extended to musical, dramatic and various forms of artistic works, and the scope of protection was broadened. Ineligible for federal statutory protection, however, were the works of nonresident foreigners. Finally, in 1891, after many years of controversy, such copyright protection was authorized for the works of foreign authors whose countries granted similar protection to U.S. authors; but to overcome the objection of the American printing trades, which feared their employment would be lost to lower-cost printers in other countries, the requirement was imposed that copies of books, photographs, chromos or lithographs must be manufactured in the U.S., and the importation of copies or plates made elsewhere was prohibited with minor exceptions. In 1909 all prior copyright statutes were replaced by a single comprehensive copyright act. In 1912, the act was amended to authorize expressly the copyrighting of photoplays and motion pictures other than

photoplays. The 1909 act, as amended, was codified and re-enacted in 1947 as title 17 of the U.S. code, entitled "Copyrights." Title 17 of the code was amended after 1947 in several particulars.

U.S. Copyright Law.—The Copyright law provides copyright protection for "all the writings of an author," specifically enumerating books, periodicals, lectures, sermons or addresses prepared for oral delivery, dramatic or dramatico-musical compositions, musical compositions, maps, works of art, reproductions of works of art, drawings or plastic works of a scientific or technical character, photographs, prints and pictorial illustrations and motion pictures. Phonograph and other sound recordings are not copyrightable under the statute. The copyright owner is given the exclusive right to use the copyrighted work in several ways, varying to a considerable extent with the type of work involved. The exclusive right to print, reprint, publish, copy and vend is applicable to all types of copyrighted works; the exclusive right to translate or to make any other version applies only to a literary work; the exclusive right of public delivery for profit and of recording applies to a lecture, sermon, address or similar production, or other nondramatic literary work; to a drama attaches the exclusive right of converting it into a nondramatic work, of public performance and of recording; to a musical composition the exclusive right of arrangement and adaption, of public performance for profit and of recording, etc. To be copyrightable, a work must be original (in the sense that it is not copied from another work except where it is an authorized new version) but need not, as in the case of a patent, be novel. Copyright does not protect ideas or titles. Infringement exists only when there is substantial unauthorized copying and not independent creation by another. Special provision is made for a compulsory licence to record musical works: when the copyright owner has made or authorized a recording of a musical work for mechanical reproduction, as on a phonograph record, any other person may make a similar use of the work upon payment to the owner of a statutory royalty of two-cents per part manufactured.

Copyright is secured by publication of the work with the notice required by the statute, and this notice must appear in each copy of the work published in the United States by authority of the copyright owner. Such publication without the notice places the work in the public domain. The form of notice, which is required for literary, musical and dramatic works and may be used on any other works, consists of the word "Copyright" or the abbreviation "Copr." or the symbol ©, accompanied by the name of the copyright owner and the year in which the copyright was secured; *e.g.*, "© 19—, by John Doe." For maps and artistic and pictorial works, however, because the longer form of notice on the face of such works might tend to detract from their aesthetic appeal, the notice may consist of the copyright symbol © accompanied by the initials or other mark of the copyright owner, provided that the owner's name appears in some accessible place on the copies or on their permanent base or mounting.

After copyright has been secured by publication of the work with the required notice, copies of the work are to be deposited in the U.S. copyright office together with an application and fee for registration of the copyright claim. The copies deposited are made available to the Library of Congress. Registration of the copyright claim is a prerequisite to any action in the courts for the infringement of the copyright. The copyright office issues a certificate of registration which is prima-facie evidence in any court of the facts stated in the certificate. The copyright endures for 28 years from the date of first publication and may be renewed for a second term of 28 years. Renewal is secured by filing an application in the copyright office during the last year of the original 28-year term. In the special cases of posthumous works, composite works (such as periodicals or encyclopaedias, in which the work of a number of authors is collected) and works made for an employer for hire, anyone owning the copyright may obtain the renewal. Generally, however, the right to secure the renewal belongs only to the author; or if the author is deceased, then to his widow or children; and if there is no surviving widow or child, then to the author's executor or in the absence of a will his next of kin. Such expectancy in the renewal term may be expressly assigned in advance, but such an assignment is effective only if the assignor would otherwise have the right to secure the renewal at the time of renewal.

The typesetting, printing and binding of printed books or periodicals in the English language must be done in the United States. However, a book or periodical in the English language first published abroad will be given ad interim copyright protection for five years if a copy is deposited and the copyright registered in the U.S. copyright office within six months after its publication. When ad interim copyright is so secured, not more than 1,500 copies of the book may be imported into the United States during the five years. If copies of the book are manufactured and published in the United States at any time within the five-year period, the deposit and registration of that American edition will extend the copyright to the full term of 28 years with the right of renewal for another 28 years.

Works of specified classes not reproduced in copies for sale—lectures, sermons and addresses prepared for oral delivery, dramatic or dramatico-musical compositions, musical compositions, works of art, drawings or plastic works of a scientific or technical character, photographs, motion pictures—are eligible for statutory copyright prior to publication by registration and deposit in the copyright office. The initial 28-year copyright term therein runs from the date of registration, and the securing of such statutory copyright terminates common-law copyright. However, books, periodicals or other nondramatic literary material not prepared for oral delivery, maps, reproductions of works of art, prints and pictorial illustrations are not eligible for statutory copyright prior to publication, and hence any prepublication protection for such material can be based only upon common-law copyright.

The statute provides that a copyright may be assigned or mortgaged by an instrument in writing and may be bequeathed by will. Assignments are to be recorded in the copyright office. Records of all copyright registrations and recorded assignments and other instruments relating to copyright are maintained in the copyright office where they are open to public inspection. Upon request, the copyright office will conduct a search of its records and supply a report of the copyright information shown by its records regarding any particular work or works, for a statutory fee.

In 1955, the copyright office, under authorization of congress, undertook a program of studies with a view to a general revision of the United States copyright law, which had been amended only slightly since 1909. Thirty-four studies were prepared and distributed to a Panel of Consultants on General Revision and other interested persons. On the basis of the studies and the comments received on them, the copyright office in 1961 issued a report containing its tentative recommendations for revision of the law, preparatory to the drafting of a general revision bill.

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(Ar. F.; Ha. G. H.)

GREAT BRITAIN AND THE COMMONWEALTH

Up to 1911 the law of copyright in England had been the subject of a network of statutes, each relating to a particular aspect of the subject. Substantially the whole of the law was for the first time brought within the bounds of a single statute by the Copyright act, 1911, later replaced by the Copyright act, 1956. Some account of the earlier statutes may be useful before summarizing the law as it stands under the Copyright act, 1956. The English law of copyright applies to Scotland and Northern Ireland without modification.

Historical Development.—Literary copyright was protected by the Literary Copyright act, 1842, which provided that the copyright in every book published in the life of the author should endure for the life of the author and for seven years after his

death, or for 42 years, if longer. Provision was made for registration at Stationers' hall, and no action for infringement could be brought without prior registration. "Book" was defined as including volume, part or division of a volume, pamphlet, sheet of letterpress, sheet of music, map, chart or plan separately published. Engravings were protected by three acts, the Engraving Copyright acts of 1734 and 1736 and the Prints Copyright act, 1777, and were entitled to copyright for 28 years from publication. Registration was not required but the name of the proprietor and the date of the first publication had to be engraved on the plate and printed on each print. Copyright was given to sculptors by an act of 1814, provided that the name of the author and date of issue to the public appeared on each work. The last class to be protected was artists and photographers, whose protection was first secured by the Fine Arts Copyright act, 1862. The sole right to perform dramatic pieces was secured by the Dramatic Copyright act of 1833 and to play musical works by the act of 1842.

The Copyright act of 1911 repealed substantially the whole of the earlier copyright statutes. It provided that no person should be entitled to copyright except in accord with its provisions, so that the common-law copyright previously recognized in unpublished works was no longer in force. Copyright in published and unpublished works was in fact assimilated except for the provisions limiting the area and term of protection.

It is also important to observe that after 1911 registration at Stationers' hall was no longer necessary, so that copyright was thereafter secured to the author by the act of creation and no formality of any kind was acquired. The Copyright act, 1956, repealed the Copyright act, 1911, save for the provisions relating to the delivery of copies of books to the British museum and other libraries.

The Copyright act, 1956, besides re-enacting the main provisions of the Copyright act, 1911, created copyright in several fresh forms of endeavour, namely, in sound recordings, motion-picture films, television and sound broadcasts and in new editions of literary works. It also widened the scope of the protection given to all works, *e.g.*, by making it an infringement to broadcast a work or cause it to be transmitted to subscribers to a diffusion service.

Subject Matter of Copyright.—Copyright, as provided by part i of the 1956 act, subsists in every original literary, dramatic, musical and artistic work. These expressions are defined in the act. It has been decided that the word "literary" does not connote style or literary finish but is used merely to indicate written or printed matter. The only limit would appear to be that the work in which copyright is claimed must be sufficiently extensive to have demanded some skill in composition. Copyright protection is given not to ideas but to literary forms. Compilations such as directories, dictionaries and also tables, which are included as literary works, are in a rather special position. The originality which entitles these to copyright resides not in any literary form but solely in the labour and skill which the author has expended in collecting, sifting and arranging information or in making calculations so as to produce the resulting work. Though much of the matter contained in such works may of itself be unoriginal, that which is protected is the product of the compiler's individual labour and skill in collation or calculation.

On the other hand, mere cutting down of a standard work into a form suitable for schools has failed to receive protection. There must be real exercise of labour and skill and not a mere commonplace selection of ordinary items of information. Artistic works are defined as including paintings, drawings, sculptures and photographs and engravings, and works of artistic craftsmanship and architectural works of art. An engraving or photograph may be made of a picture and it has been decided that such a work is original though depicting the same object or scene as the picture. The definition of dramatic work includes choreographic work or entertainment in dumb show, if reduced to writing. This definition excludes mere "gag" which has no fixed form, but it would include, for example, the movements of a musical-comedy chorus, which are often represented for the producer by a rough sketch or by symbols.

The wide definition of artistic works in the 1911 act included designs, which were already protected by the Designs acts but for a shorter period and subject to registration. It was therefore provided by s. 10 of the Copyright act, 1956, that designs registered under the Designs act, 1949, or reproduced in large numbers should not receive copyright protection. The corresponding provision under the 1911 act gave rise to a great deal of difficulty because, although the intention obviously was to exclude only purely utilitarian devices, the definition in the Designs act was and still is wide enough to include purely artistic works such as sculptures and some paintings or drawings. If reproductions of these are intended to be sold in any quantity, therefore, such works enjoy only the lesser protection given by the Designs act and require registration.

Under part ii of the Copyright act, 1956, copyright subsists in sound recordings, motion-picture films and television and sound broadcasts made by the British Broadcasting corporation or the Independent Television authority. It also subsists in every published edition of a literary, dramatic or musical work provided it does not reproduce the typographical arrangement of a previous edition.

Rights of Owners of Copyright.—Copyright is the exclusive right to do certain acts in relation to the work, known as "restricted" acts. In the case of literary, dramatic and musical works, the restricted acts are those of reproducing the work in any material form, publishing it, performing it in public, broadcasting it or causing it to be transmitted to subscribers to a diffusion service, and making any adaptation of the work. In the case of an artistic work, the restricted acts are reproducing the work in any material form, publishing it, including it in a television broadcast and causing a television program which includes the work to be transmitted to subscribers to a diffusion service. It is an infringement to do or to authorize another to do any of the restricted acts in relation to the work without the permission of the copyright owner. Section 5 (1) of the 1956 act provides for the liability of persons dealing with articles which they know to infringe copyright by selling such works or by distributing or exhibiting them by way of trade. It is also an infringement of copyright to import for sale into the country any work which to the importer's knowledge would infringe copyright if made there. An additional protection to copyright owners is the provision in s. 18 (1) that any copy of a work which is an infringement of the owner's copyright is the property of the owner. The owner can therefore bring an action for recovery or damages against anyone in possession or who has been in possession of such copies.

There are three exceptions to the general rule that the author is the owner of the copyright: (1) Where a literary, dramatic or artistic work is made by the author in the course of his employment by the proprietor of a newspaper or periodical under a contract of service for publication in a newspaper or periodical, the proprietor is entitled to the copyright insofar as it relates to newspapers and periodicals. For all other purposes, however, the author remains the owner of the copyright. (2) A person who commissions any photographs, portrait, drawing, painting or engraving for good consideration is entitled to the copyright. (3) If a work is made by the author in the course of his employment under a contract of service, the copyright belongs to his employer.

The owner of copyright can assign his right or may grant interests therein by way of licence. He may assign any separate part of the rights given him by the act and he may assign his rights for a limited area or for a limited period of time. The assignee is in the position of an owner in respect of the right assigned. No assignment is effective unless it is in writing signed by or on behalf of the assignor. The 1956 act provided for the establishment of a performing-rights tribunal to decide disputes between licensing bodies and persons requiring licences or organizations claiming to represent such persons.

Duration of Copyright Protection.—Copyright in published literary, dramatic and musical works endures for 50 years from the year of the author's death. The period is the same for artistic works, except in the case of photographs, and of engravings not published at the death of the author, copyright in which runs for

50 years from the year of first publication. Copyright in works falling within part ii of the 1956 act lasts for varying periods dependent on the nature of the work in question, the most usual period being 50 years from the year of first publication. In the case of new editions the copyright lasts for 25 years from the year when the new edition was first published.

Infringement of Copyright.—Infringement of copyright under the act of 1956 is committed by any person who does or authorizes another to do any of the restricted acts in relation to the work in question without the licence of the copyright owner. As under the old law, it is essential for the owner of copyright to prove that a defendant has either copied his work or copied something which was itself a copy. Resemblance, though it may often lead to the inevitable conclusion that the defendant has in fact seen the plaintiff's work and so be excellent evidence that copying has occurred, is not in itself sufficient to substantiate a claim for infringement. The resemblance, though resulting from the fact that the second author has seen the original, may be so remote as not to injure the first author.

In fact, however, one of the most difficult questions which the courts have to determine is whether a defendant has so far copied the plaintiff's work that he can be said to have created a colourable imitation of it, or whether he has taken the idea only and clothed it in a new literary or artistic form. This problem arises forcibly in the case of plays which are alleged to infringe the copyright in a novel and in the case of motion-picture films. Because of the differences between the forms of expression in such cases, it is unlikely that much literal copying will be discoverable. The result of decisions on the subject appears to be that while the mere taking of a plot is not sufficient in itself to constitute an infringement, yet this, coupled with a close resemblance of situations and incidents, even without the taking of actual words or phrases, will be enough to give rise to a cause of action. In dealing with the question of colourable imitations of artistic works the following test has been suggested: "A copy is that which comes so near the original as to suggest that original to the mind of every person seeing it."

Another matter which has to be considered in relation to infringements is whether enough of the first work has been taken to create a wrong. The act provides that it is an infringement to take "a substantial part" of the original work. Cases dealing with the earlier acts which, though they did not use this exact phrase, were held to have implied it, have decided that "substantial" does not refer to quantity alone but also to the importance of the part taken in relation to the whole; a few bars out of a long piece of music may contain the essential melody or a few lines may hold the real beauty of a poem, and the taking of these bars or lines would certainly be prohibited.

A further question which arises is how far copyright can be infringed by reproductions in a different form of art. The infringement of literary and dramatic works by their respective reproduction as plays or novels has already been mentioned, as has also the question of mechanical reproductions. It had been considered before the act of 1911 that a statue would not infringe the copyright in a picture. The judgment given in the living-picture case of *Hanfstaengl* v. *Empire Palace,* 1894, 2 Ch. I, had decided that *tableaux vivants* did not infringe the copyright in the picture which they purported to represent, and it was thought that this doctrine would apply also in the case of sculptures. Under the act of 1911, however, it was an infringement to reproduce the copyright work "in any material form whatsoever." By virtue of these words a *tableau vivant* was in *Bradbury Agnew and Co.* v. *Day,* 32 Times L.R., 349, held to infringe the copyright in a picture; and by the decision of the house of lords in *King Features Syndicate, Inc.* v. *O. and M. Kleeman, Ltd.,* 58 Rep. Pat. Cas., 57, 207, it was clear that three-dimensional articles such as sculptures and two-dimensional works such as drawings or pictures might be infringements of one another respectively. Under the 1956 act it is necessary to contrast the words of s. 3 (5) (a), whereby "reproducing the work in any material form" is a restricted act, with the provisions of s. 9 (8), according to which "the making of an object of any description, which is in three dimensions, shall not be taken to infringe the copyright in an artistic work in two dimensions, if the object would not appear, to persons who are not experts in relation to objects of that description, to be a reproduction of the artistic work." These provisions would seem likely to lead to fresh confusion.

Permitted Reproductions.—The Copyright act, 1956, expressly provides that certain acts shall not constitute an infringement of copyright. There is a general provision that any fair dealing with a work for purposes of criticism or review or for the purpose of reporting events in a newspaper, magazine or periodical or by means of handwriting or in a motion-picture film shall be allowed. Obviously "fair dealing" is difficult to define, but it would seem that the question of whether the two works compete is of importance in judging the fairness of the reproduction. A liberty of a similar nature is the publication of short passages from published literary works in collections for the use of schools. There are also special exceptions in the case of reproduction for the purpose of judicial proceedings and, in certain cases, by librarians.

There is a further provision which was also intended to protect the innocent, since it provides that if a defendant proves that at the date of the infringement he was not aware of and had no reasonable ground for suspecting that copyright subsisted in the work the plaintiff shall not be entitled to damages. It was held, however, in *Byrne* v. *Statist,* 1914, I K.B. 622, that this provision did not assist a defendant who thought he had a licence to copy but was innocently mistaken. Since any work may be the subject matter of copyright, it is very difficult for any defendant to prove that he had no ground for suspecting that any particular work was covered, so that the section does not in practice afford much protection.

Commonwealth.—The scheme of the Copyright act of 1911 was that it should extend throughout the dominions as one comprehensive code. The act initially applied to British possessions but not to the self-governing dominions. It was provided that either the act might be declared to be in force in such a dominion by its own legislature or that, if a self-governing dominion enacted a similar act, the secretary of state for the colonies might by certificate cause the imperial act to apply to the colony, or, if the dominion legislature did not go so far in following the imperial act but gave adequate protection to British subjects residing elsewhere, an order in council could give protection in Britain to the subjects of that dominion. The dominions took different courses. Australia adopted the act but with certain modifications. New Zealand and Canada adopted their own copyright acts, but in both cases certificates were given by the secretary of state for the colonies. By orders in council made from time to time under the provisions of s. 28 of the act of 1911, that act was extended to certain protectorates. The 1956 act does not have such a wide scope territorially. It does not extend automatically to the colonies, though it may be so extended by order in council to protectorates.

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INTERNATIONAL COPYRIGHT

The early copyright laws of all countries limited protection to their own nationals or residents. The first International Copyright act of Great Britain was passed in 1838, and it was not until 1891 that the United States passed a statute enabling qualified nonresident foreign authors to have their works protected under U.S. copyright law. The international copyright relations of most countries are governed by multilateral conventions, the earliest being the Berne union of 1886, which has been periodically revised. More than 40 nations have adhered to one or the other of the latest revisions—the Rome revision of 1928 or the Brussels revision of 1948. The Copyright act of the United Kingdom, as revised in 1956, conformed the British domestic law to the re-

quirements of the Brussels revision.

The United States has never been a party to the Berne union, but U.S. works are protected in Berne union countries if published in one of those countries simultaneously with their publication in the United States. Most U.S. books and musical compositions are simultaneously published in both the United States and Canada in order to ensure Berne protection. The most recent multilateral copyright treaty is the Universal Copyright convention, adopted in Geneva in 1952 and adhered to by both the United States and the United Kingdom. In addition to these world-wide conventions, 17 countries of the western hemisphere, including the United States, have adhered to the Buenos Aires convention of 1910. As of the early 1960s, there were no copyright relations between the United States and the Soviet Union, Communist China, Egypt, Iran, Turkey and Venezuela.

The Berne Convention.—The core of the Berne convention is its provision that each of the contracting countries shall provide automatic protection for works first published in other countries of the Berne union and for unpublished works whose authors are citizens of or resident in such other countries.

Each country of the union must guarantee to authors who are nationals of other member countries the rights which its own laws grant to its nationals. If the work has been first published in a Berne country but the author is a national of a nonunion country, the union country may restrict the protection to the extent that such protection is limited in the country of which the author is a national (art. vi). As of the early 1960s, this retaliatory provision had not been invoked. The works protected by the Rome revision of 1928 include every production in the literary, scientific and artistic domain, regardless of the mode of expression, such as books, pamphlets and other writings; lectures, addresses, sermons and other works of the same nature; dramatic or dramatico-musical works, choreographic works and entertainments in dumb show, the acting form of which is fixed in writing or otherwise; musical compositions; drawings, paintings, works of architecture, sculpture, engraving and lithography; illustrations, geographical charts, plans, sketches and plastic works relative to geography, topography, architecture or science. It also includes translations, adaptations, arrangements of music and other reproductions in an altered form of a literary or artistic work, as well as collections of different works. The Brussels revision of 1948 added cinematographic works and photographic works. In addition, both the Rome and Brussels revisions protect works of art applied to industrial purposes so far as the domestic legislation of each country allows such protection.

One of the controversial features of the Berne convention is the protection of so-called "moral rights." The Rome revision provides that, independently of the author's copyright and even after transfer of such copyright, the author shall have the right to claim authorship of the work, as well as the right to object to any distortion, mutilation or other modification of the work which would be prejudicial to his honour or reputation. It permits every country, however, to determine the conditions under which these rights shall be exercised and the means of redress for safeguarding them (art. vi). The Brussels convention expressly provides that these rights shall continue after the author's death at least until the expiration of copyright and shall be exercisable by the persons or institution authorized by the domestic legislation of the country where protection is sought.

The term of copyright in the Rome revision for works other than photographic works, posthumous works, anonymous and pseudonymous works is the life of the author plus 50 years, but it was recognized that some countries might have a shorter term. With respect to works originating in such countries, the shorter term provided by their law governs in all other countries even though the latter have a longer term of protection. U.S. works first published in Canada (a Berne country) enjoy (in all Berne countries) the Canadian term of copyright, which is life plus 50 years, although the United States term of 56 years may expire sooner. In the case of works of joint authors, the term is measured from the date of the death of the author who died last. The Brussels revision of 1948 requires a minimum term of protection of the life of the author plus 50 years, provided that if a particular country grants a longer term its nationals cannot claim a term longer than life plus 50 years in countries which limit copyright protection to that period, and in no event may the term be longer than that in the country of origin. The Brussels revision permits domestic legislation to fix the term of copyright for cinematographic and photographic works and provides for a term of 50 years from the date of publication in the case of anonymous and pseudonymous works where there is doubt about the author's identity. The term for posthumous works is 50 years after the death of the author (art. vii of both revisions).

Both revisions protect the right of making translations (art. viii). With respect to articles in newspapers, news items have no protection at all; articles on current economic, political or religious topics may be copied by the press unless the reproduction is expressly forbidden, but the source from which they are copied must be clearly indicated (art. ix).

The specific rights accorded to authors are more clearly set forth in the Brussels revision than in the Rome revision. Authors of dramatic, dramatico-musical or musical works are guaranteed the exclusive right of authorizing the public presentation and performance of their works, as well as their public distribution by any means (art. xi). This protection is subject to the limitation that with respect to the right of radio diffusion or of communication to the public by any other means of wireless diffusion of signs, sounds or images, or the communication to the public over wires or loudspeakers, each country may determine the conditions under which the rights apply; provided, however, that such domestic legislation must not be prejudicial to the moral right of the author or to his right to obtain just remuneration which, in the absence of agreement, shall be fixed by competent authority (art. xi). Such rate-fixing bodies are provided for in the laws of Great Britain, Canada and Turkey.

Additional rights are the right of public recitation and the exclusive right of authorizing adaptations, arrangements or other alterations (art. xi, xii). Authors of musical works have the exclusive right of authorizing the recording of their works and the public performance of such recordings, subject to domestic legislation which must not be prejudicial to the author's right to obtain just remuneration (art. xiii). Authors of all works have the exclusive and absolute right of authorizing the making, distribution and presentation of motion pictures (art. xiv).

The Brussels revision introduced a new doctrine called the *droit de suite*, which safeguards the inalienable right of an author to an interest in any sale of his work of art or original manuscript subsequent to the first disposal of the work by the author. In spite of the express grant of this right, it is not mandatory but exists only where enacted by domestic legislation. Such legislation may name the persons or institutions who become the beneficiaries of this right after the author's death as well as indicate the procedure for collection and the amounts to be collected (art. xiv).

The convention established an international office under the authority of the Swiss government to examine copyright questions and to publish a periodical report on the current changes in the law of copyright (art. xxi). Nonmember states may join the union by giving notice of their accession in writing to the Swiss government (art. xxv). In the early 1960s the following countries adhered to the Rome revision but not to the Brussels revision: Australia, Bulgaria, Canada, Ceylon, Czechoslovakia, Denmark, Finland, Federal Republic of Germany, Hungary, Iceland, Japan, Lebanon, Netherlands, New Zealand, Norway, Pakistan, Poland, Rumania, Sweden and Syria.

The following countries adhered to both Rome and Brussels: Austria, Belgium, Brazil, France, Greece, Holy See, India, Republic of Ireland, Israel, Italy, Liechtenstein, Luxembourg, Monaco, Morocco, Portugal, Spain, Republic of South Africa, Switzerland, Tunisia, United Kingdom and Yugoslavia (subject to reservation with respect to translations into the national languages of Yugoslavia).

The Philippines, Dahomey and Turkey have adhered only to the Brussels revision, the latter country taking a reservation with respect to the right of translation.

The Universal Copyright Convention.—The Universal Copyright convention of 1952 (U.C.C.), sponsored by the United Nations Educational, Scientific and Cultural organization, differs from the Berne convention in two important respects: (1) it does not provide for automatic copyright protection without formalities (although it limits formalities to a prescribed form of copyright notice indicated below); (2) it does not require adhering countries to ensure any minimum basis of protection to authors of other countries so long as domestic authors are not accorded more favourable treatment, except that all adhering countries must grant an exclusive right of translation for a seven-year period, subject to a compulsory licence under certain circumstances for the balance of the term of copyright. In addition, the minimum term of copyright in member countries (except for photographic works and works of applied art, which have a ten-year term) must be the life of the author plus 25 years. However, if the term of protection in any contracting state on the effective date of the convention in that state is less than life of the author plus 25 years, these shorter periods of protection will control, provided that the term of protection for any class of work shall not be less than 25 years from the date of first publication (art. iv). The U.C.C. thus depends on national treatment for the duration of protection of a work, unlike the Brussels revision of the Berne convention which requires a minimum term of the life of the author plus 50 years.

The only formality permitted is a copyright notice in all copies of the work, consisting of the symbol ©, the name of the copyright owner and the year of first publication. The place of notice is not prescribed but the notice must be placed in such a manner and location as to give reasonable notice of the claim of copyright (art. iii). If the notice is properly given and the work is first published in any member country, each other member must accord the same protection to the author as it accords to domestic works first published by its own citizens (art. ii). However, each country may require other formalities for works first published in its territory or for works of its nationals wherever published (art. iii). Like the protection accorded by the Berne convention, photographs and works of applied art are protected only in those member countries which protect them by domestic legislation.

The convention did not abrogate any other multilateral or bilateral conventions or arrangements between two or more member states. Where there are any differences, the provisions of the U.C.C. are to prevail except as regards the Berne convention, which takes priority over the U.C.C., and conventions or arrangements between two or more American republics.

As of the early 1960s, 40 countries had ratified or acceded to the U.C.C., including both the United States (which adhered in 1954) and the United Kingdom (which adhered in 1957). These countries were: Andorra, Argentina, Austria, Belgium, Brazil, Cambodia, Chile, Costa Rica, Cuba, Czechoslovakia, Denmark, Ecuador, France, Federal Republic of Germany, Haiti, Holy See, Iceland, India, Republic of Ireland, Israel, Italy, Japan, Laos, Lebanon, Liberia, Liechtenstein, Luxembourg, Mexico, Monaco, Nicaragua, Nigeria, Pakistan, Paraguay, Philippines (which adhered to and later denounced the U.C.C.), Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

Buenos Aires Convention.—The Buenos Aires convention of 1910 comprises 17 western-hemisphere countries including the United States. Authors of member states, whether nationals or domiciled foreigners, are assured exclusive power of disposing of their literary and artistic works, of publishing, assigning, translating and reproducing them in any form whether wholly or in part (art iv). Although the convention appears to provide for protection of the reproduction rights of authors, two cases in the United States have held that, with respect to musical compositions, in the absence of a specific presidential proclamation for the country concerned relating to mechanical reproduction rights, the Buenos Aires convention does not secure the right of mechanical reproduction to nationals of other member countries (*Todamerica Musica, Ltda.* v. *Radio Corporation of America,* 171 F. 2d 369 [1938]; *Portuondo* v. *Columbia Phonograph Co.,* 81 F. Supp. 355 [1937]).

The Buenos Aires convention has eliminated all formalities except those required by the country of origin, provided however that a statement in the work indicates the reservation of the property right (art. iii). Copyright protection obtained in one member country secures protection in all other member countries. Authors enjoy in the different signatory countries the rights granted by the laws of those countries, not to exceed the term of protection in the country of origin (art. vi). Protection cannot exceed that granted by the country in which it is claimed.

Translations are protected as original works (art. iv and ix). The country of origin is the convention country of first publication, and if a simultaneous publication appears in several signatory countries the country which fixes the shortest period of protection is deemed the country of origin. The confiscation of publications infringing copyright is provided for (art. xiv).

The members of the Buenos Aires convention in the early 1960s were: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Nicaragua, Panamá, Paraguay, Peru, United States and Uruguay. Nine of these countries were also members of the Universal Copyright convention: Argentina, Brazil, Chile, Costa Rica, Ecuador, Haiti, Nicaragua, Paraguay and the United States.

Place and Length of Copyright.—The table shows, for each country listed, the office (if any) charged by statute with responsibility for copyright matters (or which is the legal depository of copyrighted works) and the duration of the copyright term in years. (In some countries a shorter duration applies for photographic works, works of applied art, anonymous, pseudonymous and posthumous works, and works by artificial legal entities such as corporations.)

Country, Office and Duration of Copyright

Country	Office	Duration in years
Andorra	None	Life + 25
Argentina	National copyright registry	Life + 50
Australia	Copyright office	Life + 50
Austria	Ministry of education	Life + 50
Belgium	Ministry of public education	Life + 50
Bolivia	Ministry of public education	Life + 30
Brazil	National library, national music institute or national school of fine arts of the federal districts	Life + 60
Bulgaria	Copyright office	Life + (1) surviving parents for their life; (2) surviving spouse for his or her life or until remarriage; or (3) all others until majority
Burma, Union of	President of the union	Life + 50
Cambodia	None	Life + 25
Canada	Copyright office	Life + 50
Ceylon	None	Life + 50
Chad	None	Life + 50
Chile	National library	Life + 50
China, Republic of	Ministry of interior	Life + 30
Colombia	Governors of departments; national library; library of the national university	Life + 80
Costa Rica	Directorate general of public libraries; industries department of ministry of industries; National library; office of the secretary of public education	Life + 50
Cuba	Secretary of education	Life + 80
Cyprus	None	Life + 50
Czechoslovakia	None	Life + 50
Dahomey	None	Life + 25
Denmark	None	Life + 50
Dominican Republic	Copyright registry; state secretariat of education and fine arts	Life + 30
Ecuador	District registration offices; Ministry of education; National library; Provincial library	Life + 50
Egypt (U.A.R.)	National library	Life + 50
El Salvador	Ministry of development	Life + 25
Finland	Ministry of education	Life + 50
France	None	Life + 50 (plus periods of two world wars)
German Federal Republic	None	Life + 50
Ghana	None	Life + 50
Greece	None	Life + 50
Guatemala	None	Life + 50
Haiti	Secretariat of state for home affairs	Life + life of surviving spouse plus 20 if there are children, or plus 10 if no children
Holy See (*See* Italy)		
Honduras	Patent office; secretariat of development	10, 15 or 20
Hungary	Patents court; office for copyright protection	Life + 50
Iceland	None	Life + 50
India	Copyright office; copyright board	Life + 50

Country, Office and Duration of Copyright (Continued)

Country	Office	Duration in years
Indonesia	None	Life + 50
Ireland, Republic of	Industrial and commercial property registration office; National Library of Ireland; Library of Trinity College, Dublin; National University of Ireland; British museum	Life + 50
Israel	None	Life + 50
Italy	Office of literary, scientific and artistic property of under secretariat for the press and information	Life + 50 (plus periods of two world wars)
Japan	Administrative office; ministry of education	Life + 30
Jordan, Hashemite Kingdom of	Ministry of education; directorates of education	Life + 30
Korea	Ministry of education	Life + 30
Laos	None	Life + 50
Lebanon	Copyright protection office	Life + 50
Liberia	Department of state	Life + 25
Liechtenstein	None	Life + 50
Luxembourg	Miuistry of state	Life + 50
Mexico	Secretariat of education; general copyright directorate	Life + 25
Monaco	None	Life + 50
Netherlands	Ministry of justice	Life + 50
New Zealand	Copyright office	Life + 50
Nicaragua	Ministry of development; national library; general archives; national conservatory of music; school of fine arts	Perpetual
Nigeria	None	Life + 50
Norway	None	Life + 50
Pakistan	Central government	Life + 50
Panamá	Secretariat of education	Life + 80
Paraguay	Ministry of education	Life + 50
Peru	Ministry of education; National library	Life + 20
Philippines	Copyright office; bureau of public libraries and museum	30 + 30
Poland	Council of ministers	Life + 20
Portugal	Director of National library; register of intellectual property	Perpetual
Rumania	Ministry of culture	Life + (1) surviving spouse and ascendants for lives of each; (2) descendants for 50 years; (3) others for 15 years
South Africa, Republic of	Copyright office	Life + 50
Soviet Union	Ministry of education	Life + 15
Spain	Ministry of development; general directorate of public education	Life + 80
Sweden	Justice department	Life + 50
Switzerland	Federal council; bureau of intellectual property	Life + 50
Syria	Copyright protection office	Life + 50
Thailand	Noue	Life + 30
Tunisia	African copyright office	Life + 50
Turkey	None	Life + 50
United Kingdom	Board of trade; British museum	Life + 50
United States	Copyright office	28 + 28
Uruguay	National library; copyright council	Life + 40
Venezuela	Copyright registration office; ministry of interior; ministry of development; ministry of education	Life + 30
Yugoslavia	Secretariat of public education and culture of the executive federal council	Life + 50

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COQUELIN, (BENOÎT) CONSTANT (1841–1909), French actor, known as Coquelin *aîné* to distinguish him from his brother (*see* below), was born at Boulogne on Jan. 23, 1841, the son of a pastry cook. He studied acting at the Conservatoire in 1859 and on Dec. 7, 1860, made his debut at the Comédie Française as the comic valet in Molière's *Dépit amoureux*. At the age of 23 he was a full member of the Théâtre Français (Comédie Française). Mascarille in Molière's *Étourdi* and Figaro, comic valets of brilliant exuberancy, were his greatest parts in the classical repertory, but he did not confine himself to the drolleries and effronteries of agile servants. He could also be delicate and pathetic when he played Pierre in Théodore de Banville's *Gringoire* (1866), and a romantic lover in the title role of Charles Lomon's *Jean Dacier* (1877). The old Alsatian schoolmaster in Erckmann-Chatrian's *Ami Fritz* (1876) was likewise within his range, as well as the chief in Octave Feuillet's *Chamillac* (1886). Coquelin was equally at home in prose tirades, which he could build to an artful climax, and in the delivery of verse, which he handled with superb virtuosity.

In 1886 he resigned his position at the Comédie Française because he intended to tour in Europe and the United States, rejoining the Comédie in 1890. Two years later he left the House of Molière for good and toured the European capitals with a company of his own. He was a member of the Renaissance theatre in Paris from 1895 until 1897, becoming in the latter year director of the Théâtre de la Porte St. Martin, where he created Rostand's Cyrano (1897). In 1900 he toured in America with Sarah Bernhardt. During his last years he acted on the boards of the Théâtre Sarah Bernhardt. He died on Jan. 27, 1909, while rehearsing for Rostand's *Chantecler*. Coquelin *aîné* was the author of three treatises on the craft of the actor: *L'Art et le comédien* (1880), *Les comédiens par un comédien* (1882) and *L'Art du comédien* (1894).

His younger brother, ERNEST ALEXANDRE HONORÉ COQUELIN (1848–1909), called Coquelin *cadet*, was a member of the Comédie Française from 1879 until his death. He specialized in supporting comedy parts. (A. M. N.)

COQUES (Cocx), **GONZALES** (1614–1684), Flemish portrait painter, son of Pieter Willemsen Cocx, was born at Antwerp on Dec. 8, 1614. At the age of 12 he was apprenticed to Pieter Brueghel III and later became a journeyman in the workshop of David Ryckaert the elder. At 26 he matriculated in the guild of St. Luke; he then married Ryckaert's daughter. He became president of his guild in 1665, and in 1671 painter in ordinary to Count Monterey, governor general of the Low Countries. A few genre pictures by Coques are known, but his characteristic métier is the full-length portrait group painted on a small scale and in a technique nearer to the contemporary genre painters than to his older compatriots Rubens and Van Dyck. However, in composition and colour his groups show the influence of Van Dyck, and sometimes he also achieves a pleasingly fluent handling. He died in his native place on April 18, 1684. (R. E. W. J.; X.)

COQUIMBO, province and city of northern Chile. The province lies between Aconcagua and Atacama provinces and extends from the Pacific to the Argentine frontier. It is within the arid to semiarid region of east-west trending valleys and brush-covered ridges which is known as the Little North (Norte Chico). Area 15,401 sq.mi. Pop. (1960) 308,991. It is one of the eight original Chilean provinces created in 1826; nevertheless, alterations in boundaries and in administrative subdivisions have occurred. Present limits and internal administrative structure date from 1929 and 1939, respectively.

Pastoral activity (goats, sheep, cattle) is widespread, but the economically more important irrigation and dry farming are concentrated primarily in the valleys of the Elqui, Limarí and Choapa. Subtropical fruit, wines, small grains, edible legumes, early vegetables and alfalfa are produced, primarily for the national market. Mining is scattered, but large-scale operations exist near La Serena (*q.v.*), the provincial capital. Iron ore (formerly at El Tofo and after 1956 at Romeral), gold and manganese are the most valuable minerals but apatite, silver, copper and lead are produced also. There is a cement plant near Cerro Juan Soldado. From 1956 most of the iron ore has been shipped abroad or to the steel town of Huachipato, Concepción, through the mechanized loading facilities at Guayacán, although some is embarked at Coquimbo. The large iron-ore operation is foreign controlled; other mining activities and cement production are Chilean owned.

COQUIMBO, main port and second city of the province (pop. [1960] 41,304 mun.), was founded in 1850. Its industry includes fertilizer manufacture and ore concentrating. The roadstead and dock area, among the best sheltered in Chile, is winter haven for the Chilean navy as well as embarkation point for such cargoes as

cement, phosphate fertilizer, agricultural products and various ores and concentrates. Coquimbo and the adjacent La Serena have air, highway and rail communication to the north and south. Branch railways extend into the Choapa and Elqui valleys from the longitudinal line. Among the towns served by the Elqui branch is Vicuña (pop. [1960] 12,106 mun.), birthplace of the poetess Gabriela Mistral (Nobel prize, 1945). Other cities of note are Ovalle (46,553 mun.) and Illapel (21,662 mun.). About 23 mi. S.E. of Coquimbo is the small village of Andacollo famous for the shrine of the Virgen del Rosario de Andacollo, a place of pilgrimage. (J. T.)

CORACIIDAE, members of the roller family, remarkably coloured old world birds belonging to the order Coraciiformes (*q.v.*). *See* ROLLER.

CORACIIFORMES, an order of birds comprising several families of doubtful mutual affinities: the Coraciidae (rollers; *q.v.*), Meropidae (bee eaters) and Upupidae (hoopoes; *q.v.*) of the old world; the Phoeniculidae (wood hoopoes) of Africa and Leptosomatidae (cuckoo rollers and ground rollers) of Madagascar; the Bucerotidae (hornbills; *q.v.*) of Africa and southern Asia; the Momotidae (motmots; *q.v.*) of tropical America and Todidae (todies; *q.v.*) of the Greater Antilles; and the cosmopolitan Alcedinidae (kingfishers; *q.v.*). In the most recent classifications, the oil-bird, frogmouths and nightjars (*qq.v.*) or goatsuckers are separated as the order Caprimulgiformes, the swifts and hummingbirds (*qq.v.*) as the order Apodiformes (Micropodiformes), the colies (coly; *q.v.*) as the order Coliiformes, and the trogons (*q.v.*) as the order Trogoniformes. *See* BIRD: *Classification* for complete classification of birds.

CORAL, the stony skeletal structure built by any of several simple marine plants and animals, such as calcareous algae and the coral polyp. The skeleton of the polyp, for instance, is built by cells on its bottom and sides that extract calcium carbonate from the sea and deposit it as solid limestone at the polyp's bottom and upward from there to form the walls of the tube-shaped shell that encases the polyp. Limestone processes also are projected inward, creating an interior of stone-walled compartments that the body of the polyp occupies. The animal continues to build upward as it grows and only the top of its body appears over the edge of its stone house. Branching colonies of coral are formed by the budding of new polyps from the tops of older ones, each new creature undertaking the building of its own limestone shell. Coral polyps also are reproduced from eggs expelled by a parent and by a vertical division of the creature's body into two distinct polyps. When a polyp dies its skeleton of coral remains. (*See* ANTHOZOA: *Zoantharia: Order Scleractinia.*)

The famed precious red coral is found in Mediterranean waters and has been used for centuries as an ornamentation. The Gauls decorated their helmets and weapons of war with coral. The Romans not only prized it for its beauty but also attributed magical and medicinal virtues to it. Roman children wore necklets of coral to ward off danger. It was valued greatly in India and the far east also. India frequently provided so large and so lucrative a market for the substance that the supply in Europe was sometimes severely limited.

The richest yields of coral come from the coastal waters of Algeria and Tunisia. Other profitable deposits are found off the coasts of Spain, Provence, Sardinia, Corsica, Sicily, and in the Bay of Naples. Coral is found at depths ranging from 20 to 1,000 ft. The finest quality, however, is generally found at depths of 100 to 160 ft. Coral is attacked by worms and sponges that bore into it and cause discoloration and decay. Precious coral that is sound usually ranges in colour from white through pink to a deep red. Colour in single pieces of coral tends to be uniform and variations in shade are rare.

Coral fishing is chiefly a summer occupation. The best catches are usually made about five miles out to sea, although some coral can be found nearer shore. The fishermen drag for coral with systems of weighted nets. The catch is brought aboard the fishing boat and sorted out. Coral that shows decay or discoloration has only a marginal value and usually is returned to the sea. Pieces of ordinary red coral in varying sizes are in greatest number, but there are generally some specimens of rare size and beauty. It is estimated that about ten years are required for a coral bed to replenish itself; consequently a bed is fished only once every ten years.

Coral is processed largely by Italian craftsmen who are skilled in the art of cutting, polishing and carving the material. Small pieces of different shapes are perforated and strung on cords as bracelets and necklaces. Beads, some of them carefully faceted, are fashioned, and domed pieces are formed to set in brooches. The skill of the craftsmen is demonstrated best in their expertly carved cameos and small figurines of coral. The coral industry is centred in the Neapolitan area, particularly at Torre del Greco.

A shining, jet-black coral found in the Indian ocean is highly esteemed in India. The name "king's coral" was conferred upon it because the sceptres of kings were made of it. From Japan comes a lovely shell-pink coral with a pearly sheen. Skilful Japanese craftsmen have created a considerable demand for their finely wrought products.

The coral reefs of the tropics provide limestone material that has been found useful in building roads. The great coral reefs are built by coral polyps and calcareous algae called nullipores. The reef is a mass of cemented skeletal material that has been modified by the placing into solution and recrystallization of its original calcareous content. The top of the reef is largely overlaid by shell and coral flotsam carried in by the sea, and few living creatures are present. On the seaward slope of the reef, however, healthy growths of coral polyps and nullipores increase and multiply, and proceed with their limestone building. Road-making material is obtained from the tops and faces of the reefs by dredging. Blasting is sometimes required.

The coral reefs have been the subject of much geophysical research. Efforts have been made to determine their geological age and to account for the particular nature of the coral atolls.

See CORAL REEF; also references under "Coral" in the Index volume. (E. L. Y.)

CORAL-BELLS, a hardy perennial herb (*Heuchera sanguinea*) belonging to the saxifrage family (Saxifragaceae; *q.v.*). It is exclusively North American ranging from Mexico to the arctic regions. Coral-bells, the best known of the alumroots (*Heuchera genus*), is a compact, bushy plant growing in tufts with flower stems about 18 in. tall. From its ornamental foliage rise graceful spikes covered with pendant flowers about the size of lily-of-the-valley bells, of a bright coral-crimson colour, blooming about the middle of the summer. The sprays of bloom make excellent cut flowers.

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CORAL-BELLS (HEUCHERA SANGUINEA)

Coral-bells are most attractive when planted by themselves among shrubbery. They are effective also when planted in rockery, where they become robust and the foliage completely covers the rocks. They like a warm soil of medium texture, but will grow in almost anything but pure sand and heavy clay, and they prefer an open or partly shaded situation.

Propagation is by division of the crowns during spring, the divisions being replanted in beds of sandy soil in a warm sheltered position and grown there for a year. (R. T. V. T.; X.)

CORAL GABLES, a residential city of Dade county, on the lower east coast of Florida, U.S., adjoining Miami on the southwest. George E. Merrick developed the city from a nucleus of his family's 160 ac. of citrus and farm land and named it in 1925, the year it was incorporated, for the family's gable-roofed "coral" (actually limestone) house. Well-planned from the beginning,

A CORAL ATOLL IN THE INDIAN OCEAN

Left: A reef flat, exposed at low tide, forming a fringe of coral and containing varied marine life along the shore of one of the Keeling Islands

Below: West Island, largest atoll in the Keeling Islands, showing typical coral formation enclosing a quiet lagoon. The island is protected from the pounding surf by the outer reef in the foreground

PHOTOGRAPHS BY JOHN DOMINIS FOR "LIFE." © TIME INC. 1959

CORAL REEF

Damselfish among clusters of coral which serve to protect them from larger predators. At top and left are colonies of staghorn (*Madrepora*) corals; rounded corals in centre are Porites

A collection of deep-sea corals, photographed with ultraviolet light, glowing with fluorescence. Among them are mushroom, brain, rose and soft corals

FORMATIONS OF CORAL

(TOP) PHOTOGRAPH BY JOHN DOMINIS FOR "LIFE." © TIME INC., 1959. (BOTTOM) PHOTOGRAPHED FOR "LIFE" BY TOM HUTCHINS. © TIME INC., 1959

building is still controlled by a board of supervising architects. Winter residents live chiefly in their own winter homes or in apartments. There are 12.25 sq.mi. of land area and 22.75 sq.mi. of water in the city. Six miles of waterway navigable for small boats provide access to Biscayne bay and outside waters. Recreational facilities include the Venetian pool, five parks, an extensive youth centre and golf courses. Two private and one veterans hospital are in the city. The University of Miami, founded in 1925 in Coral Gables, is made up of seven schools and a graduate school. The Lowe Art gallery, the University of Miami Symphony orchestra and the "Miracle Mile" shopping area win patronage from greater Miami. For comparative population figures *see* table in FLORIDA: *Population.* (C. W. TE.)

CORAL REEF, a ridge formed in shallow ocean areas by the calcareous skeletons of certain coelenterates, of which coral polyps are the most important. The biology of these marine animals is discussed in ANTHOZOA and COELENTERATA. Coral polyps build a small skeleton around themselves, and also produce new polyps called buds, which remain attached to the parent skeleton, create a new skeleton of their own and form new buds. By repetition of this process a great mass of coral skeletons is produced, and the resultant form is called a coral reef. There are three chief types of reef: (1) the barrier reef, backed by a lagoon in which an island is located; (2) the atoll (*q.v.*), in which the reef, taking the shape of an irregular horseshoe or ring, encloses a lagoon with no island; and (3) the fringing reef, a sea-level flat, built out from the shore of a continent or island.

Corals can live only under fairly restricted conditions. Reef builders cannot live more than 300 ft. beneath the sea surface, and corals proper do not live below 150-ft. depth. Corals cannot endure temperatures lower than 65° F. nor higher than 96°, flourishing best between 77° and 86°. They cannot live out of water. Because they demand such warm water, corals are found mostly within the tropics, their maximum range being from about latitude 30° N. to a slightly higher latitude south. Corals prefer moving water because it brings more food and contains more oxygen. They cannot tolerate very silty water because it will bury them. Corals usually establish themselves by attaching to rocks, but in still water they can live directly on sand. The great area for coral reefs is the central, western and southwestern Pacific, but other extensive coral formations are found in the West Indies, along the coast of Brazil, in the Red sea, the western Indian ocean and Indonesia.

The outer edge of the coral reef pitches downward at a steep angle, sometimes to more than 1,000 ft. depth. In places the reef may overhang, having been built outward by the coral polyps in an effort to reach additional light. Where the surf is great, corals ordinarily cannot live at depths of less than six or eight feet, but certain kinds of algae, which can, add to the substance of the reef at the windward edge. The character of the reef's inner slope, dropping off into the lagoon, varies according to its exposure to waves. It is usually a gentle slope, covered with calcareous sand derived from the reef surface.

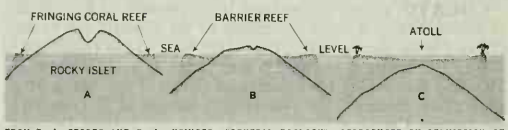
The surface of the reef varies from a few hundred feet to a few thousand feet in width. It lies nearly at sea level, and during periods of low tide the higher parts project above the surface of the water. Calcareous sand and blocks are strewn over the surface and caught in the hollows. On large reefs low islands sometimes develop from detritus derived from the reef surface.

The lagoons that lie behind barrier reefs and in the centres of atolls have mostly smooth, sandy bottoms, but some contain numerous (even hundreds) of little hills formed by coral erected from the bottom of the lagoon.

Barrier reefs usually are pierced by several channels which give access to the lagoon and island behind the reef. Around the leeward sides of most islands possessing fringing reefs there are large interruptions of the reef. The most famous of all barrier reefs is the Great Barrier reef of northeastern Australia (*see* BARRIER REEF), which is more than 1,100 nautical miles in length. Atolls range in size from less than a mile to more than 40 mi. in diameter. The parts of the reef are the same as those of the barrier reef. Chains of small atolls are called faros.

Coral reefs and their associated lagoons are commonly very beautiful and attractive places. The lagoons are generally calm and extremely clear and the water is an extraordinarily attractive and characteristic shade of blue. The inner slope of the reef thus exhibits an abundance of colourful and variegated animal life, and the often colourful coral, while out on the reef itself a giant surf may ceaselessly pound.

The problem of the origin of coral reefs is one of the most difficult in geomorphology. Since the 19th century attempts have been made to account for coral reefs by a single theory of origin, but students have begun to believe that several factors are important and that different reefs have had quite different histories. The first scientific theory to explain coral reefs was developed by Charles Darwin, who asserted that the reefs began to grow around



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL CO., INC.

DARWIN'S THEORY OF FORMATION OF A CORAL REEF: (A) FRINGING CORAL REEF ENCIRCLES A ROCKY OCEANIC ISLET; (B) BARRIER REEF ENLARGES AS SEA LEVEL RISES (OR LAND SINKS); (C) AS SEA LEVEL CONTINUES TO CHANGE, AN ATOLL, SURROUNDED BY THE CORAL REEF, REPLACES THE ISLET

islands as fringing reefs and that as the island gradually sank beneath the sea the coral grew upward and outward as rapidly as the sea rose. Thus the fringing reef became a barrier reef. As the island sank completely beneath the sea the barrier reef became an atoll. Numerous other theories have been developed, of which the most important is based on known fluctuations in sea level during the glacial periods. Darwin's subsidence theory, however, still explains more facts of coral development more rationally than any other. *See* also PACIFIC ISLANDS.

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(W. C. C.)

CORAL SEA, BATTLE OF THE (May 7–8, 1942), the first naval engagement in which all losses were inflicted by air action and no ship on either side sighted an enemy vessel. The main objective of the U.S. forces was a Japanese fleet under Adm. Takeo Takagi en route from Rabaul to capture Port Moresby on the island of New Guinea. About noon on May 7, Japanese planes sank the U.S. naval tanker "Neosho" and the escorting destroyer "Sims." Planes from Adm. Frank Jack Fletcher's American carriers, "Yorktown" and "Lexington," sank the small Japanese carrier "Shoho." On the morning of May 8, planes from the "Yorktown" damaged the "Shokaku," another Japanese carrier, with two bomb hits. Both the "Lexington" and the "Yorktown" were hit by Japanese planes and the "Lexington" eventually sank. The Japanese force withdrew and returned to Rabaul. *See* WORLD WAR II: *The War at Sea.*

CORAM, THOMAS (1668–1751), English philanthropist who established the London Foundling hospital, was born at Lyme Regis, Dorset. He became a merchant sea captain, trading between England and America, but from about 1693 to 1703 he was a boatbuilder and farmer at Boston and at Taunton (Mass.), and he finally retired to England in 1720. Appalled at the number of infants abandoned in London, he enlisted the help of influential people and after 17 years' work obtained in 1739 a royal charter for a hospital for foundling infants (*see* FOUNDLING HOSPITAL). He had used all his money on the scheme and an annuity of 160 guineas was raised for him by public subscription. Coram also worked to promote the settlement of Georgia and Nova Scotia. He died in London on March 29, 1751.

See R. H. Nichols and F. A. Wray, *The History of the Foundling Hospital* (1935). (FR. C. B.)

COR ANGLAIS, a wood-wind instrument also known as the

English horn. It is a large oboe pitched a fifth below the ordinary oboe, from which it also differs in having a bulbous bell, and at the top end a bent metal crook on which the double reed is placed. Its music is written a fifth higher than it sounds. The name first appeared in Vienna, about 1760; "cor" refers to the curved or hornlike shape in which the instrument was then built, but "anglais" remains a mystery (an allusion to the Anglo-Hanoverian bugle horn has been suggested). The curved form survived locally up to 1900, though the modern straight form was first exhibited by Henri Brod of Paris in 1839. The veiled, pastoral tone has been romantically employed in many operas and symphonic works, and the instrument, played by an oboist, is a regular member of the orchestral wood wind and is used also for Bach's *oboe da caccia* parts. *See* also OBOE. (A. C. BA.)

CORATO, a town of southeast Italy, province of Bari, region of Puglia, lies on a slope descending to the Adriatic sea 41 km. (25 mi.) W. of Bari by road. Pop. (1957 est.) 43,554 (commune). The ancient centre of the town is surrounded by modern buildings. The chief features are the romanesque church of Sta. Maria Maggiore (13th century), the 14th-century church of S. Domenico, the Palazzo Catalano (15th century) and the Palazzo Ottinera. The main industries are agriculture, including vegetables, and the production of wine and oil. Founded by the Normans, Corato became subject to Alfonso V of Aragon at the end of the 15th century and later to the Carafa. In World War II it was captured by the Allies in Sept. 1943. (M. T. A. N.)

CORAX OF SYRACUSE (5th century B.C.) is believed to have written the first Greek treatise on rhetoric. There is little reliable information about his life or his work, of which nothing survives. He was active at a time when democratic constitutions had replaced tyrannies in Sicily. He specialized in the theory of forensic oratory and is said to have advocated argument "from probability" and to have prescribed rules for the subdivision of speeches. Corax and his pupil Teisias were proverbially associated by the Greeks and Romans with legal quibbling.

See L. Radermacher, *Artium Scriptores* (1951). (H. L. H.-W.)

CORBEIL (CORBAIL, CORBEUIL), **WILLIAM OF** (d. 1136), archbishop of Canterbury, was born probably at Corbeil on the Seine and educated at Laon. He entered the order of St. Augustine, became prior of the Augustinian foundation at St. Osyth in Essex and in 1123 was chosen archbishop of Canterbury, being consecrated only after a long conflict with Thurstan, archbishop of York. After a dispute with the papal legate, Cardinal John of Crema, William himself was appointed legate in England and Scotland, an important precedent in the history of the English church. William built the keep of Rochester castle and finished the cathedral at Canterbury, which he dedicated with great pomp in May 1130. He died at Canterbury on Nov. 21, 1136.

See the article by T. F. Tout in the *Dictionary of National Biography*, where earlier work on the subject is summed up.

CORBEL, in architecture, a means of supporting a projecting weight; a bracket or weight-carrying member, built deeply into the wall so that the pressure on its embedded portion counteracts any tendency to overturn or fall outward. Corbels may be either individual pieces of stone, separated from each other like brackets, as in the case of many medieval cornices; or continuous courses of masonry, *e.g.*, the corbels under projecting oriel windows. A corbel table is a projected band or string course carried on corbels. Corbels are favourite places for decoration. Medieval cornices frequently have corbels ornamented with leaves, animals or human heads, and the corbels common in English Gothic, to support vaulting shafts, are rich with leafage. The sides and faces of Renaissance corbels are carved with scrolls and acanthus leaves. In many cases corbels have molding, without other carving, especially those carrying medieval battlements. Corbels decorated with an S-scroll are known as consoles. *See* also ARCH AND VAULT.

FROM F. S. MEYER, "HANDBOOK OF ORNAMENT"

SIDE VIEW OF CONSOLE FROM THE VATICAN, ROME

CORBETT, HARVEY WILEY (1873–1954), U.S. architect, one of the designers of Rockefeller Center, New York city, and other distinguished modern public buildings, was born in San Francisco, Calif., Jan. 8, 1873. He graduated from the University of California, Berkeley, in 1895 and from the École des Beaux-Arts, Paris, in 1900. As a member of the firm of Corbett and MacMurray he was instrumental in designing the Bush Terminal office building, New York; Bush house, London; and Holy Innocents church, Brooklyn, N.Y.

The firm of Corbett, Harrison and MacMurray collaborated with others in creating the imposing group of skyscrapers of Rockefeller Center. Constructed between 1932–40, the buildings represent the first skyscrapers built as a unified group. Corbett died April 21, 1954, in New York city.

His wife, GAIL SHERMAN CORBETT (1873–1952), a sculptor, was born in 1873 in Syracuse, N.Y. Her best-known works are the Hamilton S. White memorial and the Kirkpatrick fountain in Syracuse, N.Y., the bronze entrance doors of the municipal group at Springfield, Mass., and the medallion head of Washington in the pediment of the George Washington National Masonic memorial at Alexandria, Va. She died in New York city Aug. 27, 1952.

CORBETT, SIR JULIAN STAFFORD (1854–1922), British naval historian, was born at Imber court, Thames Ditton, Surrey, Nov. 12, 1854. After attending Trinity college, Cambridge, he was called to the bar by the Middle Temple in 1877 and practised law until 1882. He published a number of novels and then became a lecturer on history at the Naval War college. Corbett's fame rests on his naval writings, which include: *Drake and the Tudor Navy* (1898); *The Successors of Drake* (1900); *England in the Mediterranean, 1603–1714* (1904); *England in the Seven Years' War* (1907); *The Campaign of Trafalgar* (1910); *Some Principles of Maritime Strategy* (1911); and *The Official History of the Great War Naval Operations* (1920–23). He was knighted in 1917 and died Sept. 21, 1922. (J. B. HN.)

CORBETT, RICHARD (1582–1635), bishop of Oxford and Norwich, and one of the most fashionable minor Caroline poets. Born at Ewell, Surrey, in 1582, he was educated at Westminster school, Broadgates hall (later Pembroke college) and Christ Church, Oxford, with which college many of his poems are connected. In the controversy with the Puritan party in the university, Corbett supported the Arminians, under Laud, but he owed his advancement to friends like Sir Thomas Aylesbury, a patron of learning and secretary to the duke of Buckingham. In 1620 he became dean of Christ Church; his marriage to the daughter of a canon of the cathedral brought him a son, Vincent (to whom he addressed one of his happiest poems) and a daughter. Flattering verses written to Buckingham helped to procure him (in 1628) the bishopric of Oxford, whence Laud translated him (1632) to Norwich, a larger though hardly more lucrative see. Corbett constantly satirized the Puritans, but he did little to repress their activities in East Anglia. He died in Norwich, July 28, 1635. His memory survives partly because of several good stories told of him by John Aubrey, but more because of his felicitous "Faeries Farewell," from the first line of which Rudyard Kipling took the title *Rewards and Fairies*. Most of his other verses (including the long "Iter Boreale," in heroic couplets) were occasional, and no edition appeared till 1647; the value of this and later collections is discussed by J. A. W. Bennett and H. R. Trevor-Roper in their edition (1955), which includes a biography, notes and a list of manuscript sources.

See also O. Gilchrist's edition (1807), the only one between the 17th century and the 20th, a valuable work including a *Life*. (J. A. W. B.)

CORBIÈRE, TRISTAN (real name ÉDOUARD JOACHIM CORBIÈRE) (1845–1875), an important and original French poet, was born, July 18, 1845, at Coat-Congar, near Morlaix, Brittany. Educated at Morlaix and the *lycées* of Saint-Brieuc and Nantes,

he settled in Roscoff where, apart from three years in Paris, he spent the rest of his life and wrote most of his only volume of poems, *Les Amours jaunes* (1873). The main themes are love, Paris, the sea and, above all, Brittany. But Corbière is more than the poet of Brittany and his realistic pictures of sea-faring life and the pilgrims at the *pardon* of Ste. Anne transcend the region that inspired them. He is original in his use of irony and of a familiar, spoken kind of poetry in opposition to the elevated lyricism of the Romantics whom he frequently parodied. His work has affinities with that of Charles Baudelaire, but he did not belong to any literary school and was almost unknown until Paul Verlaine included him in *Les Poètes maudits* (1884). His importance as an innovator and his greatness as a poet are generally recognized, as is also the influence he exercised on several French writers (notably Jules Laforgue; *q.v.*), on the development of French poetry and on the early works of Ezra Pound and T. S. Eliot. He died at Morlaix, March 1, 1875.

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CORBRIDGE, a town of Northumberland, Eng., is 17 mi. W. of Newcastle by road, on the north bank of the Tyne, there crossed by a seven-arched bridge of 1674. Pop. (1951) 2,434. The Roman station of Corstopitum lay ½ mi. W. on the line of Dere Street and was the principal Roman military and civilian settlement behind Hadrian's wall. It was abandoned in the 5th century, but by about 760 nearby Corbridge was again an important town in the Northumbrian kingdom, and its church dates partly from this period. It was the scene of a battle in 914, was occupied by David of Scotland in 1138, and ravaged by Wallace in 1296, by Bruce in 1312 and by David II in 1346. It has two peel towers, one the vicar's house, and many harmonious 18th- and 19th-century houses and market place. The Roman excavations and museum are open to the public. (MI. G. C.)

CORBULO, GNAEUS DOMITIUS (d. A.D. 67), Roman general, gained successes on the Rhine in A.D. 47 over the German tribe of the Frisii and a reputation which led to his appointment by the emperor Nero as legate of Cappadocia and Galatia in 54 to recover Armenia, then occupied by Tiridates, brother of the Parthian king, Vologaeses (*q.v.*). At first Corbulo seems to have proposed that Tiridates should hold Armenia as a Roman vassal; only when this was rejected, did he invade Armenia (58–60), and install a Roman nominee, Tigranes, on the throne. Corbulo then retired to his province of Syria. But Tigranes provoked a new Parthian attack (61), and as he was unable to maintain himself without Roman aid, and Vologaeses still refused the proffered compromise, Nero sent out L. Caesennius Paetus, ostensibly to conquer Armenia from Cappadocia, while Corbulo defended Syria. Paetus, however, was forced to surrender at Rhandeia (62) and Corbulo once more had to enter Armenia with a larger army to restore Roman prestige. Vologaeses at last recognized that he could not secure Armenia for Tiridates by force (63) and after prolonged negotiations Tiridates went to Rome and did homage to Nero (66). Corbulo remained in Syria till 67, when his son-in-law Annius Vinicianus conspired against Nero. Corbulo was recalled and had to commit suicide. His exceptionally long tenure of command shows that he had till then enjoyed Nero's confidence; despite some modern theories, he must have been the trusted executant, if not the prompter, of Nero's Armenian policy.

See Tacitus, *Annals*, xii–xv *passim*; J. G. C. Anderson in *Cambridge Ancient History*, vol. x, ch. 22 and bibliography (1934). (P. A. BR.)

CORBY, a town and urban district of Northamptonshire, Eng., lies 22 mi. N.E. of Northampton by road. Designated as one of the New Towns (*q.v.*) in 1950, Corby grew from a village of 1,596 people (1931 census) to a community of 36,322 in 1961. The anticipated population is 70,000. The town centre, opened in 1954, is built on an "H" pattern comprising the three main streets, the market square and bus station and enclosed by the police station, courthouse, civic centre, technical college and library. The civic centre gives access to a public open space of about 225 ac. Corby stands at the centre of an iron ore bed stretching from Lincolnshire to Oxfordshire, and the surrounding areas of woodland were originally part of Rockingham forest. The church of St. John the Baptist dates from the 13th century. The chief industry is the manufacture of steel tubes, the Corby works being one of the largest in Europe. (G. B. BL.)

CORDAY, CHARLOTTE (1768–1793), the assassin of the French revolutionary Jean Paul Marat (*q.v.*), was born at St. Saturnin, near Séez, in Normandy on July 27, 1768, of the noble family of Corday d'Armans. Educated in a convent at Caen and royalist by sentiment, with an easily excitable imagination, she is said to have derived ideas of grandeur and heroism from the literature of the Enlightenment. When the Girondins were being overthrown in the Convention in Paris (May–June 1793), she was living with an aunt in Caen. Caen then became the centre of a "federalist" movement in the Norman *départements* against the Convention, and the Girondin refugees J. Pétion de Villeneuve, François Buzot and Charles Barbaroux arrived to urge military action against Paris. Inspired especially by Barbaroux, Charlotte Corday decided to devote herself to the Girondin cause and set off for Paris. There she saw how Marat's newspaper was exercising a predominant influence on the masses. After writing to solicit an interview with Marat on the pretext of wanting to tell him of events in Caen, she went to his house and finally got herself admitted to his presence while he was in his bath. When she named persons connected with the dissidence in Normandy, he noted them and assured her that they would be guillotined in a few days. She then drew a knife from under her dress and stabbed him through the heart. This was on July 13, the very day on which the insurgent Normans marching on Paris were defeated by a column of Parisian *sans-culottes* at Pacy-sur-Eure. Arrested on the spot, Charlotte Corday was sentenced to death by the Revolutionary tribunal and executed on July 17, 1793. Her act of assassination had a very different effect from what she had expected; it prompted the Convention and the people of Paris to take effective measures against counter-revolution. These saved the republic.

See C. Vatel, *Charlotte Corday et les Girondins*, 3 vol. (1864–72). (A. So.)

CORDELIERS, CLUB OF THE (SOCIETY OF THE FRIENDS OF THE RIGHTS OF MAN AND OF THE CITIZEN), one of the popular clubs of the French Revolution. It was founded in the Paris district of the Cordeliers and at first held its meetings in the nationalized monastery of the Cordeliers (Franciscans of the strict observance). Its main aim, as quoted by the *Moniteur* of May 5, 1790, shortly after the club's foundation, was "to denounce to the tribunal of public opinion abuses of the various powers and all infractions of the rights of man."

In 1791, under the leadership of such men as Marat and Danton, the Cordeliers became a political force. Having denounced (April 17) Louis XVI's collusion with the resistance to the Civil Constitution of the Clergy and the support that this collusion was receiving from the mayor of Paris, J. S. Bailly, and inspired the demonstration (April 18) against the king's proposal to leave Paris for St. Cloud, the club was expelled from the convent on May 12. It then reassembled at the Salle du Musée in the rue de Thionville (now rue Dauphine). After the king's flight to Varennes (June), the club demanded his deposition and, to present their petition, organized the famous demonstration in the Champ-de-Mars (July 17), which was dispersed by the national guard, 50 demonstrators being killed. Some of the Cordeliers, including A. F. Momoro, editor of the club's *Journal*, were then arrested, others went into hiding, but the club was meeting again by August.

After the fall of the monarchy (Aug. 1792) Danton and his friends seem to have neglected the club, leaving such men as Momoro, F. R. Vincent, C. P. H. Ronsin and, most important, J. R. Hébert (*q.v.*) in control of it. In 1793 the Cordeliers took a preponderant part in the overthrow of the Girondins. Thenceforward they were the extremists of the popular movement, favouring autonomy for the local sections, direct democracy, the formation of the "revolutionary army" to terrorize Paris, and

the atheistic program of the Paris Commune. Conflict with the government ensued. When Vincent and Ronsin were arrested (Jan. 11, 1794) under pressure from the moderates, the Cordeliers reacted violently, expelled their own moderate members (including Camille Desmoulins) and secured the prisoners' release (Feb. 2). Then, on March 4, they attempted to seize power by insurrection. This failed. Hébert and his friends were arrested and, on March 24, executed.

The leaderless remnant of the club tried a *rapprochement* with the Jacobins but fell into stagnation and oblivion. By the end of 1794 nothing more was heard of it.

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CORDIERITE, a silicate of magnesia, ferrous oxide, and alumina, is a rock forming mineral named in 1813 by R. J. Hauy in honour of P. L. Cordier who discovered its remarkable pleochroism, or exhibition of different colours when viewed from different directions.

The natural mineral, sometimes known as iolite, has little or no commercial use, principally due to the large amount of ferrous iron in the crystals. Synthetic magnesian cordierite has a low thermal expansion and is valuable as a semirefractory thermal shock resistant ceramic material.

Cordierite occurs in igneous rocks only as a result of contamination of the magma by aluminous sediment. As such it is known in granites, norites, rhyolites, andesites and lamprophyres. The true home of cordierite is in the thermally altered argillaceous or clayey sediments surrounding igneous intrusions and in the paragneisses (*see* GNEISS) and schists. In the former it is the commonest constituent of the spots of spotted slates. In the hornfelses it is frequently associated with andalusite, sillimanite, spinel and corundum. Pre-Cambrian deposits of the Laramie range, Albany county, Wyo., contain more than 500,000 short tons of cordierite analyzing 8%–11% FeO, 6%–7% MgO, about 2% CaO, 28%–30% Al_2O_3 and 50%–52% SiO_2.

Fine, well-developed crystals of cordierite are rare. It crystallizes in the orthorhombic system, well developed crystals being usually short prisms with large basal planes. In rocks cyclic twins are common, giving crystals a pseudohexagonal habit. A. Miyashiro, T. Iiyama and their colleagues have claimed that at least two pseudohexagonal forms of cordierite occur in nature and that these forms differ from the more pure, practically iron-free synthetic compounds which have been called α, β and μ-cordierite. They suggest that the synthetic forms be called α, β and μ-indialite and that cordierite be reserved for the naturally occurring types.

In refraction, density and hardness, natural cordierite resembles quartz (*q.v.*), but it can be distinguished by its optical character when viewed under the petrographic microscope.

The formula of cordierite is $2(Mg,Fe)O.2Al_2O_3.5SiO_2$. Pure magnesian cordierite can be prepared artificially, a low temperature β form by hydrothermal methods (by H. S. Yoder at 490° C. and 5,000 lb. per square inch), a high temperature α form by reacting MgO, Al_2O_3 and SiO_2 above 1,300° C., and a metastable μ form by crystallizing the finely powdered glass at 850° C. for 15 days. The β and μ forms revert easily to the α form when heated to 1,000° C. Synthetic cordierite will take silica into solid solution, forming a range of compositions from $2MgO.2Al_2O_3.5SiO_2$ to $MgO.Al_2O_3.4SiO_2$. The 2:2:5 composition melts incongruently to mullite ($3Al_2O_3.2SiO_2$) and glass at 1,470° C. and it will completely melt at 1,530° C. (F. A. HL.)

CORDILLERA, a Spanish term for a range or chain of mountains, derived from the Old Spanish *cordilla*, the diminutive of *cuerda*, a cord or rope. The name first given to certain mountain ranges of South America, Las Cordilleras de los Andes, was applied to the extension of the system into Mexico. In North America the Rocky mountains, the Sierra Nevada and the mountains between them are collectively known as the Cordilleras, and the entire area has been termed the Cordilleran region. The name is not restricted to the Americas but is often used as a generic term for any long parallel ranges of mountains.

CORDILLERA, LA, a department of central Paraguay (area 1,910 sq.mi.; pop. [1960 est.] 184,415), was previously named Caraguatay. Its present name is derived from Cordillera de los Altos, the spur of the Brazilian plateau which reaches the Paraguay river bounding the department on the west. The principal road of Paraguay, the Mariscal Estigarribia highway, penetrates this hilly country where the capital, Caacupé, is situated. Piribebuy, the scene of a critical battle (Aug. 12, 1869) in the War of the Triple Alliance and a centre of a fertile agricultural district producing sugar, oranges, tobacco and cattle, is also in La Cordillera. San Bernardino on Lake Ypacaraí is Paraguay's most famous tourist resort. (G. J. B.)

CORDITE, a British propellant of the double-base type, so called because of its customary but not universal cordlike shape. Double-base propellants generally contain nitrocellulose (guncotton), a liquid organic nitrate (*e.g.*, nitroglycerin) having the property of gelatinizing nitrocellulose, and a stabilizer. The amounts of these ingredients may vary but generally have contained 30% to 40% nitroglycerin and 5% petroleum jelly as a stabilizing agent. Cordite is soluble in acetone, which is used in colloiding the mixture. The original cordite (Cordite Mark I), as manufactured at the royal gunpowder factory, Waltham Abbey, Eng., in 1890, was composed of 37 parts of guncotton, 57.5 parts of nitroglycerin and 5 parts of mineral jelly together with 0.5% of acetone. Because of its large content of nitroglycerin this cordite had a high temperature of explosion and produced considerable erosion of big guns. A modified composition, Cordite M.D., which was introduced in 1901, contained 64 parts of guncotton, 30.2 parts of nitroglycerin and 5 parts of petrolatum with about 0.8% of acetone. Cordite M.D. proved to be a very stable composition with long storage life. The nitrocellulose had a nitrogen content of 13.1%. Modified cordite compositions containing other organic nitrates, replacing the nitroglycerin, were introduced during World War II. Such nitrates include dinitrotoluene, nitronaphthalene, nitroguanidine and diethylene glycol dinitrate (DEGN). The use of these nitrates significantly lowered the burning temperature, which resulted in reduced gun erosion, permitting the firing of many more rounds from a gun barrel. *See* EXPLOSIVES; PROPELLANTS. (P. M. FE.)

CÓRDOBA, a central province of Argentina. Pop. (1960) 1,759,997; area 65,161 sq.mi. The western margins of the province contain the famous mountains, Sierras de Córdoba, which rise to an altitude of 9,462 ft. above sea level. The land slopes eastward to the great pampa, being drained by the five rivers rising in the sierras (Primero, Segundo, Tercero, Cuarto and Quinto). Only the Tercero reaches the Paraná; the others terminate in swamps or in the saline Mar Chiquita in northeast Córdoba.

Winters are mild and summers hot in Córdoba. Most rain falls between November and February. Except in their highest parts the sierras are forested, but the plains form part of the great pampa grassland. The wooded valleys and contrasting relief of the hills make the sierras a favourite holiday centre.

The principal settlements in Córdoba were founded in the 16th century, when trade was carried on with Bolivia and Chile. Cattle and mules were bred on the plains and in the irrigated valleys for the farms of the province of Salta. Córdoba was a stubborn centre of Spanish resistance in the war of independence but joined the republic in 1816. In 1852–62 it strongly supported the Argentine confederation against the dominance of Buenos Aires. The completion of the railway from Rosario in 1869 was the first important link with the east, but Córdoba remained a centre of provincial loyalties and played a significant part in the overthrow of Pres. Juan Perón in 1955.

Córdoba shared the general economic expansion resulting from the increased investment and immigration of the late 19th and early 20th centuries, which transformed the Argentine pampa. More than 15,000,000 ac. are devoted to the production of wheat, maize, flax, alfalfa, oats and barley. Stock-raising is of great importance; granite and limestone are quarried; and wolfram, mica and beryllium are mined in the sierras. The chief industrial

centres, which process foods and manufacture textiles, are the capital Córdoba, Río Cuarto (*qq.v.*) and Villa Maria. Alta Gracia, Cosquín, La Cumbre, Capilla del Monte and La Falda are important tourist resorts in the sierras. A network of 3,000 mi. of roads, 3,000 mi. of railways and national and international airlines provide the province with excellent communications.

(G. J. B.)

CÓRDOBA, a department of northern Colombia facing the Caribbean sea. Area 9,945 sq.mi.; pop. (1961 est.) 418,400. Córdoba was created out of the southwest portion of the department of Bolívar in 1952. It is one of the most important cattle-raising areas of Colombia, annually exporting thousands of head to interior and export markets. Cotton, rice and maize have been cultivated on extensive holdings along the Sinú river. The capital and chief town is Montería (1951 pop. 23,682). It is connected with Medellín and Cartagena by daily air service and by river boat with Cartagena and the lower Sinú ports of Cereté and Lorica. During most of the colonial period the area was sparsely settled, the original dense Indian population, evidenced by archaeologic remains, having disappeared by the time of the first major Spanish *entrada* in 1534. A large proportion of the settlers, especially in the area above Montería, come from Antioquia. *See* COLOMBIA.

(Js. J. P.)

CÓRDOBA, the third city of Argentina, capital of the central province of the same name, lies on the Río Primero, 432 mi. by rail northwest of Buenos Aires via Rosario. Pop. (1960) 589,153. The city stands on a high plain called the *altos*, 1,440 ft. above sea level, the older part being south and west of the river. Founded in 1573 by Jerónimo Luis de Cabrera, Córdoba was long the regional headquarters of the Jesuits and for a time capital of the Spanish *intendencia* of Tucumán. The Jesuit foundation of the university in 1613 made Córdoba the cultural metropolis of southern South America. It played an important part in the struggle between Buenos Aires and the provinces. Pres. Domingo Sarmiento (*q.v.*) completed the railway from Rosario to Córdoba, thus linking the city to the developing economy of the pampas. Córdoba remained the traditional centre of conservatism but after 1912 its control by the Radicals reflected the growth of the industrial population. In 1955 Gen. Eduardo Lonardi's capture of Córdoba initiated the downfall of Pres. Juan Perón.

Córdoba's rich colonial inheritance is displayed by the old *cabildo* (town council chambers), the cathedral, the viceroy's palace, and the Jesuit churches grouped near the core of the old city. The Plaza San Martín commemorates the liberator of Argentina.

The new town is built on a rectilinear plan. Colleges of mining and agriculture, the republic's premier astronomical observatory and numerous industrial plants indicate its regional importance. The Dique San Roque on the Río Primero is one of the largest dams in South America. It supplies Córdoba with water and makes possible the irrigation of orchards and grain fields. The dam also is the source of hydroelectric power for the city's leather, textile, glass and food-processing factories.

Córdoba is the railroad and highway hub of central Argentina, providing the principal links between the pampas and the important centres of the northwest. It has an airport at Pagos Blancos.

(G. J. B.)

CÓRDOBA (CÓRDOVA), capital of the southern Spanish province of the same name, lies on the southern slopes of the Sierra de Córdoba and the right bank of the Guadalquivir river (ancient Baetis), 132 km. (82 mi.) N.E. of Seville by rail. Pop. (1960 est.) 189,566 (mun.). Córdoba is an episcopal see. It is a typically Moorish city with narrow winding streets, especially in the older quarter of the centre and west. Apart from several ruined towers and gates, few fragments remain of the ancient walls which once surrounded it, except in the southwest where they show traces of Roman foundations, and in the northeast. The hills behind the city are planted with olive and orange groves and there are gardens beyond the walls on the west. A Moorish bridge with 16 arches on Roman bases connects Córdoba with its suburb across the river. At the southern end of the bridge stands the tower of La Calahorra; at the north a ruined gateway and near by an elevated statue of the city's patron, Archangel Raphael. West of the bridge, near the river, lies the Alcázar or palace quarter, probably the original nucleus of the town. Here stood the Roman civil and military buildings which the Arab caliphs converted into a royal residence. The site of the Old Alcázar, where the royal guards were quartered, was gradually built over by workmen's houses. The New Alcázar, which was the palace itself and later the residence of the Holy Inquisition, is now mainly in ruins, except one wing, which is used as a prison. Gardens overlooking the river, the bishop's palace and an ecclesiastical seminary also occupy part of the site. Other important public buildings are the old monastic establishments, the churches (notably S. Hipólito and S. Nicolás de la Villa), the city hall, the hospitals, the schools and colleges (including the academy for girls, founded in 1590 by Bishop Pacheco of Córdoba, which is empowered to grant degrees), a music conservatory, and museums of fine arts and archaeology.

But the glory of Córdoba, surpassing all its other Moorish or Christian buildings, is the *mezquita*, or mosque, now a cathedral (consecrated in 1236 to honour the Assumption of Mary), but originally founded on the site of a Roman temple and a Visigothic church by Abd-al-Rahman I, who wished to make his capital a great religious centre, rivalling those of the east. The growing population of the city soon rendered a larger mosque necessary and, by orders of Abd-al-Rahman II and al-Hakam II, the original size was doubled. After various minor additions, al-Mansur, the vizier of the caliph Hisham II, again enlarged the Zeca, or House of Purification, as the mosque was named, to twice its former size, rendering it the largest sacred building of Islam, after the Kaaba at Mecca. The ground plan of the completed mosque forms a rectangle, measuring 590 ft. by 425 ft., or little less than St. Peter's in Rome. About one-third of this area is occupied by the famous Patio de los Naranjos (Court of the Oranges) and the cloisters which surround it on the north, west and east. Passing through the courtyard, the visitor enters on the south a labyrinth of pillars in which porphyry, jasper and many-coloured marbles are boldly combined. Part came from the spoils of Nîmes or Narbonne, part from Seville or Tarragona, some from the older ruins of Carthage and others as a present to Abd-al-Rahman I from the Byzantine emperor Leo IV, who sent also from Constantinople his own skilled workmen, with 16 tons of tesserae for the mosaics. Originally of different heights, the pillars have been adjusted to their present standard of 13 ft. either by being sunk into the soil or by the addition of Corinthian capitals. The present 850 pillars divide the building into 19 north-to-south and 29 east-to-west aisles, each row supporting a tier of open Moorish arches of the same height (12 ft.), with a third and similar tier superimposed upon the second. The Moorish character of the building was unfortunately impaired in the 16th century by the erection in the interior of a *crucero*, or high altar and large cruciform choir, by the formation of numerous chapels along the sides of the vast quadrangle and by the addition of a belfry 300 ft. high in place of the old minaret. The removal of modern vaulting has revealed a wooden Moorish ceiling carved and painted and still practically intact. The most exquisite work in the whole mosque is found in the third *mihrâb*, or prayer niche, a small octagonal recess roofed with a single block of white marble, carved in the form of a shell and with its walls inlaid with Byzantine mosaics.

JOSEF MUENCH

BELL TOWER OF THE CÓRDOBA CATHEDRAL, 1593. THE CATHEDRAL WAS BEGUN IN 785

Córdoba was celebrated in Moorish times for its silversmiths, its silk embroideries and for a peculiar kind of leather which took its name from the city, whence is derived the word "cordwainer." Fine gold and sil-

ver filigree ornaments are still produced but the leather industry has degenerated into an imitation of Moorish work. The chief modern industries of Córdoba are brewing and distilling and the manufacture of textiles. Besides some copper from neighbouring mines, the main trade is in filigree work and oil and rough clothing for sale in the Andalusian fairs. Tourist traffic forms an important source of wealth to the inhabitants.

History.—Corduba, probably of Carthaginian origin, was occupied by the Romans under Marcus Marcellus in 152 B.C., and shortly afterward became the first Roman *colonia* in Spain, later with the title of *Patricia*. After the battle of Munda in 45 B.C. the city was severely punished by Julius Caesar, and 20,000 of its inhabitants were massacred for having supported the sons of Pompey. Under Augustus, if not before, it became a municipality, and capital of the province of Baetica. Strabo (*c.* 63 B.C.–*c.* A.D. 21) testifies to its importance at this period. Its prosperity was due partly to its position on the Baetis, then navigable up to the city, and on the Via Augusta, the great commercial road from northern Spain built by Augustus, and partly to its proximity to mines and rich grazing and grain-producing districts. Under the rule of the Visigoths from the 6th century to the beginning of the 8th century its importance declined but, captured and largely destroyed by the Moors in 711, it entered 50 years later on its period of greatest prosperity. In 756 Abd-al-Rahman I made it the capital of Moorish Spain. Under the Omayyad dynasty the city was reconstructed and filled with palaces and mosques and the walls extended so that the enclosed area was doubled. It reached the summit of its splendour in the middle of the 10th century, under Abd-al-Rahman III (*see* CÓRDOBA, CALIPHATE OF). A period of decadence began in 1010 owing to rivalry for the caliphate, and in 1236 Córdoba was easily captured by Ferdinand III of Castile. The substitution of Spanish for Moorish supremacy rather accelerated than arrested the decline of art, industry and population; and in the 19th century Córdoba never completely recovered from the disaster of 1808, when it was stormed and sacked by the French. It was captured by Gen. Francisco Franco Bahamonde's nationalist troops early in the civil war of 1936–39.

The city is noted as the birthplace of the rhetorician Marcus Annaeus Seneca, and his more famous son Lucius (*c.* 4 B.C.–A.D. 65); of the poet Lucan (A.D. 39–65); of the philosophers Averroës (1126–98) and Maimonides (1135–1204); of the Spanish men of letters, Juan de Mena (1411–56) and Luis de Góngora y Argote (1561–1627); and of the painters Pablo de Céspedes (1538–1608) and Juan de Valdés Leal (1630–91). The celebrated captain Gonzalo Fernández de Córdoba (*q.v.*), the conqueror of Naples, was born in the nearby town of Montilla.

CÓRDOBA PROVINCE forms part of Andalusia (*q.v.*). Pop. (1960) 798,437. Area 5,296 sq.mi. The Guadalquivir river, flowing through the province from east-northeast to west-southwest, divides it into two very dissimilar portions. North of the river lies the Sierra Morena, a sparsely populated mountainous area which provides winter pastures for the Castilian sheep flocks. Coal mining is carried on at Peñarroya-Pueblonuevo, and silver-lead and zinc are also mined. South of the narrow Guadalquivir valley lie the fertile plains known as La Campiña, rising in the southeast through undulating country to the borders of the Sierra Nevada. These plains are adapted to the cultivation of cereals and provide grazing land for bulls and horses. There are fine vineyards and olive groves, and salt is mined at Rute. This region is the basis of the present wealth of the province and has a density of population twice that of the Sierra Morena. The climate exhibits great contrasts. Snow may lie for months on the mountain peaks while temperatures are mild in the plains, except in the few torrid summer months, when rain seldom falls. Apart from the provincial capital, the most important towns (pop. 1960) are: Puente-Genil (30,185), Lucena (28,287), Priego de Córdoba (25,168), Montilla (23,896), Cabra (20,739), Palma del Rio (15,757) and Rute (13,106). The main Madrid-Linares-Seville railway line follows the Guadalquivir valley and at Córdoba meets the north-south line from Almorchón to Málaga.

See also references under "Córdoba" in the Index.

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CÓRDOBA, CALIPHATE OF, the Muslim state that existed in Spain from Jan. 16, 929, when Abd-al-Rahman III assumed the supreme title of caliph, to 1031, when the puppet ruler Hisham III was deposed by his viziers and the caliphate disintegrated into the so-called kingdoms of the Taifa. During this century there were 12 caliphs, all except the first two of whom were puppets and most of whom died by violence.

Abd-al-Rahman III (*q.v.*) was followed by the studious al-Hakam II (961-976), who gathered a library of 400,000 catalogued volumes, founded 27 free schools in Córdoba and attracted scholars from the east to teach in the university. His reign was succeeded by the dictatorship of al-Mansur (Mohammed ibn abi-'Amir), a professional letter writer who achieved power through the favour of the Basque-born Sultanah Subh ("Dawn") during the minority of her son Hisham II. Al-Mansur's rule (981–1002) marked a period of brilliant military successes abroad and increasing unrest at home. With his mercenary army he won a series of spectacular but ephemeral victories against the Christians, capturing Zamora (981), Barcelona (985), Coimbra (987) and Santiago de Compostela (997), the shrine of the Moor-killing saint. Thence he returned with the cathedral bells to serve as braziers in the famous mosque of Córdoba. (*See* also MANSUR, AL-.) Popular opposition to al-Mansur's successors degenerated into partisan warfare between the Cordobans, the Berbers and the slave officials of the royal household, sometimes with Castilian intervention, all sides using the caliphs as pawns in the competition for control of the state. The last caliph was imprisoned with his family in a vault attached to the great mosque and reacted to the news of his deposition by begging for a crust of bread.

The collapse of the caliphate shortly after attaining its military zenith was due partly to the weakening of Omayyad authority by al-Mansur's dictatorship, but mostly to continuous hostilities among Arabs, Berbers, the slave officials, the Jews, the native Spanish converts to Islam (*muladíes*) and the Arabized Christians (*mozárabes*). Under the caliphate Muslim Spain was the most populous and prosperous country of Europe. Increased irrigation produced an agricultural surplus which, with manufactured luxury goods (Cordoban leather, Valencian pottery, "damask" arms and silk from Toledo), was exported mainly eastward.

For the literary and artistic achievements of the caliphate, *see* ANDALUSIA. *See* also SPAIN: *History;* CÓRDOBA.

See R. Altamira, *A History of Spain,* Eng. trans. by M. Lee (1950). (K. Ga.)

CORDOVA, a town of south central Alaska, U.S., is situated on the east shore of Orca inlet, a branch of Prince William sound, about 1,500 mi. N.W. of Seattle and 150 mi. E.S.E. of Anchorage. The supply and distribution point for a number of fishing and fur farming localities of Prince William sound. The docks and other fishery and cannery shore facilities suffered damage in the severe earthquake that struck Alaska on Good Friday, March 27, 1964.

Cordova was founded (1908) as a port for the Copper River and Northwestern railroad, which ran to the Kennecott Copper company's mines, 196 mi. away. These famous mines, four in number, reached a depth of about 2,500 ft., with more than 40 mi. of underground workings, and in the 30 years of their operation produced $200,000,000 worth of copper from ore assaying a 70% metal. After the closing of the mines and the railroad in 1938, Cordova became dependent on its fisheries and salmon, crab and clam canneries. The population is about 1,000. (J. E. CL.)

CORDUROY, a strong filling-pile fabric known for its excellent wearing qualities. The material has a rounded cord, rib or wale surface, with cut pile yarn providing the effect in the vertical direction. The back of the goods has a plain (tabby) or a twill (Genoa) weave. Corduroy is in the family of pile cloths that includes velvet and velveteen. It is made from any of the

major textile fibres and with one warp and two fillings. After corduroy is woven, the back of the cloth is coated with glue; the floats of pile yarn are then cut in their centre. The glue prevents the filling from drawing out of the goods during the cutting. The glue then is removed from the face of the goods, which are subjected to a series of brushings, waxings and singeings to produce a velvetlike ribbed finish. Corduroy is used for breeches, coatings, hunting apparel, millinery, slacks, jackets and trouserings. Its name is believed derived from the French *corde du roi*, "king's cord." (G. E. L.)

CORELLI, ARCANGELO (1653–1713), one of the leading violinist-composers of his day, was born at Fusignano, near Imola, Italy, Feb. 17, 1653, and studied principally at Bologna, then a centre of instrumental music. By 1675 he had settled in Rome, which remained his home for the rest of his life. He won a great reputation in society as a performer and composer, as a result of which he made extended visits to other Italian cities and, possibly, abroad. His music was published not only in Italy but also abroad, and he attracted several pupils who later became eminent, among them Francesco Geminiani. He died in Rome, Jan. 8, 1713.

His published chamber works consist of five sets of 12 sonatas; two of *sonate da chiesa* and two of *sonate da camera*, all for two violins, violoncello and continuo (respectively for organ and harpsichord), and one of solo violin sonatas with harpsichord continuo (*see* CHAMBER MUSIC). He also wrote a set of *concerti grossi*. Corelli seems not to have been on the whole a virtuoso violinist—the technical demands of his surviving violin music never go beyond the third position—but rather one who cultivated a pure, graceful, yet lively style. His slow movements are on the whole his finest, his fast movements tending to become somewhat mechanical. He used only the simplest harmonies within the then-new tonal system.

See M. Pincherle, *Corelli* (1933). (N. Fo.)

CORELLI, MARIE (pseudonym of MARY MACKAY) (1855–1924), English writer who achieved great popularity by her melodramatic expression of Victorian moral fervour, was born in London in 1855. Her pseudonym was chosen for her early career as a pianist and singer. Her fame as a popular writer came with *Barabbas: A Dream of the World's Tragedy* (1893) in which her treatment of the Crucifixion was designed to appeal to popular taste. *The Sorrows of Satan* (1895), also based on a melodramatic treatment of a religious theme, had an even wider vogue, and the climax of her career was reached with *The Murder of Delicia* (1896). Thereafter she was frequently attacked by the more critical public for her sentimentality and poor taste. She had, however, amassed a fortune and in 1901 settled in Stratford-upon-Avon, where she stanchly opposed attempts at its modernization. She died there on April 21, 1924.

See B. Vyver, *Memoirs of Marie Corelli* (1930); E. Bigland, *Marie Corelli* (1953).

COREOPSIS, a genus of the Compositae (*q.v.*) family, commonly known as tickseed, containing more than 100 species native almost wholly to America, with a number cultivated in gardens for their showy summer and autumn flowers. They are annual or perennial herbs, seldom shrubs, with conspicuous yellow, rose, purplish-red or purplish-brown flower heads. (J. M. BL.)

CORESPONDENT: *see* DIVORCE.

CORFE CASTLE, a large village and parish in the "isle" of Purbeck, Dorsetshire, Eng., is about 18 mi. E.S.E. of Dorchester. Pop. (1961) 1,381. The geology and scenery are varied, the principal features being two parallel ridges of chalk and Purbeck limestone enclosing fertile tracts, to the north of which lie sandy heathlands around Poole harbour. The region was exploited in Roman times for the pottery, "marble" and shale industries, and there are many early historic remains, including well-marked Celtic farmstead earthworks at Kingston. The great house at Encombe was the home of the celebrated Lord Chancellor Eldon.

The castle, dramatically situated to command a gap in the chalk hills, has been in ruins since it was dismantled by Parliamentary forces in 1646 after its heroic defense for six weeks by Lady Bankes. Much of its fabric dates from the 12th and 13th centuries, but there is early Norman work in the middle ward. There is little save legend to connect its site with the lodge of Elfrida or Aelfthryth at *Corfe gate* where her stepson, the Saxon king Edward the Martyr (*q.v.;* to whom the church is dedicated), was murdered in 978.

The town that grew up beneath the castle was once important enough to send two members to parliament (until 1832), and became a corporate borough; it was the centre of the Purbeck marble industry which reached its peak in the 14th century, when the stone was widely exported for interior embellishments, shrines, and tombs like that of Edward, the Black Prince. Quarries are reopened only for repair work, but the mining of clay continues in the heathlands. The stone-roofed village is a tourist attraction. (R. A. H. F.)

CORFINIUM, in ancient Italy, the chief city of the Paeligni (*q.v.*), about 7 mi. N. of Sulmo (mod. Sulmona) in the valley of the Aternus (Aterno) river, near the modern village of Corfinio in the *regione* of Abruzzi and Molise. It is first recorded in Roman history in the Social War (90–89 B.C.), when it was adopted by the Italians as the capital and seat of government of their newly founded state under the name Italia. Thereafter it became a *municipium* (*q.v.*). In 49 B.C. L. Domitius Ahenobarbus tried in vain to hold it against Julius Caesar. Situated on the Via Valeria, and an important road centre in the imperial period, it was a town of some size. The origin of the imposing church of S. Pelino may be traced to the end of the 5th century A.D. when it was the cathedral of the see of Valva, the town which succeeded Corfinium.

See R. Gardner in *Papers of the British School at Rome,* vol. ix, 89 (1920).

CORFU (modern Gr. KERKIRA; Lat. *Corcyra*), an island of Greece in the Ionian sea, separated from the coast of Epirus by a strait from 2 to 15 mi. broad. With some small islands it forms a *nomos* (department) of modern Greece. The name Corfu is an Italian corruption of the Greek *koruphai* ("crests"). Its length is about 58 km. (36 mi.), its greatest breadth about 27 km. (17 mi.). The island consists of three districts, of which the northern is mountainous, the central undulating and the southern low lying. All are of limestone formation and have picturesque scenery. There are two principal ranges: one, the highest peak in which is Pantokrator (2,972 ft.) in the northeast, lies east and west from Cape St. Angelo to Cape St. Stefano; the other culminates in Santa Decca (Greek *oi Ayioi Deka,* "the Ten Saints"). Pop. (1951) 100,957 (isl.), (1961) 101,770 (*nomos*). Area 593 sq.km. isl.; 643 sq.km. *nomos* (229 sq.mi. isl.; 248 sq.mi. *nomos*).

Corfu is well watered, widely fertile and the most beautiful of the Greek isles, but the prevalent olives give monotony to its colouring. Myrtle, arbutus, bay and ilex form thick brushwood. Figs, oranges, lemons, vines and maize are cultivated and olive oil, fruit, grain and wine are exported. Stock is raised and there is fishing. In the town of Corfu, soap and textiles are manufactured.

The common form of land tenure is the *colonia perpetua,* by which the landlord grants a lease to the tenant and his heirs forever in return for a rent fixed at a certain proportion of the produce. The capital is the only city on the island, but there are numerous villages. Near Gastouri stands the Achilleion palace, built for the empress Elizabeth of Austria and later owned by William II of Germany.

The town of Corfu (pop. [1951] 27,431) stands on the broad part of a peninsula within the central bay of the east coast. The steep twin-peaked citadel has the sea on two sides and is cut off from the town by a natural gully with an artificial salt-water ditch at the bottom. The old fortifications were built in 1550 by the Venetians. The town is a labyrinth of narrow, tortuous, up-and-down streets, but there is a wide esplanade between the town and the citadel and a promenade by the seashore toward the suburb Castrades. The palace, of white Maltese stone, was built in 1816 by Sir Thomas Maitland, lord high commissioner of the Ionian Islands, 1815–24. A few houses survive from Venetian times with

traces of past splendour, but the modern buildings are in French or Italian style. The city is the seat of a Greek metropolitan and a Roman Catholic bishop. The cathedral is dedicated to Our Lady of the Cave, and St. Spyridon's church contains the tomb of the patron saint of the island. The church of St. Anthony is the only Roman Catholic church left and there were by mid-20th century only a few Roman Catholics in the city. The theatre was built between 1663 and 1690; the museum was transferred to the palace in 1931 and the library, which was housed in the gymnasium, was destroyed in World War II, together with many of Corfu's other buildings. The former university, inaugurated in 1824 through the efforts of Frederick North, 5th earl of Guilford, was disestablished when the British protectorate ceased.

The site of the ancient city is about 1½ mi. to the southeast of Corfu, between the lagoon of Calichiopulo and the bay of Castrades, the ancient Hylleic port and the port of Alcinous, the legendary king of the Phaeacians. The circular tomb of Menecrates (discovered in 1843) and the remains of the archaic Doric temple of Artemis (of which the famous Gorgon pediment was placed in the museum) are noteworthy. Of ancient Cassiope, the name is preserved by the village of Cassopo, but the temple of Zeus Cassius has disappeared. There are numerous monasteries on the island.

History.—In local tradition Corcyra was the Homeric island of Scheria, the home of the Phaeacians. The Corinthian colony was established about 734 B.C., supplanting a previous settlement of Eretrians. The position of Corcyra on the highway between Greece and the west favoured rapid growth and freedom of action, and its people, contrary to the usual practice of Corinthian colonies, maintained an independent and even hostile attitude toward the mother city. About 664 B.C. their fleets fought the first naval battle recorded in Greek history. The Corinthian tyrant Periander (*c.* 600) temporarily reduced Corcyra, installed a viceroy and induced the island to join in the colonization of Apollonia and Anactorium. However, it regained its independence and devoted itself to purely mercantile policy. During the Persian invasion of 480 it manned 60 ships but took no active part. In 435, in a quarrel with Corinth, it sought assistance from Athens. This was one of the immediate causes of the Peloponnesian War (*q.v.*), in which Corcyra was a useful naval station and supply base for the Athenians though it was twice nearly lost by internal feuds. On each occasion, 427 and 425, the popular party ultimately won. After a third rising in 410 it quit the war. A fresh Athenian alliance (375) resulted in hostilities with Sparta. Within the 25 years following 303, the island changed hands among Cleonymus the Spartan, Cassander, Agathocles of Syracuse, Pyrrhus of Epirus, Demetrius Poliorcetes and Pyrrhus again. Seized by the Illyrians in 229, Corcyra was delivered by the Romans, who retained it as a naval station and made it a "free state." In 31 B.C. Octavian used it as a base against Antony, but his victory foundation, Nicopolis, soon outrivaled it and Corcyra lost its prestige.

With the rise of the Norman kingdom in Sicily and the Italian naval powers, Corcyra again became a frequent object of attack. The Byzantines lost it successively to Robert Guiscard (1081–85), to Roger II of Sicily (1147–54) and to Genoese privateers (1197). These last were expelled by the Venetians after the establishment of the Latin empire in Constantinople, but in 1214 the island was annexed to the Greek despotate of Epirus. Thence it passed to Manfred of Sicily (1259) and subsequently to the Angevins of Naples (1267). From these the Venetians acquired a form of protectorate over Corcyra in 1386 and full sovereignty in 1401.

Though they encouraged the Corfiots to cultivate the olive, the Venetians prevented them from competing with Venice commercially, and the island suffered occasionally in the republic's wars with the Turks. The Greek population meanwhile was increased by refugees from the mainland and in 1732 the first modern Greek academy was founded in Corfu.

On the dismemberment of the Venetian republic under the treaty of Campo Formio (1797), Corfu was assigned to France, but the French garrison was expelled by a Russo-Turkish armament in 1799. Then, for a short time, Corfu was the capital of the ephemeral Septinsular republic. Incorporated in the French empire under the treaty of Tilsit (1807), it was attacked by a British fleet in 1809. When the Ionian Islands were placed under a British protectorate by the treaty of Nov. 5, 1815, Corfu became the seat of the British high commissioner. Though the local senate and assembly were retained, British administration, although it improved conditions, displeased the inhabitants by its strictness and in 1864 Corfu was ceded with the other Ionian Islands to the kingdom of Greece, in accordance with the wishes of the populace. (*See* IONIAN ISLANDS.)

The neutral status of Corfu, stipulated in the treaty of cession to Greece, was maintained throughout the Balkan Wars. In World War I, however, as the Serbian resistance was collapsing on the Balkan mainland, French troops landed in Corfu in Jan. 1916, and within a month about 80,000 Serbs had joined them, with a number of Montenegrins. Corfu then became the seat of the Serbian government in exile. The pact of Corfu, which proclaimed the union of the South Slavs or Yugoslavs, was signed on July 20, 1917 (*see* SERBIA).

In 1923 Corfu was the scene of an incident which first tested the strength of the League of Nations. On Aug. 27 Gen. Enrico Tellini, the Italian member of the delegation appointed to settle the Greek-Albanian frontier under the auspices of the conference of ambassadors in Paris, was murdered on Greek soil, together with members of his staff. On Aug. 29 the Italian government sent the Greek government a humiliating ultimatum and on Aug. 31 Italian forces bombarded and seized the town of Corfu. The Greek government, though willing to accept several clauses of the ultimatum, appealed to the League of Nations on Sept. 1. The League referred the dispute to the conference of ambassadors, which decided (Sept. 7–13) substantially in favour of Italy, although there was as yet no evidence that the assassins were Greeks, still less that their crime was officially condoned. Greece accepted the decision, and the Italian occupation of Corfu ended on Sept. 27.

The peace of the island was next disturbed in World War II, when the town was bombed by the Italians and later occupied (1941–44) by the Italians and Germans in succession. After the liberation of the Greek mainland in the autumn of 1944, Corfu received a large number of refugees from Epirus when the Communist-controlled army of E.L.A.S. (*see* GREECE: *Modern History*) swept the loyal Greek forces of Gen. Napoleon Zervas off the mainland in the last week of December. Most of these returned to their homes when E.L.A.S. was defeated by British intervention. In 1946 the Corfu strait, which narrowly separates Greek from Albanian territory, was the scene of more than one attack by the Albanian Communist regime (using coastal artillery and mines) on British naval vessels. Corfu was not, however, directly involved in the series of guerrilla operations along the Greek-Albanian frontier during the Communist rebellion in Greece (1947–49). The island escaped the earthquakes which destroyed large parts of the southern Ionian Islands in Aug. 1953.

The text of most documents relevant to the crisis of 1923 is printed in *L'Europe nouvelle* (Oct. 6, 1923). For incidents of 1946–49 *see* the judgments of the International Court of Justice, *Corfu Channel Case*, 3 vol. (1949–50). *See* also A. Philippson, *Die gr. Landschaften*, vol ii, ch. ii, pp. 422 ff. (1959). (J. L. My.; C. M. We.; W. G. F.)

CORI, CARL FERDINAND (1896–), biochemist and Nobel prize winner, was born in Prague, Czech., on Dec. 5, 1896. His scientific training was received in Europe (M.D., German University of Prague, 1920) but he emigrated to the United States soon after his graduation and became a naturalized citizen in 1928. After nine years as a biochemist at the Institute for the Study of Malignant Disease in Buffalo, N.Y., he became professor of pharmacology and biochemistry at the Washington university school of medicine, St. Louis, Mo., in 1931, and was appointed chairman of the biochemistry department of that institution in 1947.

His investigations have been of fundamental value in biochemistry and medicine. Most of his scientific work has been carried out in collaboration with his wife, Gerty Theresa (Radnitz) Cori, and they were jointly awarded the Nobel prize in medicine and physiology in 1947 for their studies in carbohydrate metabolism; they shared the award with Bernardo A. Houssay (*q.v.*) of Argentina.

The Coris have been concerned with the study of the detailed chemistry of the enzymic reactions involved in the conversion of glycogen to lactic acid. Noteworthy have been the isolation of the "Cori ester," glucose-l-phosphate; demonstration of the in vitro enzymic synthesis of glycogen from this intermediate; the in vitro effects of hormones on enzymic activity; and studies on the mode of action of the individual enzymes involved in lactic acid formation. (E. A. Es.)

CORI, a town and episcopal see of the province of Latina, Lazio region, Italy, 45 km. (28 mi.) S.E. of Rome, lies on the lower slopes of the Volscian hills (Monti Lepini) overlooking the coastal plain. Pop. (1957) 9,470 (commune). The ancient Cora, traditionally a Latin foundation, played an active part in Rome's early wars with the Volsci and the Aurunci, but the site lost much of its importance when the Appian Way was built in 312 B.C., 10 km. (6½ mi.) to the southwest. Sacked by the partisans of Marius and restored by Sulla, its later classical history was uneventful. In the 15th century, under the church, it enjoyed a further period of relative prosperity, but by 1811 its population had dwindled to 3,800. It was badly damaged in World War II. On the summit of the upper town stands the little Doric tetrastyle temple of Hercules (89–80 B.C.). Below, terraced down the hillside, are three concentric *enceintes* of cyclopean masonry, established almost certainly on a single occasion, although containing work of three distinct qualities and, presumably, dates, of which the latest may be attributed to the years following the final recapture of the place by Rome from the Volsci, about 330 B.C. Below the town there is a fine single-arched bridge of republican date, the Ponte della Catena. The church of Sta. Oliva has an elegant two-story cloister (1466–80), and there are 15th-century frescoes of the Roman school in the chapel of the Annunziata outside the town. (J. B. W.-P.)

CORIANDER, the fruit, improperly called seed, of an umbelliferous plant (*Coriandrum sativum*), a native of the south of Europe and Asia Minor, but cultivated in Europe, where it is also found as an escape from cultivation, as it is in many parts of the United States. The plant produces a slender, erect, hollow stem rising one to two feet in height, with bipinnate leaves and small flowers in pink or whitish umbels. The fruit, globular and externally smooth, having five indistinct ridges, is scarcely separable into its sections (mericarps).

Coriander is one of the few umbelliferous plants producing fruit with a concave face. It was once used in medicine as an aromatic and carminative, but its only modern use is to mask the unpleasant taste or odour of other drugs. The active principle of its volatile oil (coriandrol) is highly aromatic and a favourite ingredient in hot curries and sauces. The fruit is also used in confectionery and as a flavouring ingredient in liqueurs. The young leaves and shoots are frequently used in soups. (N. Tr.)

CORINNA (date uncertain), lyric poet of Tanagra in Boeotia, is the only writer in the Boeotian dialect of Greek of whose work any distinct idea can be formed. A number of anecdotes preserved by later writers make her out to have been a contemporary, a competitor and even a teacher of Pindar, in which case she must have been active about 500 B.C., but there is nothing in the fragments of her poetry or in any even approximately contemporary source to confirm this inference. The fragments, to which 20th-century papyrological discoveries made considerable additions, are written in an orthography which seems to have been current in Boeotia in the 2nd century B.C.; and though it is possible that the texts have been transcribed from an older orthography, such as is known to have been current in Boeotia in the 5th century, there is no conclusive evidence of this. The metrical evidence is as inconclusive as that of the orthography; on the one hand it is clear that Corinna's metrical ideas were strongly influenced by Anacreon, but on the other it has been argued that she was also influenced by Euripides. Her style is so simple as to be all but timeless, and her chief subjects are the local legends of her native Boeotia (her self-satisfied provincialism according to the anecdotists exasperated Pindar to such a pitch that he called her a sow; *i.e.*, a Boeotian). Poems in a manner very like hers, but dealing with non-Boeotian legends, were found among papyri in the 1950s; the papyri do not explicitly ascribe these poems to Corinna, and some scholars have therefore been inclined to doubt whether she wrote them. Further evidence was still needed to settle this problem; and also to decide the fascinating question of Corinna's date: certainty on this point would assist in the solution of several other problems, literary and metrical.

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CORINTH, LOVIS (1858–1925), German painter, a leader of the *Sezession* group and a great influence on modern German art through his teaching and writing, was born at Tapiau, East Prussia, on July 21, 1858. His training was academic and taken after 1884 in Paris under A. W. Bouguereau. There, however, he was influenced both by the French Impressionists and by the work of Rubens, and after he settled in Berlin in 1900 his pictures, sombre at first, gained brilliance from the former and vitality from the latter. Thus equipped he led the *Sezession* movement against the academic school in Berlin, with the collaboration of M. Slevogt and M. Liebermann. Though best known for his landscapes of the Walchensee area and for his portraits, he also painted religious scenes, often violent ones such as the "Golgotha" altarpiece (1909–11, Tapiau) and a "Deposition" at Leipzig (1907). He also painted themes from antiquity and studies from the nude and made etchings and lithographs. He died on July 17, 1925, at Zandvoort, Neth. *See* also Painting: *Expressionism and the German School.*

See A. Kuhn, *Lovis Corinth* (1926); L. Corinth, *Selbstbiographie* (1926); Gert von der Osten, *Lovis Corinth* (1955). (D. C. T. T.; X.)

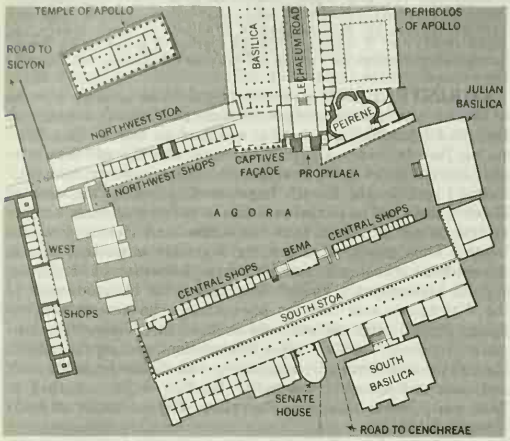
CORINTH (Gr. Korinthos), a city of Greece. The ancient Hellenic city (see *History,* below) grew (after *c.* 1100 B.C.) from settlements round the citadel or Acrocorinthus, 2.5 km. (1½ mi.) S. of the isthmus which connects the Peloponnese and central Greece and separates the Saronic and the Corinthian gulfs (*see* Corinth, Isthmus of). The citadel rises precipitously above the old city to a height of 1,886 ft. and commands all routes into the Peloponnese.

Modern Town.—The modern town of Corinth, the chief town of the *nomos* of Corinth (Korinthia) and an episcopal see, is situated on the western side of the isthmus, 5.6 km. (3½ mi.) N.E. of the Hellenic city. Pop. (1951) 17,728. It was refounded in 1858 when old Corinth (*i.e.*, the post-Justinian city) was destroyed by earthquake, and was itself almost wholly destroyed by earthquake in 1928. It is connected by railway with Athens (92 km.; 57 mi.), with Patras (140 km.; 87 mi.) and with Nauplia (64 km.; 40 mi.), the capital of Argolis, and also by main roads. After the opening of the ship canal in 1893 Corinth had sea communication with Patras, the Ionian Islands and the west coast as well as with Athens. It has few local resources. Its chief exports are currants (which have their name from the town), olive oil, silk and cereals from the northeast Peloponnese.

Corinth *nomos* includes the resorts of Loutraki (hot springs) and Xilokastron, the ruins of Sicyon (*q.v.*) and Stymphale and the currant-packing station and port of Sikionia.

Archaeology.—The ancient city occupies two natural terraces at the northern foot of Acrocorinthus to which it is joined in a circuit wall about 6 mi. in circumference. With its principal port, Lechaeum, on the Corinthian gulf (near the earlier site of Korakou), the city was connected by two parallel walls and a paved highway which led past the large public baths of Eurycles (2nd century A.D.) to the propylaea, the entrance to the agora. This propylaea was in its earlier form a long shallow building with five arches but was replaced after the refoundation of 46 B.C. by a single entrance in the form of a Roman triumphal arch. Immediately to the east lay the famous fountain house of Peirene which owed the most splendid of its many remodelings to the generosity of Herodes Atticus (*c.* 175 A.D.). Most of the substantial remains in the agora, including the artificial terracing, the central row of shops and the bema or rostrum, scene of St. Paul's trial before Gallio, are also works of the Roman period, but it

acquired its present extent in the 4th century B.C. with the construction of the enormous portico, 525 ft. in length, which closes its south side. Immediately behind the south stoa begins the road to the city's other port on the Saronic gulf, Cenchreae, about 13 km. (8 mi.) to the east. On a small rise northwest of the agora stand seven Doric columns, the remains of the magnificent peripteral temple of Apollo (*c.* 540 B.C.). Approximately 250 yd. due west was an odeum and immediately north of it a theatre rebuilt in the Roman period. Farther north against the city wall were the sanctuary of Aesculapius and the fountain of Lerna, the former containing a small prostyle temple of the 4th century B.C. About 0.8 km. (½ mi.) W. of the agora a Roman villa containing notable mosaics was excavated, while still farther to the southwest can be seen the remains of the ceramicus, centre of Corinth's noted pottery industry (*see* GREEK ART). On the citadel the surviving fortifications are principally of the Venetian period but much earlier material has been found. After 1896 the site was extensively excavated by the American School of Classical Studies at Athens.



MRS. D. HUXLEY

PLAN OF ANCIENT CORINTH, GREECE

History.—The site of Corinth on the lower slopes of the hill Acrocorinthus was occupied by Neolithic and Early Bronze Age settlers, but their successors moved to the coast at Korakou whence they traded overseas. In the Late Bronze Age (*c.* 1600–*c.* 1100 B.C.) Korakou was a prosperous port whereas the site of Corinth has yielded only a small amount of fine pottery of this period; therefore it is likely that the "wealthy Corinth" of the Achaean catalogue in the *Iliad* should be identified with Korakou, whether named Corinth or Ephyra. Corinthia at that time was in the realm of the kings of Mycenae. Its wealth was probably gained from the transit trade by land between Boeotia and Argolis and by sea between the Corinthian gulf and the eastern Mediterranean; indeed mythology associated with Ephyra the names of Sisyphus, Bellerophon and Melicertes who were connected with Lycia and Phoenicia. When in the 12th century Mycenaean civilization began to collapse, the isthmus was firmly held at first by its Aeolic-speaking inhabitants, and the Dorians came probably from Argos to conquer and occupy Corinthia early in the Iron Age (after 1100 B.C.).

The Dorians abandoned the Mycenaean sites and settled in hamlets inland, three of them being on the site of classical Corinth. Their choice shows a lack of interest in trade by sea, but they were only a dominant minority and the older inhabitants of Corinthia retained their seafaring tradition. Corinth played a leading part in the renaissance of civilization after the Dorian migrations. By 800 B.C. the city-state of Corinth had probably been formed as a political union of eight villages; the Corinthians planted a settlement in Ithaca *c.* 800 B.C. and exported their Geometric pottery east and west of the isthmus. In the period 750–700 B.C. Corinth annexed the southern Megarid, securing control of the narrow neck of the isthmus; possession of Perachora safeguarded the port of Lechaeum. The tradition of epic poetry which had probably been maintained by the Aeolic-speaking population culminated in the poetry of Eumelus. Potters began to develop the Protocorinthian style, inspired by contact with the near east, and Corinthian wares were to be supreme down to 550 B.C.

The Corinthians planted colonies at Corcyra and Syracuse, destined to assure them a dominant position in western trade. The expansion of Dorian Corinth was led by a capable clan of nobles, the Bacchiadae.

The Bacchiadae were overthrown by Cypselus (*q.v.*) and his family who ruled as tyrants *c.* 657–582 B.C. and probably came to terms with exiled Bacchiadae in the colonies, in Lyncus (western Macedonia) and in Etruria. The tyrants planted further colonies in the northwest—on the coasts of Greece and Albania—and in the Thermaic gulf at Potidaea; they tapped the overland trade between Epidamnus and the Thermaic gulf, and the Corinthian wares have been found far inland. But the chief source of Corinth's wealth was its control of the isthmus. Periander (*q.v.*) facilitated transit of ships and cargoes, which were hauled across from gulf to gulf, by building a stone carriageway (*diolkos*). His fleets sailed both seas; diplomatic contacts were maintained with Miletus, Lydia and Egypt; and the fine silver coinage, carrying the winged Pegasus of Bellerophon, was a strong currency throughout the Mediterranean. The tyranny was followed by an oligarchy with a board of executive magistrates (*probouloi*) and a powerful council. The franchise was probably limited to members of the propertied class. The aristocratic Pindar praised the Corinthians for their orderly constitution, promotion of the arts and prowess in war.

In the following period of interstate competition Corinth was outstripped by Athens in seamanship and commerce. The Corinthians sought outside support by entering the Spartan alliance which involved them in warfare by land. Although Corinth rendered good service in the Greco-Persian Wars (*q.v.*), it was the Athenians who founded the Confederacy of Delos and controlled the Aegean sea. In 460 B.C. Athens enticed Megara into alliance, defeated Corinth by land and sea, and delivered a successful offensive in the Corinthian gulf. In 446 B.C. Corinth gained a respite under the Thirty Years' treaty. The Corinthians tried to win Athens' favour by refusing to help Samos but in vain; for Athens supported Acarnania against Corinth's colony Ambracia and then Corcyra against Corinth. In 433 B.C. the Corinthians fought and lost their last sea battle as a great power. The Peloponnesian War (*q.v.*) ended in the overthrow of Athens but not in the revival of Corinth. Its strategic position was coveted now by stronger states which one after another forced their alliance upon it—Athens, Argos, Sparta, Thebes—and the constitution seesawed between oligarchy and democracy with outbreaks of revolutionary violence. Yet Corinth struck a blow for Greek independence in 343–342 B.C. when it brought Athens into alliance and saved Ambracia and Leucas from the onslaught of Philip II of Macedonia.

Corinth's freedom ended in 338 B.C. when Philip garrisoned Acrocorinthus and used the city as the centre of the Greek league or League of Corinth. It became the puppet of Macedonia and the Achaean league until the latter involved it in a fatal conflict with Rome. The city was destroyed in 146 B.C. A century later Julius Caesar founded a Roman colony on the site. The new Corinth became a centre of commerce and the administrative capital of Achaea. It was destroyed by the Goths in A.D. 521, but refounded under the emperor Justinian. *See* also references under "Corinth" in the Index volume.

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mond, "The Heraeum at Perachora and Corinthian Encroachment," *Annual of the British School at Athens,* 49 (1954); E. Will, *Korinthiaka,* with full bibliography (1955). (W. G. F.; N. G. L. H.)

CORINTH, ISTHMUS OF (Gr. Isthmos Korinthou), in Greece, dividing the Gulf of Corinth from the Saronic gulf. It is composed of heavily faulted limestone rocks, which rise from the south in terraces to a central plateau a little under 300 ft. above sea level. Its thin limestone soils are very parched and afford little opportunity for agriculture, which is generally limited to poor crops of wheat and barley, though here and there, on the upper edges of the terraces and along the stream banks, vineyards will thrive. Away from the fields the land carries only a light vegetation of stunted shrubs and occasional open woods of dwarf Aleppo pine. Ships were dragged across the isthmus in ancient times. Nero, in A.D. 67, began a canal through it. A ship canal begun in 1881 was opened in 1893 with its western entrance about 1¼ mi. N.E. of New Corinth. It is 3.9 mi. long, 69 ft. broad at the bottom and 26 ft. deep. It shortens the journey from the Adriatic to Piraeus by 202 mi. for such vessels as can navigate it. Traces of an ancient wall may still be seen parallel to the canal. Just to the south of it lies the fortified sanctuary of Poseidon, where the Isthmian games were celebrated. The Gulf of Corinth is an inlet of the Ionian sea, separating Peloponnesus from mainland Greece. It is 80 mi. long and between 3 and 20 mi. wide. (Wm. C. B.)

CORINTHIAN ORDER: *see* Order.

CORINTHIANS, EPISTLES TO THE, two books of the New Testament addressed by Paul the apostle to the Christian congregation in Corinth, Greece, where he worked for more than 18 months after his apparently not very successful stay in Athens. By supplementing the connected report of Paul's activities at Corinth in Acts xviii with the incidental information in the two Epistles to the Corinthians, a more detailed picture of the historical background to these Epistles can be obtained.

Historical Background.—Paul arrived alone in Corinth (I Thess. iii, 1) and lived in the house of Aquila and Priscilla, a Jewish couple who may have been Christians before they were driven out of Rome by the emperor Claudius' decree. Paul taught first in the synagogue and then in the private house of a gentile "worshipper of God" nearby. His teaching seems to have been very successful mainly with the lower classes of the pagan population (*cf.* I Cor. i, 26–28; xii, 2), but a few Jews, including Crispus, the ruler of the synagogue, joined the Christian congregation.

When Paul had been in Corinth for 18 months he was accused by the Jews before Gallio (a brother of the philosopher Seneca), the Roman proconsul of Achaea, who refused to concern himself at all with a purely Jewish affair. Paul however shortly afterward felt that he should leave Corinth, together with Priscilla and Aquila.

Paul went first to Palestine, and then for three years to Ephesus, where Priscilla and Aquila had gone directly from Corinth. They had found there an Alexandrian Jew called Apollos who had learned "the way of the Lord" but knew only the baptism of John. After receiving their further instruction Apollos went with an introduction from them to Corinth, where he continued Paul's work ("I planted, Apollos watered," I Cor. iii, 6). While at Ephesus Paul must have sent to Corinth a letter which is no longer extant (*cf.* I Cor. v, 9) and the Corinthian reply must have posed various moral and doctrinal questions (*cf.* I Cor. vii, 1; viii, 1; xii, 1). This letter may have been brought personally by Christians from Corinth (perhaps by "Chloe's people," I Cor. i, 11, or by Stephanas, Fortunatus and Achaicus, I Cor. xvi, 17); in any case Paul was informed by Corinthian visitors about the affairs of their congregation (I Cor. i, ii; v, i; xi, 2, 18). This letter from Corinth and the news brought verbally led Paul to write the first extant Epistle to the Corinthians before Pentecost in the year of his departure from Ephesus (*i.e.,* probably A.D. 56). Before writing Paul had apparently sent to Corinth his close friend Timothy, who had previously been his companion there, in order to remind them what they had learned from him; as Paul expects that Timothy will arrive after the letter, it must have been written in response to sudden need and sent by the quickest route to Corinth.

After sending this letter Paul must have received bad news from Corinth, perhaps when Timothy returned to him, so he decided to pay another visit to the city (II Cor. ii, 1; xii, 14; xiii, 2). But this short stay must have caused him grief (II Cor. ii, 1), for a member of the church wronged him, or rather the whole congregation, in some way which is not made explicit (II Cor. ii, 5; vii, 12). After departing earlier than he had intended Paul wrote a letter "with many tears" (II Cor. ii, 4; vii, 8) asking for the punishment of the wrongdoer, and at the same time sent his disciple Titus to Corinth. As a result the majority of the Corinthians excluded the wrongdoer from the congregation (II Cor. vii, 6 ff., 14). But Paul was so eager to get fuller news that he left his preaching in Troas and went into Macedonia, where he met Titus and heard from him that the situation in Corinth was much improved. Paul then wrote the second extant Epistle to the Corinthians in the autumn of A.D. 56 (*i.e.,* about six months after writing the first Epistle). It is not known how the second epistle was received by the Corinthians, but at least there is no mention of any difficulties at Corinth when Paul wrote his Epistle to the Romans six months later during a stay in Corinth.

First Epistle.—This is probably the fourth of the extant letters of Paul, coming chronologically after the two Epistles to the Thessalonians and the Epistle to the Galatians. It differs in structure from his other letters in that there is no real sequence of thought, several unconnected subjects being treated in succession. This is due to the fact that he is answering the miscellany of questions which had been put to him by the Corinthians in their letter or through the members of their congregation who had visited him. The Epistle however is ruled by one central theme. The newly converted pagans were still strongly influenced by the conviction that man must be delivered from his material existence by receiving some supernatural saving quality, while his moral behaviour was unimportant to his salvation. In his Epistle Paul tries to combat this "gnostic" attitude still lingering in the minds of the Corinthian converts who had not really understood his message of the saving action of God through the historical Jesus Christ at the end of this transitory evil age, and had not been convinced that man could be renewed by this eschatological action of God and thereby enabled to lead a new life.

Summary.—Paul puts in the foreground the "word of the cross" (I Cor. i, 18), the "gospel . . . by which you are saved" (xv, 1 ff.), which is his central proclamation in dealing with the single problems that have arisen in the life of the newly converted congregation. The Corinthians were divided into several groups, respectively called after Paul, Apollos, Cephas and Christ (i, 12), the first three being the baptizers of each group, though the special character of the last group is not clear. Paul condemns this splitting up of the one body of Christ, and points out that the identity of the person who preached them the gospel or baptized them is quite irrelevant (i, 12–iv, 21). Marriage with one's stepmother (v, 1–13), going to law before pagan judges (vi, 1–11) and sexual intercourse with a prostitute (vi, 15–20) are all said to be out of the question for members of the body of the crucified Christ. Against the inclination of some Corinthian Christians to reject marriage entirely Paul claims that marriage is necessary and indissoluble for those who have not the gift of continence, but as the end of the world is very near it would be better not to marry if possible (vii, 1–40). Joining in sacrificial meals with pagans is not in itself harmful to Christians, but if taking part in such meals offends the conscience of the weak who cannot convince themselves that sacrificial meat has no connection with demons, then these meals should be avoided (viii, 1–xi, 1).

Paul then turns to three questions concerning the assemblies of the congregation. He defends the oriental custom of praying with the head covered against the desire of women members of the church to appear bareheaded in the assembly (though his reasoning here is hardly convincing to the modern mind!) and he stresses the necessity of courtesy and respect when they come together for "the Lord's Supper" by reminding them of the con-

nection between this communal meal and the death of Christ (xi, 2–34). As the Corinthians have a high regard for ecstatic speech in their assemblies, Paul, who himself has the gift of speaking with tongues, points out that such speech is not to be encouraged because it is unintelligible to the congregation as a whole, which is thus not edified by it (xii–xiv). It is in connection with edification that the famous chapter in praise of love (or charity) is inserted (xiii). Finally, as some of the Corinthians were denying the resurrection of the dead, including the resurrection of Christ, Paul stresses the historical fact of Christ's resurrection as accepted by all the apostles and argues from it that the future resurrection of all Christians is a certain hope (ch. xv). The final chapter concludes the letter with personal news and greetings (ch. xvi).

Unity of the Epistle.—The apparent contradictions in Paul's advice about the eating of sacrificial meat, which is both forbidden in some circumstances and permitted in others, has led some scholars to suppose that this Epistle is a combination of two or three separate letters. This hypothesis is strengthened by the fact that there is little connection between the different sections of the Epistle and the fact that a lost letter did precede this "first" Epistle. But the difficulties raised by this theory are greater than the seeming inconsistencies which it is supposed to explain, and no one has been able to give a satisfactory reason why two or three separate letters should have been dovetailed together to make a new one. It is more probable therefore that the first Epistle to the Corinthians has survived in its original form.

Second Epistle.—This letter is quite different in character from the other, for in it Paul does not deal with a series of independent subjects. Instead, the whole Epistle is a discussion with the congregation to strengthen them in their new enthusiasm for the gospel Paul had preached to them and to warn them against the opposition to him which still remains in the congregation.

Summary.—The first and longer part of the Epistle (II Cor. i, 1–ii, 13 and vii, 5–16) discusses the situation that has developed between the congregation and Paul. He defends his past actions, speaks of the joy the news brought by Titus gave him and explains why he has not yet paid another visit to Corinth. This argument is broken by a long defense of his own apostolic office (ii, 14–vii, 4), at the end of which he warns against co-operation with unbelievers (vi, 14–vii, 1). Again and again Paul defends himself against attacks on his behaviour in general and to the Corinthians in particular, and against criticism of his apostolic office. He contrasts the human frailty and transitoriness of the Christian teacher (iv, 7–v, 10) with the glory of his commission to preach the gospel of reconciliation (v, 11–21). The next two chapters, which follow without any clear connection, contain two parallel summons to collect money for the poor of the Jerusalem church (viii–ix). Paul says he will send Titus with two others to Corinth for this purpose, and praises the congregation for their enthusiasm in the matter. Then follows a severe warning to those in the congregation who attack Paul and doubt his apostolic office (x–xiii); Paul calls them "superlative apostles" (xi, 5), and threatens to take strong measures against them as soon as he comes to Corinth. He warns the congregation of the danger of listening to such persons. Against these attacks Paul defends himself by pointing to his unselfishness and asserting that he can boast of all the distinctions which his opponents also possess, though such distinctions are quite irrelevant (hence he admits to speaking "as a fool," II Cor. xi, 17). It is in this context that Paul lays claim to ecstatic experiences (xii, 1–4) and gives a sober list of his apostolic sufferings (xi, 23–28). The Epistle ends with the well-known triadic formula: "The grace of the Lord Jesus Christ and the love of God and the partaking in the Holy Spirit be with you all" (xiii, 14).

Composition of the Epistle.—As the connections of thought are not always clear, in spite of the all-pervading theme, it has been suggested that this Epistle too is composed of two or three original letters. In particular some scholars maintain that II Cor. vi, 14–vii, 1 either could not have been written by Paul or must be inserted from another context. It is still more strongly maintained that II Cor. x–xiii cannot have belonged originally to this Epistle but must be part either of the letter Paul wrote between his first and second Epistles to the Corinthians (the "hypothesis of the four chapters") or of a letter written after the second Epistle. But here too the difficulties raised by these hypotheses are greater than the problems they are supposed to solve, so it seems wiser to regard the traditional form of the text as original, although some difficulties remain puzzling.

Paul's Opponents.—The much-discussed historical problem of the second Epistle to the Corinthians is the identity of the opponents whose attacks Paul criticizes in the first part of his letter and whom he assails personally in the three final chapters. It does not appear that they were "Judaizers," for they did not demand the fulfillment of the whole law like the "Judaizers" condemned in the Epistle to the Galatians. Nor does it seem that they were only the "gnostics" whose misinterpretation of the Christian message is corrected in the first Epistle to the Corinthians. Their fierce polemic against the apostolic office of Paul, their pride in their own Jewish privileges and their personal knowledge of Jesus (II Cor. xi, 22 ff.; xii, 11 ff.; v, 16) show that these opponents must have been connected with the Jerusalem church. It is likely that after Paul's first visit to Corinth Jerusalem Christians had come to Corinth and attacked Paul's apostolic position from the stronghold of their own connections with Jesus and their irreproachable Jewish behaviour. On this hypothesis Paul is defending himself in the second Epistle to the Corinthians against both gnostic and Jerusalem Christian opponents.

Importance of the Epistles.—The Epistles to the Corinthians have a fourfold importance. In them Paul provides chronologically the earliest information about Jesus and the beginnings of the church when he quotes from the oldest tradition about the Last Supper (I Cor. xi, 23 ff.) and about the first appearances of the risen Christ to the disciples (I Cor. xv, 3 ff.). Both Epistles show the difficulties caused in an early pagan-Christian congregation by the necessity of combining the implications of a religion that proclaims both a historic revelation and the imminent end of the world with the traditions of naturalistic piety inherited by the pagans. The consequence of this difficulty is seen in the abuses and exaggerations that occur in the life of the congregation or of the individual Christian not only in their dealings with sexual relationships, law suits and congregational assemblies but also in their inability to understand the proclamation of the resurrection of Christians, in their unwillingness to accept Paul as he is and in their underrating of those functions in the life of the congregation that are not ecstatic.

Still more important is the assurance with which Paul distinguishes between the Christian belief in God's salvation through a historic act of reconciliation and deliverance and the naturalistic aim of self-redemption in the Hellenistic religions. It is especially instructive to see how he masters the difficulties arising from the necessity for a completely new approach to nearly all the moral problems that beset the life of the young Christian community. The second Epistle reveals details of Paul's missionary methods, his biography, his character, his personal difficulties and the deep power of his faith. Thus these two letters are an important source both for the history of early Christianity and the life of Paul on the one hand and for the essence of the Christian faith on the other.

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(W. G. KÜ.)

CORIOLANUS, GAIUS (GNAEUS) **MARCIUS** (5th cen-

tury B.C.), legendary Roman hero of patrician descent. According to tradition, his surname was due to his bravery at the siege of Corioli (493 B.C.) in the war against the Volsci. In 491, when there was a famine in Rome, he advised that the people should not share the corn obtained from Sicily unless they would consent to the abolition of their tribunes. For this he was accused by the tribunes and, being condemned to exile, took refuge with the king of the Volsci and led the Volscian army against Rome. In vain the Romans prayed for moderate terms. At last, however, persuaded by his mother, Veturia, and his wife, Volumnia, he led back the Volscian army. He either died at an advanced age in exile among the Volsci or was put to death by them as a traitor or took his own life.

The legend is open to serious criticism. At the traditional date (493 B.C.) Corioli was not a Volscian possession but a Latin city in alliance with Rome, while it is improbable that the Volscians would have succeeded in reaching the gates of Rome immediately after Rome and the Latins had strengthened their powers of resistance through the Cassian treaty of 493. Further, Livy himself states that the chroniclers knew nothing of a campaign against the Volsci in which Coriolanus is said to have served. The conquest of Corioli by Coriolanus seems to have been invented to explain the surname. Many details of the story are suspect (*e.g.*, the flight of Coriolanus to the Volscian king bears a suspicious likeness to the story of Themistocles, while his clash with the tribunes is more typical of the 2nd than of the 5th century B.C.), but the legend at least testifies to the fact that in the early 5th century Rome suffered from Volscian pressure and from a shortage of corn.

See Plutarch's *Life;* Livy, ii, 34–40; Dionysius of Halicarnassus, vi, 92–4, vii, viii; Cicero, *Brutus*, x–xi. The story is the subject of Shakespeare's *Coriolanus*. For a critical examination of the story *see* T. Mommsen, *Römische Forschungen*, ii, pp. 113 ff. (1864–79); W. Schur, in Pauly-Wissowa, *Real-Encyclopädie der Classischen Altertumswissenschaft*, supplement v., pp. 653–660 (1931); E. T. Salmon, *Classical Quarterly*, for 1930, pp. 96 ff. (H. H. Sp.)

CORIOLIS, GASPARD GUSTAVE DE (1792–1843), French engineer and mathematician, who described the inertia force called after him the Coriolis force, was born in Paris on May 21, 1792. In 1808 he entered the École Polytechnique and continued his studies at the Écoles des Ponts et Chaussées, graduating in highway engineering. Shortly thereafter (1816) he joined the staff of the École Polytechnique as assistant professor of analysis and mechanics, a position he held until 1838, when he became director of studies. He was elected a member of the mechanics section of the Academy of Sciences in 1836. He died in Paris on Sept. 19, 1843.

Coriolis was prevented by ill health from realizing his full potentialities as a scientist. Despite this handicap, he made a number of significant contributions in his field. The one for which he is best known is described in the *Journal de l'École Polytechnique*, vol. xv (1835), under the title "Sur les équations du mouvement relatif des systemes de corps." In this paper he showed that the ordinary laws of motion of bodies may be used in a rotating frame of reference if an inertia force, acting to the right of the direction of motion of the body for counterclockwise rotation of the frame, or to the left for clockwise rotation, is included in the equations of motion. This result is of great significance, particularly in meteorology and oceanography, for motions over the earth's surface are studied relative to the earth, which is a rotating frame of reference. The Coriolis force appears prominently in practically all studies of the dynamics of the atmosphere and oceans; it is also an important factor in ballistics.

See Motion, Principles and Laws of.

Coriolis' works include two substantial treatises: *Calcul de l'effet des machines* (1829), republished posthumously under the title *Traité de la mécanique des corps solides*, etc. (1844); *Théorie mathématique des effets du jeu de billiard* (1835). (E. W. He.)

CORIPPUS, FLAVIUS CRESCONIUS (6th century A.D.), important Latin epic poet and panegyrist. Of African origin, Corippus later migrated to Constantinople: he was for a time a *grammaticus* and may subsequently have been a civil servant. His literary reputation is based on two poems. The *Johannis*, an epic hexameter poem in eight books, treats the campaign conducted against the insurgent Mauretanians by John Troglita, the Byzantine commander, and is the principal source for these events. The poem, written about 550, also shows the tenacity of the classical tradition in Africa, and the continuance of the poetic revival which took place under Vandal rule. Corippus succeeds in achieving a pleasing fluency of style: he closely models his epic on the *Aeneid* of Virgil; while some modifications are imposed by his Christian viewpoint, he introduces many traditional features of the epic such as the catalogue and the embodied narration of events prior to the poem's commencement. Claudian's influence is also apparent, and there are echoes of Ovid, Lucan and Statius and some imitation of Dracontius. Corippus' other poem, *In laudem Justini*, the four books of which eulogize Justinian I's successor Justin II, was written after the arrival of Corippus in Constantinople when he found himself in straits. This rhetorical poem contains elaborate description and excessive detail: it is interesting for the account which it gives of the death of Justinian and his successor's accession and of the embassy of the Avars. Corippus' hexameters show considerable knowledge of classical standards, and in this he may be compared with the grammarian-poet Priscian: there is however some neglect of the caesura, and quantities are sometimes distorted.

See edition by J. Partsch, *Monumenta Germaniae historica. Auctores antiquissimi*, vol. 3, part 2 (1879). (D. R. Br.)

CORISCO: *see* Spanish Guinea.

CORK, RICHARD BOYLE, 1st Earl of (1566–1643), English colonizer of Ireland whose singular capacity for lining his pocket brought himself and his children land, power and titles, was born at Canterbury on Oct. 13, 1566. He was educated at King's school and at Bennet (Corpus Christi) college, Cambridge, and studied law at the Middle Temple. Seeing no prospect of acquiring wealth in England, he went to Ireland in June 1588, possessing only £27 3*s.*, a diamond ring and a bracelet. He became subescheator to John Crofton, the escheator general, and grew so prosperous that accusations of embezzlement were soon being made against him. However, the Munster rebellion (1598) temporarily ruined him; he returned to England and was employed by the earl of Essex. Charges were again brought against him, but after two months' imprisonment he cleared himself before the Star Chamber and Queen Elizabeth I appointed him clerk of the council of Munster in May 1600.

Boyle bought in 1602 the whole of Sir Walter Raleigh's estates in Cork, Waterford and Tipperary. He encouraged settlers from England, started manufactures and industries and used much of his profits for improving the towns, building bridges and castles and for maintaining free schools and almshouses. Meanwhile, his advancement was rapid. Knighted in 1603, he became a privy councilor for Munster (1606) and for Ireland (1613), and was created Lord Boyle, baron of Youghal, County Cork (1616), and earl of Cork (1620). He was appointed a lord justice in 1629 and lord high treasurer in 1631. When Thomas Wentworth (afterward earl of Strafford) became lord deputy in Ireland in 1633, Cork's power and wealth declined; he steadily, albeit quietly, opposed Wentworth but remained loyal to the English crown and interest and fought against the Irish rebels of 1641. He died at Youghal on Sept. 15, 1643.

By his second wife, Catherine, daughter of Sir Geoffrey Fenton, Boyle had eight daughters and seven sons, four of whom received independent peerages. Richard (d. 1698), as well as inheriting his father's titles, was, by virtue of his marriage (1628) with Elizabeth, Baroness Clifford in her own right, created Baron Clifford (1644) and was made earl of Burlington in 1664. Lewis (d. 1642) was created Viscount Boyle of Kinalmeaky (1628); he was killed fighting the Irish rebels at the battle of Liscarrol. In 1660 two other sons, Roger (d. 1679), baron Boyle of Broghill (1628), and Francis (d. 1699), were created respectively earl of Orrery and Viscount Shannon. Another son was Robert Boyle (*q.v.*), the natural philosopher and chemist.

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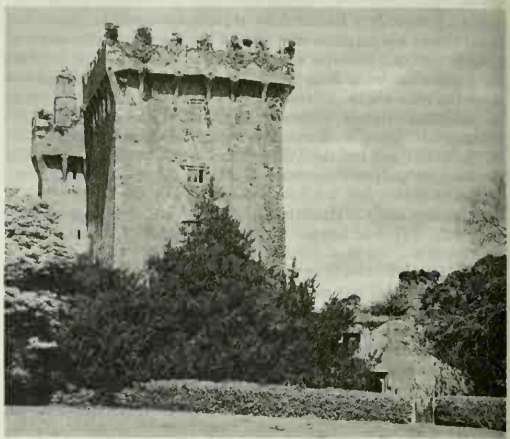
CORK (Chorcaighe), a county in the province of Munster, Republic of Ireland, is bounded on the south by the Atlantic ocean, east by counties Waterford and Tipperary, north by County Limerick and west by Kerry. With a land area of 2,880.1 sq.mi., it is the largest county in Ireland.

Physical Features.—The county has long east-west ridges forming uplands and, in some places, hills over 2,000 ft.; *e.g.*, in the Bogra, Derrynasaggart and Caha mountains. However, less than three-tenths of its area is rough pasture, while farmlands climb over the ridges to as much as 800 ft. and fill the valleys of eastward-flowing rivers, such as the great Blackwater, the Bride, the Lee, the Bandon and many tributaries and lesser rivers. The hills are mainly formed of Devonian (Old Red) sandstones and the valleys of Carboniferous limestones. In the south there are also slates and shales of the Carboniferous period which stand up in ridges, though many of the lesser ridges, such as those of Cork harbour and the area immediately east of it, are formed of Devonian sandstones. The hills are anticlinal ridges, but the beds dip more steeply than the relatively gentle slopes of the valley sides. The Carboniferous rocks preserved in the valleys are generally covered with drift or alluvium, but in places appear at the surface. The broad valleys and lowlands of east and central Cork give way in the west to narrower valleys with coastal lowlands backed by high mountains. Around Bantry bay and Dunmanus bay the long peninsulas have some scenery of great fame, *e.g.*, near Glengariff. In this area the exceptionally mild winters allow a subtropical vegetation to survive, and the woods have a richness of moss and plant growth that resembles that of the famous woods in the sheltered valleys near Killarney. (T. W. Fr.)

History.—The city of Cork was of Norse foundation and, with its immediate hinterland, remained for centuries virtually an independent entity. Outside that small area the Irish followed their traditional way of life. In 1127 Tordelbach O'Connor divided the kingdom of Munster (*q.v.*) between an O'Brien and a MacCarthy, the latter receiving the Kingdom of Desmond (*q.v.*). In the later 12th century, after the arrival of the Anglo-Norman invaders, Dermot MacCarthy made his submission to Henry II. The crown reserved the city of Cork, and Dermot was the last king of Desmond. Most of Desmond fell to the FitzGeralds who, as earls of Desmond, became increasingly Irish in their ways. Their descendants came to grief in Tudor times, when a new type of adventurer sought to possess their lands, for their revolt in the time of Gerald, 14th earl, brought about their final ruin (*see* Fitzgerald). In 1586, under the scheme for the plantation of Munster, large estates were allocated to English "undertakers" among whom Sir Walter Raleigh, associated with Youghal, was prominent. Edmund Spenser completed the first three books of the *Faerie Queene* while leasing Kilcolman castle near Buttevant. The scheme was destroyed by Hugh O'Neill's forces in 1598 in the course of the Ulster war. A turning point of this war was marked by the failure of the Irish to relieve their Spanish allies who occupied Kinsale in 1601. Afterward the rising power was that of Richard Boyle, created earl of Cork in 1620, who had bought up ruined estates of the old Munster plantation (*see* Cork, Richard Boyle, 1st Earl of). The Boyle family supported Cromwell but made advantageous terms with the restored Stuarts. Cork was the scene of much disturbance during the later 18th century and also during "the Troubles" and the Civil War in the 20th century. (Hu. S.)

Population and Administration.—In 1961 the population of County Cork was 330,106, less than half the 854,118 of 1841. More than one-third of the people live in the city and county town of Cork (77,860) and its suburbs (37,648). Another 79,583 live in the 15 country towns or in villages, the chief towns being Cobh (5,266), Mallow (5,520), Youghal (5,043) and Fermoy (3,427). Administration is by county manager and elected county council, Cork county borough having its own city manager. The county is divided by both the Church of Ireland and the Roman Catholic Church into three diocesan units, Cork, Cloyne and Ross, the Church of Ireland having one bishop for the three. Apart from the city of Cork, the county town, there are four electoral areas, North, South, East and West Cork, each returning three members to *dail eireann* (house of representatives).



NEILL WELLS FROM PAUL POPPER

BLARNEY CASTLE, 1446, LOCATION OF THE "BLARNEY STONE," COUNTY CORK, REPUBLIC OF IRELAND

Industries.—In the east and centre the county has good farms, many of them 70 ac. or more, with such crops as oats, potatoes, even wheat (though this is not prominent), and roots such as turnips and mangels and sugar beets for the factory at Mallow. The farmers' main cash resource is livestock, either for meat, or for milk sold to the creameries which are numerous in the north and west of the county. Pig rearing is traditional, though less general now than formerly because of feeding difficulties. In the extreme southwest the farms are far smaller than in the richer lowlands to the east, but around Skibbereen, and all along the south coast, there are good agricultural lands with well-tended farms of 50 ac. and more. The fishing, so prosperous at the beginning of the 20th century, has now almost disappeared, though there is salmon fishing in the rivers. Kinsale has been spoken of as a town "so depopulated, so stagnant as to be almost dead," though it now has some small factories. In the city of Cork (*q.v.*), agricultural industries such as brewing, bacon curing and flour milling are prominent, but there are also a car and tractor assembly plant, a rubber works, clothing factories, woolen mills and a large fertilizer industry. Cobh, on Cork harbour, was formerly a British naval base. Mallow is the railway junction for Killarney with a lively market trade and some small industries. Kanturk has a large hosiery works and Mitchelstown a cheese and bacon factory. Some fine tweed is still made in several rural factories near Cork, while a recent development is an earthenware factory at the village of Carrigaline. Another economic advance is the opening of a large oil refinery at Whitegate, on Cork harbour. So far tourism brings only a limited profit to the county, though Youghal and Blarney have many summer visitors.

The county has railway lines from Cork through Mallow to Dublin and Limerick: at Mallow lines run east to Waterford and west to Killarney and Tralee. (T. W. Fr.)

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CORK (Corcaigh), a county borough, seaport and county town of County Cork, Republic of Ireland, at the head of the inlet of Cork harbour, on the Lee river, 159 mi. S.W. of Dublin by road. Pop. (1961) 77,860 excluding North City and South City suburbs (37,648). It ranks as the second largest city (after Dublin) in the republic. The nucleus of the city occupies an island formed by the North and South channels, two arms of the Lee river. The name Corcaigh signifies a swamp and its original site seems to have been

in the vicinity of the cathedral of St. Finbarr, whose 7th-century ecclesiastical foundation attracted many students and votaries. According to the *Annals of the Four Masters,* a fleet burned Cork in 821; in 846 marauding Danes appeared to have been in possession of the town, for a force was collected to demolish their fortress; and in 1012 Cork again fell in flames. The Danes eventually settled and founded a trading centre on the banks of the Lee. It was anciently surrounded with a wall, an order for the repair of which is found as late as 1748 in the city council books (which date from 1610). The town under Dermot MacCarthy, Lord of Desmond, submitted to Henry II in 1172, and was granted its first charter by the king. It was subsequently held by the English for a long period. Cork showed favour to Perkin Warbeck, pretender to the English throne, when he visited Cork in 1492, a gesture resulting in the hanging of the mayor and conspirators at Tyburn, and the town being deprived of its charter. In 1649 its garrison revolted in favour of Cromwell and in 1690 it surrendered to the earl of Marlborough.

Cork has often been a principal focus of nationalist politics, and during the upheaval of 1919–20 it became the main centre of resistance to military repression. In the bitter conflict which followed the murder by a constabulary band of Lord Mayor MacCurtain and the death by a 75-day hunger strike in Brixton prison (in London) of his successor, Terence MacSwiney, the Cork city hall and most of the main shopping centre were burned down by the British in retaliation for the ambush of a military convoy. After the Anglo-Irish treaty had been concluded in Dec. 1921, the city was for a time held by the Republican forces, who would not accept the treaty settlement. Much devastation followed. Conflict between local and national authorities resulted in the temporary supersession of local councils by city and county managers. This was first tried in Cork city with such success that the Cork City Management act was passed in 1929, which restored the city council with modified powers. The county borough of Cork returns five members to *dail eireann* (house of representatives).

Natives of Cork include William Maginn, the poet; Thomas Crofton Croker (*q.v.*), the antiquary; Francis S. Mahony, "Father Prout"; and the painters James Barry and Daniel Maclise (*qq.v.*).

The Protestant cathedral, built 1865–69, is in the Early French (pointed) style. Dedicated to St. Fin Barre or Finbarr, who founded the original cathedral in the 7th century, it replaced a structure erected in 1735 on the site of the ancient cathedral. The Roman Catholic cathedral, dedicated to St. Mary and conspicuous on the north side of the city, dates from 1808. Large Roman Catholic churches were built in various districts of Cork after the Catholic Emancipation act of 1829. About the same period there was agitation for a university college in Cork, and the Queen's college was opened in 1849. As University college, Cork, it became a constituent college of the new National University of Ireland in 1908. Built in Tudor style, it stands near the river where Gill abbey (12th to 16th centuries) formerly stood, and in its grounds are the Honan Collegiate chapel and the Institute of Dairy Science. Cork city has the Crawford school of art with public galleries of paintings and sculptures. The city museum was established in the garden of Fitzgerald park.

Cork harbour, behind a narrow entrance sheltered by islands, is considered one of the finest natural harbours in Europe. The entry is about 1 mi. wide, increasing within to about 3 mi. with a length of about 10 mi. The port of Cobh (*q.v.*) is on Great Island, at the head of the outer harbour. Direct trade to and from Cork is chiefly with ports in England, Wales and Scotland; but there is also regular trade with the Netherlands, France, Scandinavia, Spain and other European countries. Imports include wheat and maize (corn), timber and building requisites and raw materials. Exports are chiefly of cattle, provisions, butter and fish. The Cork butter market has been famous since the early 17th century. The present market was built in 1769.

Established industries include distilleries, breweries, tanneries, iron foundries; the manufacture of woolen and leather goods, tweeds, gloves, hats and chemical fertilizers, and bacon curing. During World War I, Henry Ford, who had family connections in County Cork, built on the disused racecourse his first factory in Europe for producing agricultural tractors. His enterprise gave rise to a new industrial area in Cork, which includes the principal rubber factory in Ireland, grain silos and oil storage depots and an electric power station. Other flourishing industries, including nylons, carpets, tiles and paints, have arisen on the western and southern outskirts of the city. (D. G.)

CORK. Cork consists of the irregular-shaped, thin-walled, waxy-coated (suberized) cells that make up the bark of many trees. Although the winged ridges along a hackberry trunk or the peeling bark of the birch are by this definition cork, in its restricted commercial sense only bark of the cork oak (*Quercus suber* and its varieties) merits the designation. Small amounts of commercial cork are harvested in Brazil from the "Pau Santo," *Kielmeyera coriacea,* and a little in Japan from a native oak, *Quercus variabilis.*

Distribution.—The cork oak is native to the Mediterranean region, where it grows abundantly in Portugal, Spain, parts of southern France and Italy, and in north Africa. Spain alone has over 2,000,000 ac. of cork forest. It has been introduced into the southern United States, the more important plantings being in California. Trees scarcely yield significantly for at least 20 years, and at 50 years produce only about 100 lb., as compared with 500 lb. or more for octogenarians. Hence it is not surprising that chief production comes from extensive natural and a few cultivated stands in southern Europe and north Africa.

In general, continued exploitation, and some use for wood and charcoal, with only little reforestation, has gradually diminished stands and supply. The custom of letting hogs and cattle run in the cork forest, to feed on acorns, plus in many cases cultivation between trees, tends to prevent establishment of new seedlings. World production averages close to 300,000 tons annually, some 50% or 60% exported to the U.S.

Description and Properties.—The inner bark of the cork oak develops an especially uniform and continuous regenerative tissue. After the outer bark is peeled this tissue proliferates sufficient cork cells to the outside that, in a healthy tree, one to two inches of a uniform new cork sheathing (new bark) forms anew in from three to ten years. Stripping this regenerated layer yields commercial cork slabs. The original bark or first stripping is rough and uneven, fit only for grinding. Even the second stripping may not be top quality, with third and subsequent strippings producing cork fit for bottle stoppers.

The uniqueness of cork stems from the impervious air-filled cells, as much as 35% fatty acid; each is a watertight, flexible compartment. En masse they are a remarkably effective insulating medium, impervious to liquids. This is undoubtedly an adaptive response to the harsh natural environment, where the cork oak trunk needs protection from heat and drying winds in summer.

When cork is cut, the cut surface presents a myriad of closely packed half spheres each analogous to a rubber suction disk such as is often used to hold against glass or other smooth surfaces. Wet or dry, clean or greasy, these miniature suction cups adhere upon slight pressure. This attribute, combined with excellent insulating and wear-resistant qualities, makes cork a favourite medium for nonslip handles, catwalk flooring, bobbins and rollers. Constructed as it is of thin-walled cells forming a matrix of air pockets, it is among the lighter substances in weight, only one-fifth as heavy as water.

An obvious use is for floats, indeed reportedly used by the Romans as early as the 1st century. Life preservers of cork were an almost inevitable adaptation of a later age. Since the tiny cells act like balloons, compressing with pressure, then expanding back to original size upon release, cork shows excellent resiliency without set. It has been extensively used to cushion heavy machinery, and for gaskets sealing machine parts and pipe joinings.

Cork cells are chemically inert, deteriorated little or not at all by the weaker acids and bases or most organic solvents; thus cork's traditional importance as bungs and stoppers, including the familiar bottle corks. Cork suffers no breakdown with age, nor will it support combustion. It is tasteless, odourless, and of pleasant "feel" and colour.

Harvesting.—Regulation has been imposed upon harvest of cork in most production areas, in order to preserve and protect existing stands as much as possible. It is generally illegal to strip bark from trees of less than a prescribed diameter, or more frequently than at 8 to 11 year intervals. One tree in California, however, recouped and was ready for another stripping in three years' time. There is 3% to 5% mortality among trees at first stripping.

Stripping is done by hand, in summer, and has changed little through the ages. Girdling cuts ring the trunk or branch at convenient distances, after which a longitudinal slit is made with a specially designed ax or curved saw. Starting at this cut the outer bark is carefully pried loose from the inner tissues, and peeled away with the help of various levers and wedges. Care is taken not to injure the deeper regenerative layer (cork cambium); otherwise new cork will be warty and of little value. Strippers can harvest 1,200 lb. in a day.

The removed peel is usually like a hollow cylinder cleft on one side. It is traditionally steamed or boiled and pressed flat, although experiments in California have shown that the boiling step is not really necessary. Boiling or steaming removes soluble tannins, while the rough "woody" surface is scraped clean by hand.

Marketing and Uses.—In Algeria, one of the leading cork producers, cork auctions proceed much as with tobacco in the United States, a novel twist being that prices start at the "top" and come progressively downward until a bid is made. A buyer must anticipate when a competitor is likely to bid, while maintaining an unrevealing stoic attitude himself.

Whether purchased at auction or under contract, cork is usually shipped without further processing to industrial centres throughout the world. There superior sheets may be used for stamping out bottle corks, always cut in the long direction, from the end rather than across the sheet, so that the natural pores (lenticels of bark) run crossways, not through the closure (which might permit some leakage).

Although the bottle stopper has been the most familiar use of cork since the invention of the glass bottle in Germany during the seventh century, biggest modern uses are for insulating sheet and floor coverings. Insulating sheet and cork "board" may be made by compressing ground cork or cork trimmings at elevated temperatures, or mixing it with adhesive binders. Linoleum utilizes pulverized cork flour mixed with drying oils, which is bound to a burlap backing.

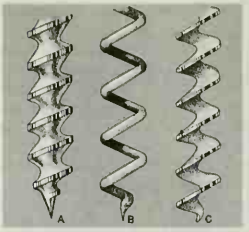
Essentially a mass of air bubbles, cork has excellent insulating and soundproofing qualities, for such uses as refrigeration chambers; with suitable binder cork makes an attractive and resilient floor and wall tile. Colour and texture make it appropriate for decorative purposes. Other familiar uses are for gaskets, floats, handles, beverage cap liners, buffers and various small pads as insulators. (R. W. Sy.)

CORK AND ORRERY, MARY MONCKTON, Countess of (1746–1840), whose witty conversation and infectious enthusiasm made first her mother's house and later her own a meeting place for the great men of the day, was born on May 21, 1746, daughter of the 1st Viscount Galway. Samuel Johnson, Sheridan, Joshua Reynolds, Edmund Burke and Horace Walpole constantly visited her at her mother's London house, and Mrs. Siddons was her closest friend.

In 1786 she married Edmund Boyle, 7th earl of Cork and Orrery (d. 1798), and continued to hold "conversation parties" at which Canning and Castlereagh, Lord Byron, Sir Walter Scott, Lord John Russell, Sir Robert Peel, Theodore Hook and Sydney Smith were regular guests. She is supposed to have been the original of Lady Bellair in Benjamin Disraeli's *Henrietta Temple* (1837) and of Mrs. Leo Hunter in Charles Dickens' *Pickwick Papers* (1837). She died in London on May 30, 1840.

CORKSCREW, an instrument for boring into a cork and extracting it from a bottle on exertion of a pull, which is found in many forms throughout the world. Corkscrews have an endless variety in screw shapes and handle styles.

Studies in the U.S. indicated that relatively few corkscrews could be relied upon invariably to remove tightly seated corks from wine bottles. The Wine institute, in California, variously tested 23 corkscrews and the best specimens were found to have more than twice the gripping power of the poorest. It was recommended that a corkscrew be long enough to penetrate fully through a long wine cork and also to provide a lifting surface below it; that the point be so situated as to make a path through the cork that the centre of the threads would follow; that the distance between threads be uniform; that the edges of threads be not sharp. Best results were observed with corkscrews having a diameter of .35 in. or slightly more, a distance between threads (measured along the axis) of .40 in. and a point tapered down for a distance (measured along the axis) of not more than .40 in.



THREE CORKSCREW SHAPES: (A) AUGER TYPE WITH METAL CORE; (B) WIRE TYPE, BENT AROUND HOLLOW CENTRE; (C) WEB TYPE

Screws formed by rigid wire spirals performed at least as well as the steel-web types; auger types with thick central shafts, which apparently weakened the cork centres, pulled out through the corks too easily. The tests showed that it was sometimes necessary to exert as much as 300 lb. of force to extract a cork from a wine bottle in a straight pull, and that therefore a leverage device was desirable. Leverage devices recommended were those that drew the cork without the need of a continued turning of the screw.

The kind most popular with restaurant and hotel personnel was a folding jackknife or boot-lever type equipped with a hinged boot, which stood on the bottle rim and provided a fulcrum while the other end of the lever was pulled upward. (L. B. L.; X.)

CORKWOOD, the name given to several tropical American trees and shrubs with light porous wood, especially to the alligator apple or pond apple (*Annona glabra*), found in the Everglades of Florida and widely in the tropics; the magaguabush (*Hibiscus tiliaceus*) of the Florida keys, the West Indies and other warm regions; and the balsa (*Ochroma lagopus*), widespread in tropical America. The North American corkwood (*Leitneria floridana*), a small tree with pale-yellow wood, is confined to semitropical swamps in Florida and Texas and to muddy sloughs in southeastern Missouri. In New South Wales, Austr., a tree, *Duboisia myoporoides*, of the nightshade family (Solanaceae), is called corkwood. The buoyant wood of these trees is utilized for floats and numerous other purposes, especially that of the balsa (*q.v.*).

CORMORANT, a long-billed sea bird, larger than the duck, of the genus *Phalacrocorax* and the family Phalacrocoracidae. The cormorant (*P. carbo*) and its subspecies are distributed throughout the world. They frequent rocky ledges of cliffs along sea coasts, estuaries and coastal lakes and sometimes inhabit inland lake islands and trees. The cliff nests consist of a large mass of seaweed and guano, and the tree nests consist of twigs.

The eggs, from four to six in number, are small and have a thick, soft, calcareous shell, bluish white when first laid, but soon becoming discoloured. The young are hatched blind and covered with an inky black skin. As squabs they are highly esteemed for food by the northern islanders of Europe. Their first plumage is of a sombre brownish black above and more or less white beneath. They take two or three years to assume the fully adult dress, which is deep black, glossed above with bronze, and varied in the breeding season with white on the cheeks and flanks, besides being adorned by filamentary feathers on the head and a bright yellow gape. The brilliant gape is displayed in courtship. The flesh of the adult is uneatable.

Taken from the nest, this bird is easily tamed and can be trained to fish for its keeper, as was in former times commonly done in England, where the master of the cormorants was one of the officers of the royal household. The practice is obsolete in Europe, though still common in China and other areas of the far east, where

cormorant fishing is done at night, the scene being lighted by colourful torches. A strap is fastened round the bird's neck so as, without impeding its breath, to prevent its swallowing its catch. The activity the bird displays under water is almost incredible. Being propelled chiefly by its webbed feet, the cormorant wheels and turns with ease in pursuit of its prey.

Nearly allied to the cormorant, and having much the same habits, is the shag or green cormorant (*P. aristotelis*). The shag is about one-fourth smaller, is much more glossy in plumage, and its nuptial embellishment is a nodding plume. Its tail feathers number 12 instead of 14. In the south of Europe a much smaller species (*P. pygmaeus*) is found. This is a fresh-water bird. Further species, to the number of more than 30, have been recorded from other parts of the world, but all have a great similarity; New Zealand and the west coast of northern America are particularly rich, and the species found there are the most beautifully decorated of any.

ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

A NORTH AMERICAN CORMORANT (PHALACROCORAX AURITUS)

All are remarkable for their curiously formed feet with all four toes connected by a web, for their long, stiff tails and for the absence in the adult of any exterior nostrils. Their voracity is proverbial; when gorged they are fond of sitting on an elevated perch, with partially extended wings. In this attitude they will remain motionless for a considerable time.

Besides the common cormorant, the crested cormorant (*P. auritus*) is found in the eastern United States, with a more southerly distribution. Brandt's cormorant (*P. penicillatus*) inhabits the North Pacific; the pelagic cormorant (*P. pelagicus*), the North Pacific and the coasts to western Mexico. The white-breasted guanay or Peruvian cormorant (*P. bougainvillei*) is one of the chief producers of guano fertilizer (*see* GUANO; PERU).

CORN (MAIZE or INDIAN CORN [*Zea mays*]). The word "corn," originally meaning a small, hard particle or grain as of sand, gunpowder, or salt (for example: "corned" beef, *i.e.*, preserved by salting), came to be applied to the small, hard seed of plants. In agriculture it generally referred to the seed of the cereal plants; *e.g.*, corn laws.

Corn is often locally understood to mean that kind of cereal which is the leading crop of the district; thus, in England it refers to wheat, in Scotland and Ireland to oats. "Corn in Egypt," a world-wide expression for plenty, when first used probably meant wheat, but may have meant barley as well, these being the only two cereals in cultivation in contemporary civilizations. Maize, the principal cereal of the new world, was first known as "Indian corn" and later as "corn."

This article discusses corn in terms of its history, botany and types, the development of hybrid corn, and distribution, uses and production. For information on various insects and other pests that may damage corn *see* CORN BORER; ENTOMOLOGY: *Principles of Insect Control;* FUNGI; SMUT AND BUNT.

Origin and History.—Corn, a plant of the tribe Maydeae of the grass family (Gramineae) is undoubtedly a plant of American origin, since there is no evidence of any kind—archaeological, linguistic, pictorial or historical—of the existence of corn in any part of the old world before 1492. In contrast, cobs and ears of corn, as well as funerary vases and other objects ornamented with figures of corn are frequently encountered among archaeological remains in both North and South America.

Through an ingenious method developed by W. F. Libby of The University of Chicago, it became possible to estimate the age of ancient vegetal remains by measuring the decay of radioactive carbon which the original plants had absorbed from the atmosphere (*see* RADIOCARBON DATING). Such measurements showed that the oldest corn found in South America by the middle of the 20th century went back to about 1000 B.C. and the oldest in North America to at least 2000 B.C. Wild corn probably occurred much earlier than this, for E. S. Barghoorn of Harvard university, in 1954, identified fossil pollen grains of corn in a drill core taken from a depth of more than 200 ft. below the present site of Mexico City.

The modern history of corn begins Nov. 5, 1492, when two Spaniards whom Christopher Columbus had delegated to explore the interior of Cuba returned with a report of "a sort of grain they call maize which was well tasted, bak'd, dry'd and made into flour." Later explorers to the new world found corn being grown by the Indians in all parts of America where agriculture was practised from Canada to Chile. The seminomadic hunting and fishing Indians in both North and South America augmented their diet of fish and game with corn from cultivated fields. The more advanced mound builders of the Mississippi valley and the cliff dwellers of the southwest were corn-growing and corn-eating people. The highly civilized Maya of Central America, the warlike and energetic Aztecs of Mexico and the fabulous Incas of Peru and Bolivia all looked to corn for their daily bread. The abundant harvest that this cereal yielded gave these ancient people leisure for weaving beautiful fabrics, molding exquisite pottery, building magnificent highways and towering pyramids, inventing a system of arithmetic and perfecting a calendar more accurate than the old world calendar for the same period. Corn was indeed "the grain that built a hemisphere."

Spread of a Cultural Complex.—Later corn became the bridge over which European civilization traveled to a foothold in the new world. To many of the early colonists, who learned its culture from the Indians, it became the daily bread by which they were nourished. Modern American corn growing is founded to a large extent upon an elaborate cultural complex taken from the American Indians, for not only did the European colonist adopt the corn plant but he also embraced the methods of culture, harvesting and utilization which the Indian had developed through generations of trial and error.

The planting of corn in hills, its interplanting with beans and squashes, the use of husking pegs in harvesting, the storing of the ears in ventilated cribs, the use of green corn for roasting ears, the removal of the hull with lye to make hominy are only a part of the Indian inventions adopted with slight changes by the settlers.

Introduced into Europe by Columbus and into Africa by the Portuguese, corn spread rapidly throughout the old world. Within one generation after the discovery of the new world it was known over most of Europe. Within two generations it had spread through Africa, India, Tibet and China, and when European ships began to reach the Chinese coast corn was already being extensively grown there and was being taxed by the emperor.

The first references to corn in literature appear early in the 16th century. The first botanical illustration of the plant occurs in the herbal of Leonard Fuchs, in 1542. The earliest Chinese illustration is found in the *Pen Ts'ao Kang Mu* of Li Shih-chen, which is dated at 1578. Of all the manifold products of the new world, corn spread the most rapidly, even more rapidly than tobacco.

Botanical Origin.—The botanical origin of corn is less clear than its geographical origin. Earlier botanists were virtually unanimous in the opinion that corn had originated from pod corn, a primitive type in which the grains are enclosed individually in chaff. A second principal theory has corn originating from a plant called by the Aztecs *teocentli,* now anglicized to teosinte (*q.v.*).

Teosinte is undoubtedly the closest wild relative of cultivated maize. Like corn it has tassels and ears borne separately, although its "ears" contain only five or six seeds, each enclosed in a hard bony shell—characteristics that make teosinte a most unpromising food plant. Also like corn, it has 10 chromosomes, the bearers of heredity, indicating that it is a closely related species. Teosinte can readily be crossed with corn to produce hybrids that are completely fertile or almost so. Still another theory postulates that corn, teosinte and Tripsacum, a third American genus of the tribe

to which maize belongs, have originated along independent and diverging lines of descent from a remote common ancestor now extinct.

After 1940 evidence from genetic experiments and archaeological remains accumulated to show that none of these theories was completely correct and none wholly wrong. Archaeological specimens of corn in the early stages of domestication, discovered in Bat Cave in New Mexico in 1948 by Herbert Dick of the Peabody museum of Harvard university, proved that the ancestor of corn was not teosinte but a form of pod corn. The small cobs of this corn, scarcely longer than the diameter of a one-cent piece, once bore about 50 tiny kernels partly enclosed in chaff. Teosinte, however, played an important role in the evolution of corn under domestication, for genetic experiments demonstrated that characteristics of teosinte can be introduced into corn through hybridization, and archaeological material from other caves in New Mexico and Arizona showed that sometime in its history corn hybridized with teosinte to produce radically new types which comprise the majority of modern corn varieties of North America.

When crossed with corn, teosinte contributed to the progeny some of its own hardness and toughness and provided the strength necessary for the evolution of greatly enlarged ears.

Botanical Characteristics.—The corn plant is a tall, annual, grass with a stout, erect, solid stem, a fibrous root system, large narrow leaves with wavy margins, spaced alternately on opposite sides of the stem, and male and female flowers borne on separate inflorescences (fig. 1).

The male or staminate flowers are borne on the tassel which terminates the main axis of the stem (fig. 1[C]). As in all grasses, the flowers occur in small clusters called spikelets, usually arranged in pairs, one borne on a short stem, the other not (fig. 1[D]). Each floret contains three anthers (fig. 1[D]); each anther, approximately 2,500 pollen grains. A single tassel may shed several million pollen grains. These are barely visible to the naked eye, approximately 1/250 inch in length and are ovoid in shape. They are light and easily carried by the wind and this accounts for the fact that corn is naturally cross-pollinated.

The female or pistillate inflorescence, which when mature is called the "ear," is a unique structure among the grasses. Botanically, it is a spike with a thickened axis, the "cob," on which the paired spikelets are borne in longitudinal rows. Each row of paired spikelets normally gives rise to two rows of grain; hence the number of rows of grain on the ear is always an even number: 8, 10, 12 and higher, up to 36.

The pistillate inflorescence is enclosed by "shucks" or "husks" which are modified leaves (fig. 1[B]). The familiar "silks" which

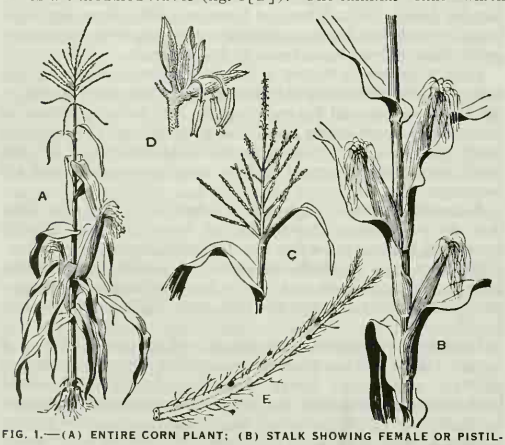


FIG. 1.—(A) ENTIRE CORN PLANT; (B) STALK SHOWING FEMALE OR PISTILLATE INFLORESCENCES; (C) THE MALE OR STAMINATE INFLORESCENCE; (D) STAMINATE SPIKELET, SHOWING ANTHERS; (E) PORTION OF STYLE OR SILK MAGNIFIED SHOWING DIVIDED END AND POLLEN GRAINS CAUGHT IN HAIRS

emerge in a pendulous mass from the end of the ear shoot are the styles attached to the ovaries (fig. 1[E]). There is a single silk for each potential seed, and the number of seeds on the ear may equal but can never exceed the number of silks which have emerged. Pollination occurs when wind-borne pollen falling upon the fine hairs of the silks germinates and sends its pollen tube down the tissues of the long styles.

Principal Types.—The diversity in corn is enormous and probably exceeds that of any other cultivated plant. There are early maturing varieties, Gaspé Flint from the Gaspé peninsula of Canada and Cinquantino from the Pyrenees mountains of Spain, which mature in 60–70 days; there are very late varieties in Colombia which require 11 months to reach maturity.

The number of leaves on a single plant varies from 8 to 48; the number of tillers or suckers from none to 12. The height of the stalk may vary from less than 2 ft. to more than 20 ft. The number of rows of grain on the ear may range from 4 to 36, and the size of the ear varies from the diminutive ears of popcorn varieties, some of which are smaller than a man's thumb, to the gigantic corn grown in the Jala valley of Mexico which produces ears up to 2 ft. in length.

Accompanying the variation in vegetative characteristics is a corresponding array of distinct colours. Stalks, leaves and shucks may be green, red, purple, brown, golden or striped. The silks may be green, salmon or various shades of red. The grain may be yellow, white, various shades of red, blue and brown or variegated.

Because of the great diversity of form and colour, the botanical classification of corn has presented unusual difficulties to the systematist. But beginning in 1951 substantial progress has been made in classifying the corn of the world into races which correspond approximately to breeds of livestock. Thirty more or less distinct races were recognized in Mexico, approximately the same number in Peru, and it was estimated that there are between 100 and 150 races of corn in the world. A commercial classification of corn based largely on the texture of the kernels has long been in use and five principal types have usually been recognized (fig. 2):

1. *Dent corn* is characterized by a depression or indentation in the crown of the kernel, which may vary from a dimple to a rough crease, and which is caused by the unequal drying of the hard and soft starch of which the kernel is composed. Dent corn is the principal type grown commercially in the United States, especially in the corn belt. Although dent corn may occur in any of the known grain colours, the majority of commercial varieties are either yellow or white. Before 1920, yellow corn was preferred in the north, white corn in the south, but with the discovery that yellow corn is richer than white in carotin, a precursor of vitamin A (that is, the carotin can be converted to vitamin A in the body) and hence frequently more valuable as a feed, there was a decided trend toward yellow varieties. White dent is still preferred for many industrial purposes, especially the manufacture of hominy.

2. *Flint corn* differs from dent corn in containing little soft starch, hence it does not become indented upon drying. The early-maturing flints are extensively grown in the northern United States and Canada, since they germinate more readily in cold soils than dent corn. The tropical flints, which because their hard seeds resist damage by weevils, are the preferred type in tropical lowlands.

3. *Flour corn*, also known as "soft" or "squaw" corn, is usually similar to flint corn in vegetative characteristics, but differs from it in the texture of the kernels, which are composed largely of soft starch. Because of its soft and mealy kernels, which are easily ground or chewed, flour corn is preferred by Indian tribes wherever it can be grown. It is of little commercial importance in the United States, but is the predominating type in the Andean region of Peru, Bolivia and Ecuador, where many large-seeded varieties, some with kernels an inch in length and almost equally broad, are known.

4. *Sweet corn* is distinguished by its wrinkled, translucent seeds, a condition resulting from the fact that the sugar manufactured by the plant is not converted to starch as it is in other types. Sweet corn is used almost exclusively for human consumption as green corn or roasting ears and as canned or frozen corn.

5. *Popcorn* is actually an extreme type of flint corn, and is in-

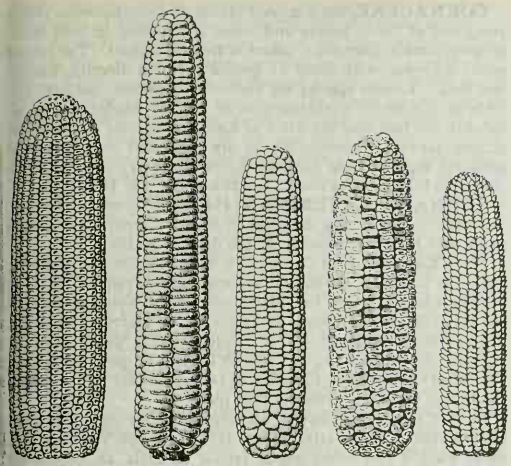


FIG. 2.—THE PRINCIPAL COMMERCIAL TYPES OF CORN FROM LEFT TO RIGHT: DENT, FLINT, FLOUR, SWEET AND POPCORN

cluded with the latter by some authorities. It is characterized by small hard kernels, completely devoid of soft starch. When heated, the moisture in the cells expands, finally causing the kernels to explode or pop. Popcorn is used extensively in the U.S. confectionery industry. Most of the commercial crop is grown in several counties in Iowa and Nebraska.

Hybrid Corn.—An important factor in the evolution and improvement of corn under domestication has been hybridization between distinct races. The American Indian through trade and migration created numerous opportunities for hybridization and for the development of new hybrid races. The white man continued the process, often unconsciously.

The world's most widely grown corn, the corn-belt dent of the United States, is the product of hybridization which occurred in the 19th century between the late, long-grained, many-rowed, "gourd seed" corn of Virginia carried into Ohio and Illinois and the early, eight-rowed flint corn of the northeast brought into the same region by settlers from New England.

Beginning about 1920 a new method of improving corn through hybridization (fig. 3) and the controlled utilization of hybrid vigour was widely adopted and became extremely effective. The method is based upon discoveries in genetics made by G. H. Shull of the Carnegie institution, E. M. East of Harvard university and D. F. Jones of the Connecticut Agricultural Experiment station (*see* PLANT BREEDING).

The first step in the production of hybrid corn is the isolation of superior inbred strains. This is accomplished by artificial self-pollination under bags, which represents a form of inbreeding approximately three times as intense as brother and sister mating in livestock. Inbreeding reduces vigour and productiveness, but results in great uniformity within the strain. The second step involves the crossing of inbred strains by pairs (A × B, C × D, etc.) to produce single crosses. Single crosses are exactly as uniform as the parental inbred strains, but because of the phenomenon of hybrid vigour (*see* HYBRIDISM), much more productive. Single-crossed seed of sweet corn is extensively used in the production of green corn for commercial canneries where uniformity in size and shape of the ears is important. Single-crossed seed is usually too expensive, however, for general farm use. A third step is necessary to reduce seed costs. This third step, the production of double-crossed seed, involves the crossing of two single crosses (AB × CD). Double crosses are slightly less uniform than single crosses, but almost equally productive.

Hybrid corn does not breed true; but once a satisfactory combination of inbred strains has been identified the hybrid seed can be produced anew each year from the true-breeding parental inbred strains. Crossing is readily accomplished by growing two stocks in alternate strips in the same field and removing all tassels from the plants of one before pollen is shed. Hybrid corn proved so productive that by the second half of the 20th century, in spite of the expense involved in producing the seed, almost 90% of the U.S. corn acreage was being planted annually to hybrid corn, and this type of corn had also become important in Italy, France, Spain and the countries of Latin America.

World Distribution.—Although pre-eminently an American crop, corn is one of the most widely distributed of the world's food plants. It is grown from 58° N. lat. in Canada and U.S.S.R. to 40° S. lat. in South America. It is cultivated below sea level in the Caspian plain, and at altitudes exceeding 12,000 ft. in the Peruvian Andes. It thrives almost equally well in the short summer of Canada and the perpetual summer of tropical Colombia. A crop of corn matures somewhere in the world every month of the year.

From the standpoint of acreage planted, corn ranks second among the world's crop plants, being exceeded only by wheat. In the United States, which produces more than half the world's crop, it is by all odds the most important crop, being grown in every state and on approximately three-fourths of all farms. It reaches its maximum importance in the corn belt, a region of fertile, well-drained soils comprising Iowa and parts of Illinois, Indiana, Ohio, Missouri, Kansas, Nebraska, South Dakota and Minnesota. In this feed-grains and livestock region, corn occupies approximately one-half the cultivated land.

In the corn belt a combination of fertile soils, agricultural technology, progressive farmers, and improved corn has created the most productive agricultural civilization the world has ever seen. An efficient corn-belt farmer with the help of one man can grow the corn to produce enough meat and livestock products to feed three or four hundred people in town.

Brazil ranks second and Argentina usually third to the United States in corn production. In Europe, corn is of greatest importance in the Danube basin and of considerable secondary importance in Italy, Spain and southern France. Egypt, India and South Africa produce considerable quantities of corn, largely for domestic consumption.

Utilization of Corn.—Corn is utilized in three principal ways: (1) as a feed for livestock; (2) as a human food; (3) as a raw material in industry.

In the United States, about 80% of the corn produced is fed to livestock; approximately half of this amount to hogs, the re-

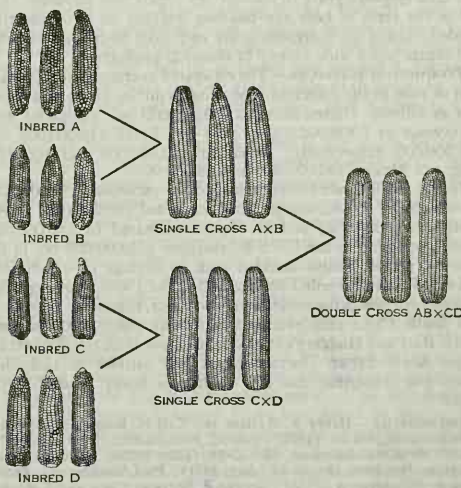


FIG. 3.—HYBRID CORN: INBRED STRAINS A AND B ARE CROSSED TO PRODUCE A SINGLE CROSS, INBREDS C AND D ARE CROSSED TO PRODUCE A SECOND SINGLE CROSS. SINGLE CROSSES AB AND CD ARE CROSSED TO PRODUCE THE COMMERCIAL DOUBLE CROSS

mainder to beef and dairy cattle, horses and mules and poultry. It requires 10–12 lbs. of corn to produce 1 lb. of beef, 6–8 lbs. to produce 1 lb. of pork. For feeding cattle, the entire plant is frequently harvested and used as ensilage (*q.v.*), the product of bacterial fermentation.

As a human food, corn is inferior to other cereals. Its gluten is of poor quality and it makes a heavy, crumbly bread. It is deficient in niacin, and diets containing excessive amounts of corn often result in pellagra. Nevertheless, corn was used exclusively for human food in prehistoric times, and is still used extensively for this purpose in Latin-American countries, in parts of Europe and the United States and in South Africa and India. The *tortilla*, a thin flat cake of corn, is the daily bread of Mexico, and corn constitutes 75% to 85% of the diet of the Maya Indians of Guatemala.

In the United States, corn is of greatest importance as a human food in the south, but is used to some extent in all parts of the country in the form of corn bread, hominy, mush or polenta, griddlecakes, scrapple, popcorn, confections and numerous manufactured cereal preparations. Sweet corn, harvested when the grain is in the "milk" stage, is an important American vegetable, consumed fresh, canned or frozen.

All parts of the corn plant are used as raw materials in industry. The stalk may be manufactured into paper and wallboard. Husks are used as filling material. Cobs are used for fuel, for making charcoal and for the preparation of industrial solvents. Corncob pipes are manufactured from a large-cobbed variety grown in Missouri. The most extensive industrial uses, however, are concerned with the grain. These consume about 9% of the annual U.S. corn crop and comprise three principal processes: wet milling, dry milling and fermentation.

In the wet milling process the grain is first soaked for 40–60 hr. in a dilute solution of sulfurous acid. Through progressive grinding and manipulation the germ and hulls are then separated from the remainder of the grain. Further treatment yields numerous products including starches, dextrins and "British gums" used in adhesives and sizing agents, syrup, dextrose, oil and gluten.

In dry milling the corn is briefly exposed to water spray or steam. This results in marked differences in the moisture content in various parts of the kernels and makes possible the physical separation of the kernel into its component parts. The principal products of dry milling are hominy, grits, meal, flour, oil and feed.

The fermentation industry first changes corn starches into sugars and then employs yeast to convert the sugars into beverage alcohol in the form of beer and bourbon whiskey or into industrial alcohol. Other microorganisms are employed to convert starches and sugars into a wide variety of chemical products.

Production Statistics.—The estimated average annual production of corn in the principal producing countries in the mid-1950s was as follows: United States 3,000,000,000 bu., compared with an average of 2,300,000,000 in 1935–39; Brazil 240,000,000 and 215,000,000, respectively; Argentina 190,000,000 and 300,000,000; and Mexico 140,000,000 and 68,000,000.

In the 1960s United States production exceeded 3,500,000,000 bu. annually. Production in Brazil exceeded 300,000,000; in Argentina, 200,000,000; and in Mexico increased to 250,000,000. Corn production in the U.S.S.R. averaged 170,000,000 bu. in the 1935–39 period, almost doubled with an average of 320,000,000 in 1955–59, and exceeded 400,000,000 in the 1960s. Among other leading corn producing countries in the 1960s, Rumania, Yugoslavia and South Africa each averaged more than 200,000,000 bu., and India, Italy and Hungary each averaged more than 100,000,000 bu.

See AGRICULTURE (ARTICLES ON) and articles on individual states and countries. *See* also references under "Corn" in the Index.

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CORN (CLAVUS): *see* SKIN, DISEASES OF.

CORNACEAE, the dogwood family of dicotyledonous plants consisting of 10–15 genera and about 100 species, in both hemispheres, some in temperate, others in tropical regions. The largest genus is *Cornus*, with about 45 species in North America, Europe and Asia. Various species are known as dogwood; the first syllable of this name, a modification of the old English *dagge*, alludes to the fact that the wood of European species was used for making skewers. Various species are cultivated for ornamental purposes, especially the Eurasian Cornelian cherry and the North American flowering dogwood. *See* DOGWOOD. (E. D. ML.; X.)

CORNARO, CATERINA (1454–1510), queen of Cyprus, was born at Venice, the daughter of Marco Cornaro, a Venetian noble, and Fiorenza, daughter of the duke of Naxos.

When King John II of Cyprus died, his succession was disputed; James de Lusignan, his natural son and a close friend of Marco's brother Andrea, seized the island and sought Venetian support for his claim to the crown, as James II, by marrying Caterina. The contract was signed in 1468. Adopted as a "daughter of the republic" by the doge and backed with the title of queen of Cyprus, Jerusalem and Armenia, Caterina, in 1472, sailed for Cyprus where the formal marriage ceremony took place.

In 1473 James died, leaving his kingdom to his queen and their unborn child. When after James III's birth the Venetian fleet sailed away a plot broke out in favour of Zarla, an illegitimate daughter of James II.

The Venetians returned and soon restored order, but began themselves to contemplate the seizure of Cyprus. Fearing an attack by Sultan Bayazid II and having discovered a conspiracy to marry Caterina to Alfonso II of Naples, Venice formally annexed Cyprus and recalled Caterina, who reluctantly abdicated in favour of the republic in 1489.

At Venice the government conferred on her for life the castle and town of Asolo, where she held court until her death on July 10, 1510.

See H. Brown, *Studies in the History of Venice*, vol. i (1907), with bibliography.

CORN BELT, the popular name of the area in the midwestern part of the United States in which corn (maize) and soybeans are the dominant crops. The region is one of considerable diversity, however, and an alternative name, feed-grains and livestock region, describes it more accurately. *See* AGRICULTURE: *United States: Corn Belt.*

CORN BORER. Foremost among insects attacking corn (*Zea mays*) throughout its world distribution is the European corn borer, the larval stage of a pyralid moth (*Pyrausta nubilalis*). This borer, with a wide geographic range in the northern hemisphere, occurs all over Europe as far north as latitude 58° N. It occurs also in many parts of Asia and in the south Pacific. Its climatic range varies from the dry steppes of southeastern Russia to the moist tropical conditions of Guam and the Philippines. It is known in Europe as an enemy of maize, hops, millet, hemp and many other food plants.

In the United States the European corn borer is one of the most devastating insect pests of American agriculture of record. Originally introduced into the country from Europe some time prior to 1912, it was first observed to be damaging corn in New England in 1916–17 in areas where the manufacture of brooms from broomcorn imported from Europe was a principal industry. Presumably, the broomcorn was the vehicle of importation of the borer. Since the enactment of the U.S. Plant Quarantine act of 1912, further importation of the pest has been checked. However, the borer has spread westward and southward to blanket the entire "corn belt" of the midwestern U.S. It is found in varying degrees of abundance in all states east of the Rocky mountains, except Florida. This spread is of varying magnitude from year to year, depending principally upon prevailing climatic conditions and the increase in numbers of borers that produce two or more broods in a growing season (the earlier strain of borers in the corn belt chiefly produced one generation per growing season).

Of aid in the borers' rapid spread are the strong flight capabilities of the moths; the use of more than 200 species of grains, weeds, vegetables and flowers as alternate hosts or sheltering

places; the tenacity of borer survival in corn plants; and non-occurrence of mountain barriers in the lake and plains states.

In spring full-grown, inch-long larval and pupating caterpillars, pinkish with dark heads, may be found in the stalks of the host plant. They emerge during the summer as yellowish-brown moths with a wingspread of about one inch. The female lays her eggs on the underside of the leaves (especially the lower ones) of the host plant. In about a week the eggs hatch and the tiny caterpillars feed externally on the plant. When they are half-grown, the larvae bore into the stalks and feed there until the cold weather. They overwinter as larvae.

Annual losses due to this pest in the United States range widely, but a particularly heavy infestation in 1949 was responsible for the loss of more than 315,000,000 bu. of field corn. Also considerable are the direct losses to sweet corn and other vegetables; and the associated losses due to contamination of infested canning crops, such as sweet corn and peppers, and ornamentals, particularly dahlias and gladioli. Control measures have not resolved the problem completely, but they have resulted in the ability of the U.S. farmer to live with the borer with a minimum impact on corn culture economy. The use of effective insecticides is complicated by the necessity to insure the noncontamination of food or feed crops with hazardous chemical residues. Of particular interest is the use of insect parasites of the borer, all originating from foreign sources; the development of strains of corn resistant to the borer; and the increasing promise of pathogens as practical control agents.

In addition to the European corn borer, a number of other borers are known to attack corn in the United States, although with a much more limited range of distribution. Foremost among these are the southwestern corn borer (*Zeadiatraea grandiosella*), occurring from Mississippi to Arizona and from Kansas to the Gulf of Mexico; and the sugarcane borer (*Diatraea saccharalis*), occurring on sugarcane, corn, rice, sorghums and wild grasses in the Gulf coast regions from Texas to southern Florida, and in southern Georgia. As with the European corn borer, the use of insecticides and the development of strains of corn resistant to attack by these borers afford some prospect for their control, but effective and economical measures are not currently available for general grower use. Other borers attacking corn in the United States, although of minor economic importance, are the stalk borer (*Papaipema nebris*), the southern cornstalk borer (*Diatraea crambidoides*) and the lesser cornstalk borer (*Elasmopalpus lignosellus*).

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CORN CRAKE: *see* Rail.

CORN CRIB: *see* Farm Buildings.

CORNEILLE, PIERRE (1606–1684), leading French dramatic poet, the creator of French classical tragedy. He was born in Rouen on June 6, 1606, and came of a well-to-do middle-class Norman family: his grandfather, father and uncle were lawyers; another uncle and a brother took holy orders; a younger brother was a well-known poet, Thomas Corneille (*q.v.*). The family house, in which he lived until past 50, still stands in the rue de la Pie in Rouen. He was educated by the Jesuits in the building which still serves as the town *lycée*, won two prizes for Latin verse, became a licentiate in law and wrote his first play before he was 20. From 1628 to 1650 he seems to have worked as crown counsel in the local office of the department of waterways and forests, and to have spent increasing leisure on writing plays. He said of his *Mélite* (performed 1629; publication, as usual with his plays, a year later) that its success surprised him and established a new company of actors in Paris. For about six years he wrote comedies: *Clitandre* (1631), *La Veuve* and *La Galerie du Palais* (1632), *La Suivante* and *La Place royale* (1634), *La Comédie des Tuileries* and *L'Illusion comique* (1635). Noticed by Richelieu, who attached him to his team of authors, Corneille seems to have enjoyed a cardinal's pension of 1,500 livres. After the success of Jean de Mairet's *Sophonisbe* in 1634 he wrote a tragedy, *Médée* (1635), but he returned to experiment with a tragicomedy which has proved his most famous play. It is an odd fact that the date of first performance of *Le Cid* cannot be fixed; early in 1637 seems most probable. The famous "Querelle," or quarrel, which followed is now thought to be due not so much to the novelty of the play as to the author's demand for an increased share of the takings and to his tactless poem, *Excuse à Ariste* (1637). After hard-hitting pamphlets on both sides, Richelieu seems to have ordered the closure with the appearance of the *Sentiments de l'Académie française sur le Cid* in Dec. 1637. The lapse of three years before Corneille's next play, the famous tragedy *Horace* (1640), has been explained partly as pique, partly by a lawsuit disputing the creation of a second legal office on a par with his own. He continued to write tragedies: *Cinna* (1641), *Polyeucte* (1643), *Pompée* (1644), *Rodogune* (1645), *Théodore* (1646), *Héraclius* (1647). In 1639 he produced a successful comedy, *Le Menteur*, and a first collected edition of plays. As soon as the troubles of the Fronde permitted, he started again with *Andromède* (1650), a play in which stage machinery was very important, and *Don Sanche d'Aragon* (1649), which he called a *comédie héroique*. This last play, like *Clitandre*, had clear political allusions, as had the next, *Nicomède* (1651). In the next year a tragedy, *Pertharite*, seems to have had a poor reception, and for the next eight years his only writing was a translation of the *Imitatio Christi* (4 parts, 1652–56). He returned to the theatre, apparently on Nicolas Fouquet's invitation, with an *Oedipe* in 1659 and another collected edition in 1660, prefaced by three essays on dramatic theory, and for the next 14 years produced almost a play a year: *La Toison d'or* (1661), *Sertorius* (1662), *Sophonisbe* (1663), *Othon* (1664), *Agésilas* (1666), *Attila* (1667), *Tite et Bérénice* (1670), *Psyché* (in collaboration with Molière and Philippe Quinault, 1671), *Pulchérie* (1672), *Suréna* (1674).

Thus for nearly 40 years in all—continuously for 20 years from 1630 and for nearly 15 years after 1660—this astonishing production of elegant drama had provided the main entertainment of the French court and of the Parisian middle class and in so doing had created a new art form, with a European reputation (of which Dryden's *Essay of Dramatick Poesy*, 1665, is but one witness) and had won for its author an immense personal prestige. If modern research shows Corneille as grasping in the "Querelle" and ungenerous toward his younger rival, it should be remembered that the whole story is not known and that what is known is insignificant beside the fact that he perfected and created a dramatic instrument which could be used, ready-made so to speak, by one of the great tragic poets of modern times, Jean Racine (*q.v.*). Corneille died in Paris, Oct. 1, 1684.

Corneille's theory of drama, as found in the essays of 1660, is disappointing, since it gives contemporary polemic rather than his own real principles. But it is fairly clear from his practice what those principles were. Time after time he would take a subject which would provide him with a minimum of physical action and almost a maximum of moral or mental conflict. These subjects he found chiefly in Roman and Byzantine history (which was not so unknown to his public as to most modern persons, as the history taught in French schools in his day was ancient history, not French history). All his plays move around a single central crucial point, usually of rivalry in love or war. In all of them the action is conveyed within a strict form; nothing is left to music or physical action, everything is said, elegantly, rhetorically, in the grand style and in Alexandrine verse. This last feature is used with amazing dexterity as an instrument to convey all shades of expression: irony, anger, soliloquy, repartee, epigram. Such a play as *Polyeucte* has lovely lines ("Honteux attachements de la chair et du monde . . .") and equally impressive stichomythy: "Imaginations.—Célestes vérités.—Étrange aveuglement.—Éternelles clartés . . ." which convey a clash, not so much between actors as between concepts. Action in this drama is reaction. It

concerns not what is done, but what is resolved, felt, suffered. Its formal principle might be said to be symmetry: presentation, by a poet who was also a lawyer, of one side of the case, then of the other, of one position followed by its opposite. In play after play Corneille uses a dramatic situation leading to a discussion of controversial issues; and it was more than anything else perhaps the skill with which he gave expression to contemporary problems that made so many of his hearers think with Saint-Évremond that "dans la tragédie Corneille ne souffre point d'égal" ("in tragedy Corneille has no equal") and with Voltaire that he was called "le grand Corneille" not so much to distinguish him from his brother as from all other men.

Seen from a 20th-century vantage point he appears as a master of drama rather than in particular of tragedy. He excels in showing personal and moral forces in conflict rather than in calling up visions of the limits of human endurance. Only in one or two of his masterpieces can he be said to have evoked the real atmosphere of tragedy. But his greater plays are so famous with his own people that some account of their themes should be given here.

Le Cid has been called an exciting overture to his work, but it is classical in that it presents not the adventures of the young Cid as in the Spanish source but a single situation created by the young man's duty to avenge his father against an insult by the father of his beloved Chimène. Hence the "wit," in the 17th-century sense, in lines that point the claims of honour and of love. Rodrigue kills Chimène's father; Chimène demands his life in return. The paradox of pursuing what one loves best is put in lines that have not yet lost their hold on French audiences.

Horace presents the combat of the Horatii and the Curiatii as told by Livy (book i, ch. 24) but without the combat. The champions are reduced from six to two, and the father and two women are included to allow a sort of crescendo of possible reactions to war. After the patriot has murdered his pacifist sister, the whole case is argued before the king. Voltaire said that never before had convictions been expressed with such sublimity on the stage.

Cinna has been called Corneille's most perfect dramatic machine; it centres around a conspiracy against Augustus. Cinna himself is a reluctant conspirator, dominated by his violent lover Émilie who is seeking revenge for a murdered father. Augustus checkmates the plotters by granting a political pardon instead of violence. The boast of the emperor that he is strong enough to be merciful ("Je suis maître de moi comme de l'univers") is a dramatic climax rather than a clue to Corneille's view of character.

In *Polyeucte* the Christian convert welcomes a martyr's death ("Je consens ou plutôt j'aspire à ma ruine") but his wife Pauline, pressed by a former pagan lover Sévère, insists that marriage makes claims as important as those of religion. The two are as irreconcilable as patriotism and pacifism, and the fanatical Polyeucte echoes the fanatical Horace: "Je ne vous connais plus si vous n'êtes chrétienne."

Rodogune shows the steps whereby ambition brings Cléopatre to crime. She poisons all rival claimants to power and finally herself: "Je t'ai défait d'un père, et d'un frère, et de moi." Corneille's favourite play, it became a storm centre in the 18th century and was attacked by Lessing, who tried to show that its counterpart, Shakespeare's *Richard III*, was morally less objectionable.

In *Nicomède*, a drama of dynastic succession, the forthright prince Nicomède fights for the throne and the lady against his weak father Prusaias, a mother-in-law and a half-brother. These contrasts have certain features of comedy and the play was acted by Molière. In 1959 it was thought to suggest the atmosphere of the German occupation, as in 1651 it had been taken as referring to Louis II de Bourbon, prince of Condé.

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CORNEILLE, THOMAS (1625–1709), French dramatist, was born at Rouen on Aug. 20, 1625, being nearly 20 years younger than his famous brother, with whom he was always and inevitably compared. For over 40 years he was one of the most prolific and practised artisans of the French theatre, constantly experimenting and showing great knowledge of public taste. His first plays were comedies, in many cases adaptations from Calderón (*q.v.*) or Francisco de Rojas Zorrilla (*Les Engagements du hazard*, 1649, *Le Feint Astrologue*, 1650, *Dom Bertran de Cigarral* and *L'Amour à la mode*, 1651, *Les Illustres Ennemis* and *Le Geolier de soy mesme*, 1655–56, and *Le Charme de la voix*, 1656–57). In 1653 he adapted the novel *Le Berger extravagant* (1627) by Charles Sorel (*q.v.*) as a "pastorale burlesque" and scored his first big success with a tragedy, *Timocrate*, in 1656, the subject of which was taken from La Calprenède. Until 1674 he produced a tragedy nearly every year, including his most famous play *Ariane* (1672), which Mme de Sévigné went to see for the acting of La Champmeslé. His chief success in comedy was probably *Le Baron d'Albikrach* (1688). After 1674 he experimented with plays and operas with much stage machinery, in collaboration with Donneau de Visé, Bernard de Fontenelle and Jean-Baptiste Lulli himself. He wrote for all the theatres of Paris: *Timocrate* for the Marais, *Dom Bertran* for Molière's company at the Palais Royal, *Ariane* and *Le Comte d'Essex* (1678) for the Hôtel de Bourgogne, *Circé* (1675) and *La Devineresse* (1679) for the Guenegaud, *L'Usurier* (1685) for the Comédie Française. His technique was admired by Philippe Destouches (*q.v.*). He died ("pauvre comme Job," says a correspondent) at Les Andelys (Eure) on Dec. 8, 1709.

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CORNELIA (2nd century B.C.), second daughter of Scipio Africanus the elder, mother of Tiberius and Gaius Sempronius Gracchus (*qq.v.*) and of Sempronia, wife of Scipio Aemilianus Africanus the younger. On the death of her husband, Tiberius Sempronius Gracchus (154 B.C.), by whom she had 12 children, she remained unmarried, even refusing the hand of Ptolemy VIII Euergetes of Egypt. She gave her time to the education of her surviving sons, Tiberius (163–133) and Gaius (154–121), to whom she was devoted: when asked to show her jewels she presented her sons. Although hostile propaganda later suggested that she had encouraged her sons' more revolutionary policy, she seems rather to have restrained them. After Gaius' murder (121) she retired to Misenum (Miseno), where she devoted herself to Greek and Latin literature. She was highly educated, and her letters were celebrated for their beauty of style. Reputed fragments of them preserved in the manuscripts of Cornelius Nepos (1st century B.C.) may not be genuine. (H. H. Sd.)

CORNELIUS, SAINT (d. 253), pope from 251 to 253, was elected during the lull in the persecution by the emperor Decius. In 253, under the emperor Gallus, he was exiled to Centumcellae (Civitavecchia), where he died in the same year. Several of his letters, including some to his friend St. Cyprian, survive. His feast is kept with that of St. Cyprian, on Sept. 16.

CORNELIUS, PETER (1824–1874), German composer and author best-known for his opera *The Barber of Bagdad*, was born at Mainz on Dec. 24, 1824. The son of an actor and actress, he played in the theatre himself in his youth, at Mainz and at Wiesbaden. In 1844 he studied composition with Siegfried Dehn and was later music critic for two Berlin journals. From 1853 to 1858 he lived at Weimar in the circle of Liszt and the Princess Sayn-Wittgenstein and translated articles by Berlioz and Liszt for the *Neue Zeitschrift für Musik*. In 1857 he began his comic opera *Der Barbier von Bagdad*, on a libretto of his own based on *A Thousand and One Nights*, which was conducted by Liszt at Wei-

mar the following year. The opera was a failure and led to Liszt's resignation from the Weimar opera. It was successfully revived in a reorchestrated version by Felix Mottl after the composer's death. From 1859 to 1864 Cornelius lived in Vienna where he became a friend of Wagner. His opera *Der Cid,* on a libretto adapted by Cornelius from the play by Corneille, was successfully produced at Weimar in 1865. In the same year he accompanied Wagner to Munich where he was reader to Ludwig II and professor at the royal school of music. His last opera *Gunlöd* (libretto adapted from the *Edda*) was completed by C. Hoffbauer and E. Lassen and produced at Weimar in 1891. He died at Mainz on Oct. 26, 1874.

A versatile and sensitive musician, Cornelius hardly fulfilled his original gifts, among them a gift for writing lyric poetry. He wrote many settings of his own poems, notably the *Weihnachtslieder,* which includes the well-known "Three Kings from Persian Lands Afar," and the *Brautlieder,* and of poems by Heine, Hölderlin and Annette von Droste-Hülshoff. Among his posthumously published works revealing his lyrical gifts is *Die Vätergruft* for baritone and orchestra. Cornelius' *Literarische Werke* was published in four volumes (1904–05) and his *Ausgewahlte Schriften und Briefe* was edited by P. Egert (1938).

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CORNELIUS, PETER VON (1783–1867), German painter notable for his part in the revival of fresco painting, was born in Düsseldorf on Sept. 23 (?), 1783. His early works are unremarkable examples of the neoclassicism current in German academies during his youth, but his style gradually changed after his meeting in 1803 with the brothers S. and M. Boisserée—collectors of German Gothic art—and under the influence of the romantic authors W. H. Wackenroder, Ludwig Tieck and A. W. Schlegel. More important still were Dürer's marginal drawings for the prayer book of the emperor Maximilian, published in lithographic facsimile in 1808. Hence in his illustrations to Goethe's *Faust* (1816) Cornelius retains from the days of his academic training an insistence on line and clear design, while introducing medieval subject matter and imitating the idiom of Dürer's graphic art.

In 1811 Cornelius went to Rome where he joined a group of young German painters, the "Lukasbrüder" or "Nazarenes," led by Franz Pforr and J. F. Overbeck. Their intentions were antiacademic; they wished to create a monumental religious art, based on the study of Italian and Flemish primitives, on Dürer and the early Raphael, and they expressed these ideals in the biblical frescoes painted in the house of the Prussian consul J. S. Bartholdy. In 1819 Cornelius was invited to Munich by the Bavarian crown prince, later King Ludwig I. For his first task, the new museum of classical sculpture (Glyptothek), Cornelius himself suggested a series of frescoes from Greek mythology which were to be understood as allegories of nature and of man's strife and passions. By now his style had come under the influence of Raphael's later works in the Stanze of the Vatican and his approach was governed by Friedrich Schelling's aesthetics; painting was to give form to metaphysical ideas. During this period Cornelius was also head of the Düsseldorf academy but resigned on becoming director of the Munich academy in 1825. Between 1829 and 1840 he and his pupils decorated the new Ludwigskirche in Munich. "The Last Judgment," filling the whole east wall, is his most remarkable design for clarity and didactic purpose. He wished to embody here the essence of a Christianity freed from all sectarian bias. Hence his picture is a lesson in theology rather than a dramatic event, like Michelangelo's.

In 1841 Cornelius was called to Berlin by Frederick William IV, whose first commission was a christening present for the prince of Wales. Cornelius designed a large decorative metal shield, embodying the basic tenets of the Christian faith, with allusions to the happy event: the king of Prussia as godfather is received on the shore of England by St. George, Prince Albert and the duke of Wellington. Cornelius' main occupation in Berlin was the planning of a vast cycle of frescoes (never executed) to decorate the walls of a cemetery, modeled on the Campo Santo in Pisa, which the king wished to build beside the Protestant cathedral.

In spite of his desire to revive fresco as a national art in order to restore painting to its rightful place in public buildings, Cornelius never developed any real sense of colour and his works look like tinted cartoons. At heart he always remained an academic artist, even if his outlook was shaped by romantic philosophy. Today we are impressed only by his penetrating intellect which gives substance to his large dogmatic pictures and order to their composition. Cornelius died in Berlin on March 6, 1867.

His influence both in Germany and abroad was considerable. When he visited London in 1841 his advice was sought for the frescoes of the houses of parliament, and his pupil J. Goetzenberger decorated Bridgewater house.

See A. Kuhn, *Peter Cornelius und die geistigen Strömungen seiner Zeit* (1921). (L. D. ER.)

CORNELL, EZRA (1807–1874), U.S. businessman, a founder of the Western Union Telegraph company and a leader in the founding of Cornell university, was born at Westchester Landing, N.Y., on Jan. 11, 1807, and was educated in the public schools. In 1828 he settled at Ithaca, N.Y., where he later served as manager of flour mills. In 1842 he became associated with Samuel Morse in the early development of the electric telegraph and superintended the construction of the first telegraph line in America, opened between Baltimore, Md., and Washington, D.C., in 1844. He then became one of the most active pioneers in the establishment of telegraph lines throughout the country, in which he accumulated a substantial fortune; he was for some time the largest stockholder in the Western Union Telegraph company, organized in 1855.

Settling on a farm near Ithaca, he became especially interested in the development of agriculture. Following the passage in 1862 of the Morrill act providing national support for agricultural colleges, he took steps which led to the founding at Ithaca of Cornell university, which was formally opened in 1868. His original endowment of $500,000, given in 1865, was increased by further personal contributions of about $400,000 and by more than $3,000,000 realized as profits from his operations in purchasing and allocating public lands for the benefit of the new institution, which rose to front rank among U.S. universities. He also established the Cornell library at Ithaca and built railway lines facilitating access to the town. He died in Ithaca on Dec. 9, 1874.

His son, Alonzo B. Cornell, wrote *True and Firm: A Biography of Ezra Cornell* (1884). *See* also the biography by Philip Dorf, *The Builder* (1952).

CORNELL UNIVERSITY, a U.S. institution of higher education founded under the Morrill act (*see* LAND-GRANT COLLEGES AND UNIVERSITIES) at Ithaca, N.Y., in 1865. *See* ITHACA.

CORNER BROOK, a city of Newfoundland, Can., is located on the west coast of the island at the head of the Bay of Islands, about 130 mi. N. of Port aux Basques; the Humber river, one of Newfoundland's best salmon rivers, flows through the city from the east. The main industry is wood pulp and newsprint, with one of the biggest paper mills in the world located there. Other industries include cement and gypsum plants. Corner Brook became a city in 1956 with the amalgamation of Town Site, Corner Brook West, Curling and Humbermouth. Newfoundland's second largest city, the population rose from 10,276 in 1951 to 25,185 in 1961. It is the site of the annual west coast agricultural and industrial fair. (R. G. HA.)

CORNERSTONE, a ceremonial building block, usually placed ritually in the outer wall of a building to commemorate dedication. Sometimes it is solid, with date or other inscription. More typically, it is hollowed out to contain metal receptacles for newspapers, photographs, currency, books or other documents reflecting current customs, with a view to their historical use when the building is remodeled or demolished.

Until the development of modern construction, the stone was usually at a corner, possibly as the first of the foundation stones, and a real support. From this practice arose figures of speech in many languages referring to cornerstones or foundation stones of character, faith, liberty or other excellences. Today the stone need not be a support, nor at a corner, nor even in the foundation.

Often it is placed ornamentally in the façade or in an interior wall or floor.

Early customs connected with cornerstones were related to study of the stars and their religious significance. Buildings were laid out with astronomical precision in relation to points of the compass, with emphasis on corners. Cornerstones symbolized "seeds" from which buildings would germinate and rise. Various religious rituals and Bible references spread and perpetuated the cornerstone custom. Ceremonies have been marked with processions, sacrifices, sprinklings of blood and water and wide participation by rulers, priests and other dignitaries who used the mason's trowel, often made of gold or silver. (H. B. Md.; H. Mn.)

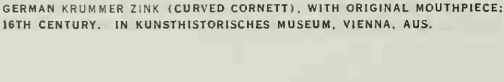
CORNET, the name of two wind instruments, one obsolete, the other modern, both sounded by lip vibration against a cup mouthpiece.

1. Cornett (an old spelling that has been revived to reduce confusion with 2; Fr. *cornet[-à-bouquin]*; Ital. *cornetto,* Ger. *Zink*), a conical wooden pipe, 24 in. long, curved, with octagonal cross section and leather covering. It has fingerholes like those on a recorder, and a small cup mouthpiece of horn or ivory. With a compass of over two octaves from the G below the treble stave (staff), it was a leading wind instrument in music of many kinds over the period 1500–1670, while with trombones, to which it supplied the treble voice, it is one of the first wind instruments to be specifically scored for, by G. Gabrieli. Other sizes of cornett, the descant and the S-shaped tenor, were of smaller importance, as were also straight-built forms, including the "mute cornett" with mouthpiece cut in the head of the pipe itself. By 1700 the cornett was obsolescent, though it continued to be played locally in Germany to support choir trebles until about 1750, and with trombones in "tower music" (*i.e.*, the religious music played in the towers of German churches) until the 1830s. Its clear tone-quality, essential for the works of Monteverdi and others, is matched by no other instrument, and its revival was tentatively begun about the middle of the 20th century.

Bibliography.—A. Baines, *Woodwind Instruments and Their History* (1957); the article in *Grove's Dictionary of Music and Musicians,* 5th ed. (1954); F. W. Galpin, *Old English Instruments of Music* (1910).

2. Cornet (Fr. *cornet-à-pistons,* or *piston*), a valved brass instrument evolved in the 1820s from the continental post horn (*cornet-de-poste*, which is circular in shape like a small French horn), one of the first makers being the Parisian Halary (Jean Asté), in 1828. The tube is conical except through the three valves, tapering gently to a narrow detachable shank into which the brass mouthpiece is placed. The taper, coupled with the fairly deep mouthpiece, imparts a mellowness to the tone and a flexibility to the technique that quickly established the cornet in a leading position in brass and military bands, especially in England and America, which it retains. It is built in B flat, its music written a tone above the actual sound. Brass bands also employ an E flat soprano cornet, a fourth higher than the B flat instrument. Some older B flat cornets built for use in theatres can be changed to the key of A by turning a rotary valve.

The cornet became a popular solo instrument. Many of the earliest virtuosi were horn players and employed different crooks for different tonalities or musical moods, the longer crooks, down to E flat, giving a darker tone-quality. Celebrated Victorian soloists included Hermann Koenig and Isaac Levy. In English and American symphony orchestras cornets were frequently used for all trumpet parts, as well as for genuine cornet parts (common in French orchestration from Berlioz onward). During the 20th century, however, the revival of the trumpet ousted the cornet from the orchestra save for parts specifically intended for it, while the use of the trumpet in modern dance music and in jazz (in which it was preceded by the cornet) has diminished the cornet's popularity as a solo instrument except with brass bands. For technique and valves, *see* Wind Instruments.



BY COURTESY OF KUNSTHISTORISCHES MUSEUM, VIENNA, AUS.

GERMAN KRUMMER ZINK (CURVED CORNETT), WITH ORIGINAL MOUTHPIECE; 16TH CENTURY. IN KUNSTHISTORISCHES MUSEUM, VIENNA, AUS.

See A. Carse, *Musical Wind Instruments* (1939). (A. C. Ba.)

CORNFLOWER (*Centaurea cyanus*), a well-known plant of the family Compositae (*q.v.*), called also bluebottle and bachelor's button. A native of Europe, the national flower of Germany, it has become widely naturalized throughout North America. It is a slender, branching annual, from one to two feet high, with narrow, more or less toothed or divided leaves and brilliant, usually blue, flowers, in heads an inch or more across, borne on long leafless stalks. In the United States it is popular for garden planting, being one of the "old-fashioned flowers." In England its cultivation, often from self-sown seed, is so common that breeders have developed many colour varieties, notably white, pale blue, pink and deep rose. There are also over 20 related plants in the genus *Centaurea* cultivated in England. *See* Centaurea. (N. Tr.)

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CORNFLOWER (CENTAUREA CYANUS)

CORNICE, in architecture, the decorated projection at the top of a wall provided to protect the wall face or to ornament and finish the eaves. The term is used as well for any projecting element which crowns an architectural feature, such as a doorway. A cornice is also specifically the top member of the entablature (*q.v.*) of a classic order (*q.v.*); it is in this case divided into three parts, a bed mold, corona and cymatium.

CORNICHE, THE, the name of a carriage road built by Napoleon I along the Mediterranean slopes of the Maritime Alps, between Nice and Genoa. It is famous for its sea and alpine views. The name is applied today to the three roads known respectively as the Grand, the Middle and the Little Corniche (Grande, Moyenne and Petite Corniche), of which the first, ascending directly from Nice, reaches within a few miles a height of more than 1,700 ft., and passing via the Col d'Eze descends via La Turbie to Menton, while the Little Corniche follows the coast route through Beaulieu-sur-Mer, Monte Carlo and Roquebrune.

CORNING, a city in Steuben county in southern New York, U.S., is on the Chemung river, 17 mi. N.W. of Elmira. Settlement of the area began in 1789. Named in 1837 for Erastus Corning, an early promoter, the village was incorporated in 1848 and was chartered as a city in 1890. Manufactured products include fibre boxes and pneumatic tools, but the industrial life of Corning, called the "Crystal city," centres about the Corning Glass works. There many forms of artistic and commercial glass are produced, including Steuben glass, flat glass, bulbs, tubing and glass fibres. In 1951, to mark the 100th anniversary of the founding of the works, Corning Glass centre was constructed. Visitors may see the original 200-in., 20-ton, imperfect telescope disk, cast in 1934 for the Palomar observatory in California, where the second casting is now in use; a comprehensive historical collection of glass, dating back more than 3,000 years; and an extensive library dealing with glassmaking. For comparative population figures *see* table in New York: *Population.* (C. C. Ma.)

CORNISH LANGUAGE: *see* Celtic Languages.

CORNISH LITERATURE. The earliest remains in the Old Cornish language are nonliterary: proper names in the Bodmin Gospels and in Domesday Book, 10th-century glosses on Latin texts and a 12th-century vocabulary (British Museum manuscript Cotton Vespasian A XIV) based on Aelfric's Latin-Anglo-Saxon glossary. The forms in the latter, although generally called Old Cornish, correspond to those of Middle Welsh and Middle Breton. The first literary text is a Middle Cornish frag-

ment of 41 lines of a dramatic nature, written about 1400 (British Museum Additional Charter No. 19, folio 491), in which a girl is offered as wife, praised for her virtues and counseled on behaviour fitting to a husband. The long poem *Pascon Agan Arluth* ("The Passion of our Lord," reprinted with Eng. trans., appendix to *Transactions of the Philological Society*, 1860–61) belongs to the 15th century. The matter of its 259 stanzas of eight trochaic heptasyllabic lines with alternate rhymes is based on the Gospels, with additions from the Apocrypha, especially the pseudo-Gospel of Nicodemus, but its literary merit is slight.

The most important Cornish literary remains are a series of long dramatic compositions related to the miracle and morality plays. The earliest and most important is the 15th-century trilogy called the *Ordinalia*. The first part, *Origo Mundi* (2,846 lines) relates the main events of biblical history down to the building of Solomon's temple, where St. Maximilla anachronistically suffers martyrdom. The second, *Passio Domini* (3,242 lines), tells the story of Christ from the temptation to the crucifixion. The third, *Ressurectio Domini* (2,646 lines), follows on and ends with the resurrection and the ascension. The dialogue is generally dull and there is hardly any dramatic invention except in the scenes of ribaldry. The *Ordinalia* is greater in bulk than all the other remains of Cornish.

Similar in form and technique is a play the unique text of which is in the National Library of Wales (Peniarth ms. no. 105, written in 1504 by "Dominus Hadton")—*Beunans Meriasek* (reprinted with Eng. trans. *Life of Meriasek*, ed. by W. Stokes, 1872), probably composed for performance in Camborne, where Meriasek was the patron saint. Its 4,568 lines show a greater variety of metres and rhyme-schemes than the *Ordinalia*. The material is drawn from Latin and English sources.

The last play, *Gwreans an Bys* ("The Creation of the World," reprinted with Eng. trans., *Transactions of the Philological Society*, no. iv, 1864), 2,548 lines in length, owes much in metre and substance to the first act of the *Origo Mundi*, from which certain passages have been borrowed. The earliest extant ms. of it was written by William Jordan of Helston in 1611, but certain references suggest a pre-Reformation date of composition.

Later minor literary remains—a folktale, a few songs, translations of passages of scripture and several versions of the Apostles' Creed—we owe to antiquaries like William Gwavas, Dr. William Borlase and Edward Lhuyd.

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CORN ISLANDS (ISLAS DEL MAÍZ). Great and Little Corn Islands are small Caribbean islands in Zelaya department, Nicaragua, between 50 and 59 mi. E.N.E. of Bluefields. Pop. (1959 est.) 1,579. They were leased to the United States by Nicaragua under the Bryan-Chamorro treaty, signed in 1914 and ratified by the U.S. senate in 1916, for use as a naval base to protect the then proposed Nicaraguan interoceanic canal. Except for building a lighthouse on Little Corn Island, the United States has not taken over the land covered by the lease. Principal products of the islands are copra and coconut oil shipped by boat and barge to vegetable oil plants near the north end of Lake Nicaragua.
(C. F. J.)

CORN LAWS. The term corn laws commonly refers to regulations governing the import and export of grain. In English history it is often applied specifically to the series of laws regulating the grain trade which were repealed, after considerable agitation, in 1846. The term corn, used in this sense, is a generic term for grain.

From the very earliest times, states which had attained to any degree of civilization found it necessary to take measures to ensure a sufficient supply of cereals for the population. In communities which were wholly or mainly agricultural, such measures were only of a temporary nature, resorted to in times of crop failure or of war. Thus the biblical story of Joseph in Egypt describes steps taken to store grain in years of plenty against the prospect of lean years to come (Gen. xli, 46–57). Similar measures were taken in China at an equally early date. When, however, populations became divided into agricultural and nonagricultural, by the institution of, for example, sacerdotal or military castes, it became necessary to make permanent provision for the feeding of this nonagricultural element. Thus in imperial Rome the tribute payable by conquered races frequently took the form of grain to ensure supplies for Rome itself and for the army. The system of tithes similarly arose from the need for supplying the clergy from the produce of the land cultivated by those to whom they ministered.

In primarily agricultural societies the problem was mainly one of providing for the members of a self-supporting community who were not in a position to produce their own food. With the rise of industrial and commercial classes, the production of the agricultural section was not sufficient to supply the needs of all, at any rate in years when the yield was in any way below normal, and supplies had to be sought elsewhere. From this arose the need for state intervention. It took the form of regulations controlling the domestic marketing of grain to alleviate local shortages and control of the foreign grain trade. Export was prohibited in years of bad harvest or permitted by licence when prices were sufficiently low to indicate sufficiency, if not saturation, in the home market; imports were permitted when high domestic prices gave evidence of a grain scarcity. This arrangement guaranteed a market to the home producer in good seasons but eliminated the risk of famine by allowing imports in times of dearth.

Before the emergence of nation-states in Europe, principalities and city-states had their own corn laws, based on the same principles of safeguarding domestic supplies and allowing exports only when there was a surplus. In modern times, instead of actual prohibition of import or export, it became the practice to impose duties so high as to be prohibitive, sometimes in conjunction with specified price limits or with a sliding scale dependent on prices in the home market. With the rise of intensive cereal culture in the United States, Canada, Rumania and elsewhere, protective import duties were levied in certain countries to prevent the flooding of the home market with cheap grain to the detriment of the domestic producer.

English Corn Laws Before 1500.—The earliest evidence of regulations governing the export and import of grain is of penalties imposed in 1177, 1178, 1180 and 1183 on persons exporting grain without licence. This prohibition on export, which was reaffirmed in the Great Winchester Assize of Customs in 1204, remained in force until 1394, although licences to export were granted to individuals and suspended in times of war or harvest failure. Imports of grain were permitted throughout the period, although the customs accounts suggest that the amount involved was negligible in all but scarce years. In 1394 the grain policy of the realm was reversed and exports were permitted freely so long as the customs and subsidies were paid. The king's council retained the right to prohibit export in times of emergency. The act became inoperative before 1426, but was reaffirmed in that year. In 1437 a new statute was passed permitting export on three conditions: grain was not to be exported to enemy countries; customs were to be paid; and the price at the port of shipment was not to exceed specified amounts, for instance, 6*s*. 8*d*. a quarter for wheat. The act lapsed in 1439, was renewed in 1442 and made permanent in 1445, although from time to time thereafter it was suspended by royal proclamation, usually in the interests of London's food supply. A complementary import policy was put into operation in 1463 when imports of grain from abroad were prohibited except when the home price exceeded 6*s*. 8*d*. a quarter.

Some historians have held the view that the corn laws for the period before 1500 lacked any consistent purpose. Others have offered explanations set within the framework of constitutional and economic development, though these, for want of sufficient evidence, cannot be finally proved. The changes of policy have been described as a political struggle between the crown and parliament, in which the crown favoured the system of special licences

for its own financial advantage while the commons opposed them on the grounds that they resulted in dearth. They have been explained in terms of a struggle between consumers and producers, the consumers demanding a regular supply of grain at low prices and therefore favouring free imports and a prohibition on exports, the producers anxious to ensure a market and a fair price in good as well as bad years by securing restrictions on imports and freedom of export. The heightening of the conflict between consumers and producers has been attributed to marketing developments in the 12th and 13th centuries. Hitherto, the bulk of the traffic in grain had been confined to groups of manors managed as one organization under a common lord. With the growth of centres of consumption in the towns a local marketing system took shape, serving urban communities with the food surpluses from surrounding districts. Against this background of marketing history, the policy of the 14th and 15th centuries can be understood as an attempt by parliament to reconcile the opposing claims of manorial producers, the crown and the newly risen and influential class of town consumers.

How far the policy was adjusted to the total grain yield of the kingdom or to population needs is a question not adequately answered. The freer policy of the 15th century prevailed at a time of agricultural stagnation, not of rapid advance. It did not effect an increase in the volume of exported grain. Yet the continuance of the policy throughout the 15th century suggests that it was rooted in economic realities. It presupposed the ability of home producers to feed the population and leave a surplus of grain for export in all but scarce years. Such an assumption did not necessarily follow from any spectacular increase in yield. Yields per acre seem to have altered little in the 14th and 15th centuries, while the cultivated area as a whole diminished. But in view of the decline of population between about 1320 and 1470, a policy that presupposed a new relation between the needs of the population and the yield of the harvest may not have corresponded ill with the facts.

Tudor and Early Stuart Policy.—A rise in prices at the beginning of the 16th century, though modest compared with that which followed in the 1540s, was accompanied by the rapid advance of enclosure in the midlands and a consequent increase of pasture in these counties at the expense of tillage. Fears were aroused concerning the adequacy of the domestic grain supply. Following several royal proclamations in which the 1445 act had been temporarily suspended, parliament decided in 1534 to prohibit entirely the export of grain in the hope of keeping food prices down. Other measures were taken to restore the arable area by prohibiting enclosure and the conversion of tillage to pasture. Modern historians differ on whether the aggregate yield of the kingdom was reduced by the spread of pasture farming in the midlands or whether the shortages were principally the result of the disorganization of the internal marketing system. The growth of London and other industrial centres imposed a strain on local supplies, which were further taxed by occasional bulk purchases of food by the government for the armed forces.

To contemporaries, however, it was enclosure and the conversion of arable land to pasture which threatened the food supply and bred the twin evils of unemployment and social unrest. The solution put forward by John Hales, one of the economic reformers of Edward VI's reign, was to permit the export of grain and prohibit that of wool, in order "to make the profit of the plough to be as good, rate for rate, as the profit of the graziers and sheepmasters." When the immediate crisis had passed, the export ban was gradually lifted. In 1555 export was permitted under licence, or without licence when prices did not exceed 6*s*. 8*d*. a quarter for wheat, 4*s*. for rye and 3*s*. for barley. That the original intention of the act was to tighten the regulations against export was evident in the preamble containing complaints against merchants who in spite of the 1534 act had exported grain and had thereby caused dearth and high prices. Severe penalties were laid down for the future. The clause allowing exports at certain price levels was appended later as a result of protests from the East Anglian grain-growing districts. In 1563 an act, based on mercantile principles (*see* MERCANTILE SYSTEM), authorized the export of grain so long as it was carried in ships belonging to English-born subjects and so long as prices did not exceed 10*s*. per quarter for wheat, 8*s*. for rye, peas and beans and 6*s*. 8*d*. for malt and barley. It was designed not only to promote the grain trade but to foster the development of the navy, the shipping industry and the fish trade.

It was superseded in 1571 by an act expressly in the interests of tillage, in which the grain supply was viewed realistically as a series of regional problems rather than a national one. Export was allowed at the discretion of the local justices of the peace according to the current price of grain in the district. Two further clauses provided that grain must be exported to friendly nations and that it must be carried in ships belonging to Englishmen. The policy of local regulation led to the abuses of price manipulation and was abandoned in 1593 in favour of central control and one price standard for the whole kingdom. Export was allowed when prices were not more than 20*s*. a quarter for wheat and for other grains correspondingly. In later acts the customs rates and price limits were revised to take account of the general price rise, but the principles of the policy remained unaltered until the Restoration. In 1604 the price limit for wheat was fixed at 26*s*. 8*d*., in 1624 at 32*s*., in 1656 at 40*s*., in 1660 at 40*s*. and in 1663 at 48*s*.

Although the grain export laws after the middle of the 16th century were couched in terms encouraging to the producer, their practical consequences were otherwise, since the price did not often fall below the statutory limit. Between 1554 and 1563, and again between 1593 and 1600, grain was never cheap enough to be exported, while in 1563–71 and 1600–60 low prices prevailed in only seven years. Moreover, the crown continued to exercise the right to suspend and override the laws whenever it deemed it desirable in the interests of the consumer. Nevertheless, the producer was not entirely frustrated by the statutes, since a certain amount of grain was sent abroad whatever the laws in operation. The contemporary historian William Camden held the view that the laws permitting export greatly accelerated agricultural development, while the customs accounts show a doubling of exports in the years 1500–34 and another period of rapid increase from about 1563 until the end of the century. The decline in exports in the early 17th century can be accounted for by the steady increase in the supply to London. The port of King's Lynn, for example, which sent only 6% of its coastwise shipments to London in the mid-16th century, sent nearly 40% by 1600 and about 50% in the second half of the 17th century.

Import regulations between 1500 and 1660 were neglected. The 1463 act prohibiting imports except when grain prices were high had lost all meaning by the mid-16th century because of inflation. In any case, imports had come to play a vital role in supplying London in years of scarcity. Any attempt to enforce the ban on imports would have injured that section of the community which virtually controlled the grain policy of the kingdom. The 1463 act was formally repealed in 1624, but nothing took its place until 1663.

Corn Laws, 1660–1791.—In satisfying the demand for corn in London, the grain trade of the kingdom came to be focused increasingly on the capital. At the Restoration, when the export surplus assumed substantial proportions, London kept its place as the principal clearinghouse for the foreign grain trade.

A new policy of plenty was initiated in 1663 by an act imposing a duty of 5*s*. 4*d*. a quarter on wheat imported from abroad when the home price did not exceed 48*s*. Correspondingly heavy rates were laid down to control the import of other kinds of grain. The duty was arranged on a sliding scale in 1670, making it prohibitive in all but scarce years. The home farmer thus enjoyed a virtual monopoly of the domestic market, except when famine threatened. By the same act he was allowed to export grain whenever wheat prices did not exceed 48*s*. a quarter. The express purpose of the policy was to encourage tillage as a means of promoting trade and bringing waste lands into cultivation. In 1670 it was carried a stage further by allowing the export of grain regardless of price, provided that the customs rates laid down in 1660 were paid. There followed in 1673 the grant of a bounty of

5*s.* a quarter on wheat exported when the home price did not exceed 40*s.*, of 3*s.* 6*d.* on rye when it did not exceed 32*s.* a quarter and of 2*s.* 6*d.* on malt and barley when they did not exceed 24*s.* a quarter. Because of a bad season the act did not come into effect for a year or more, but there is evidence that it was in force from Michaelmas 1674 to 1675 and again between 1680 and 1681. About £150,000 was paid out in bounties during the period.

The Bounty act of 1673 has been interpreted as a political triumph for the gentry over the policy of paternalism to which the early Stuart governments adhered. It was also a sound economic measure adapted to a greatly improved level of agricultural production. Whereas in the 16th century England had been obliged to import considerable quantities of grain in scarce years, a century later it had plenty and to spare. Such a transformation can only be explained as a consequence of technical improvements in farming, of land reclamation and of increasing specialization in land use. The commons, which in 1621 argued that grain imports should be prohibited because England could now feed itself, argued prematurely, but their opinion was more than substantiated a century later when Daniel Defoe described England as the supplier of Europe. By that time the value of grain dispatched abroad from London had risen from £4,315 in 1663 to an average of £274,141 per annum between 1699 and 1710. It rose to £835,394 between 1746 and 1765.

A second Corn Bounty act was passed in 1689, allowing 5*s.* on every quarter of wheat exported when the home price did not exceed 48*s.* Beyond a statement in the preamble of the act that experience had justified the bounty when prices were low, the reason behind it was not made clear. Arthur Young deemed it a reward to the landed classes for their part in establishing William III on the throne. Sir John Dalrymple regarded it as a gift to the Tories for accepting the land tax. Price tables suggest that the preamble of the act should be taken at its face value, that the bounty was due to the low prices then prevailing. Seeking a remedy for the depression, parliament understandably reverted to the precedent of 1673. The effect of the bounty was not immediately reflected in increasing exports, for poor harvests kept prices high between 1689 and 1714, while in 1698 and 1709 exports were prohibited entirely. However, they expanded rapidly between 1715 and 1750 except for three years between 1727 and 1729, and 1739 and 1740, when home crops were poor. After 1750 successive years of bad harvests brought scarcity and high prices in their wake. This aggravated a problem which was already present in the growth of population and the development of industry. A ban on exports operated between 1757 and 1759 and almost continuously after 1765. Finally, in 1773 the government passed an act forbidding exports except when wheat prices fell below 44*s.* a quarter. It continued in force until 1791. The fact that English farmers were no longer able to meet the home demand was reflected also in increasing imports from abroad from 1773 onward.

Although the bounty system was an innovation in 1673, it was not until after 1750 that public interest was aroused by the growing cost of bounties to the taxpayer. Economic arguments against the preferential treatment of farmers were coupled with allegations of fraudulent practices in the distribution of payment. The bounties were attacked by Adam Smith on the grounds that they interfered with the natural course of trade and led to high prices at home. They were defended by Arthur Young because they had eliminated sudden price fluctuations and, by encouraging farmers to expand production, had brought about a steady fall in prices. It is nowadays generally agreed that prices were stabilized by the bounties, that farmers enjoyed a security unknown before and that the export trade grew in consequence. The opposition developed out of a changed situation, when industry began to challenge the primacy of agriculture in the national economy.

(I. J. T.)

The 1791 Act and the French Wars.—There were weaknesses in the machinery for administering the 1773 act, but it was not until 1790 that efforts were made to secure new legislation. The landed interest feared substantial imports and agitated for additional protection, but counterpetitions were sent from the manufacturing and commercial centres attacking export bounties and demanding cheap food. This clash between different interests dominated much of the politics of the subsequent 60 years. In parliament there was a majority of landlords and effective political power was used to support what came to be a clearly sectional interest.

Despite urban complaints the 1791 act introduced changes which favoured agriculture. The price at which imports were allowed at a nominal figure of 6*d.* was raised to 54*s.*; a duty of 2*s.* 6*d.* was levied from 54*s.* to 50*s.*, while at 50*s.* and under a prohibitory duty of 24*s.* 3*d.* was imposed. Colonial preference was introduced for Ireland and North America, a feature which was maintained in every subsequent corn law until 1846. Wheat exports were permitted when the price was less than 46*s.* and a bounty of 5*s.* was paid when the price was less than 44*s.* A warehouse duty of 2*s.* 6*d.* was imposed on foreign wheat imported for re-export.

The 1791 act was followed two years later by a long period of war. Customary commercial relations were violently disturbed and freight, insurance and other charges on imports and exports were multiplied fivefold. War conditions as much as corn laws gave a "natural protection" to English farmers and landlords; at the same time population growth increased the seriousness of the food problem. Bad harvests produced political discontent as well as hunger and the government had to resort to special measures in crisis years. After the bad harvest of 1795 the price of wheat rose to above 100*s.*, the highest since the late 16th century. Food riots forced the government to pass scarcity laws and to pay bounties on imported grain, including rye. In the towns there was popular outcry against forestallers, engrossers and regraters, while in many parts of the countryside local magistrates copied the Speenhamland example and fixed poor relief in terms of bread prices. The crisis of 1799–1801 was even more severe: there were demands for peace, the extension of government controls and an increase in enclosure, as well as rioting against grain dealers. Prices continued high until 1801, when in March the average was 154*s.* 2*d.* Relief came not from government policy but from the moderately abundant harvests of 1801, 1802 and 1803. As grain prices fell there were cries, this time, of agricultural distress and an 1804 act actually increased the protection granted in 1791.

The provisions of the act were inoperative, however, for between 1805 and 1813 there was a sequence of bad harvests and high prices. There was little outcry against the corn laws until 1811, for it was recognized that Napoleon's blockade and not parliament was preventing the import of foreign grain. In the meantime landlords and farmers prospered. Rents and profits rose and there was a great increase in the extent of arable cultivation and an improvement in agricultural methods.

Protection in the 19th Century.—After the enormous harvest in 1813 there was a rapid fall in wheat prices (June 1813, 117*s.* 10*d.*; May 1814, 69*s.* 7*d.*) and farmers and landlords realized that the golden age could not last indefinitely. Even before the bad harvests a select committee, appointed in March 1813, had demanded additional protection. After the price fall there was a crop of protective resolutions. The first idea broached in parliament was an increase in the duty on foreign imports along with the prices at which it was levied, and freedom of export, without bounty, whatever the home price might be. The latter suggestion was passed into law in June 1814, but there was great popular clamour in the cities and manufacturing districts against substantial duties on imports. Although the outcry persisted, in 1815 the government carried its important new corn law, fixing 80*s.* (14*s.* more than during the wars) as the price at which imports of wheat were allowed duty free. Manchester was as ineffective against the landed interest represented at Westminster as was the London mob, which rioted near the house of commons. In 1815, however, the manufacturers themselves were for the most part unwilling to give up protection on manufactured goods and were consequently compelled to talk in crude terms about comparative costs of production.

The 1815 act was designed to maintain the price of wheat in peacetime at 80*s.*, but, as William Cobbett correctly predicted, far from producing the expected result it merely provoked a sense of injustice. Between 1815 and 1822 grain prices fluctuated vio-

lently. Changes in currency legislation were often blamed for the difficulties. During the wars suspension of cash payments (from 1797) and liberal use of paper money in loans and discounts maintained high prices. In 1819 it was decided to resume cash payments. The general price level had already begun to fall when payments were resumed in 1821 and the nation was beginning to feel the naked weight of war debt. Some spokesmen of the agricultural interest claimed that 1819 canceled out the benefits of 1815. Others blamed high taxation for their distress and pressed for the setting up of select committees in 1821 and 1822. Although the prime minister, Lord Liverpool, pointed out that it was beyond the scope of parliament to legislate a market for agricultural produce, a modification of the 1815 act was eventually made in 1822. Foreign wheat was to be excluded completely until the price reached 70*s.*: above that figure it was to be admitted only after duty had been paid according to a scale.

The act of 1822 never operated, except occasionally in the case of barley, for wheat prices never reached 80*s.* The agricultural interest, in short, was unable by legislation to counterbalance economic tendencies leading to a fall in prices and rents. By the time it realized that the tendencies could not be checked, manufacturers and town labourers had already begun a drive to reduce protection still further and even to abolish it altogether. Agitation against the corn laws increased particularly after 1825 when William Huskisson substantially reduced duties on manufactured articles and raw materials. Violent attacks were made on the landlords as a social class in widely read pamphlets, such as Thompson's *Catechism on the Corn Laws*.

Two new government measures in 1827 and 1828 did little to satisfy the most determined advocates of either side. In 1827 George Canning introduced a new system of duties, abandoning the principle of protection by absolute exclusion of wheat up to a certain price and employing a sliding scale of duties. His death and the consequent change of ministers involved the failure of his project, but in 1828 Charles Grant introduced a new sliding scale with more abrupt leaps in the amount of duties levied at particular price points. A duty of 34*s.* 8*d.*, for instance, was levied when the price of wheat was 52*s.*, but fell to 1*s.* when the price was 73*s.* Similar scales were applied to other kinds of grain and colonial preference was increased. The 1828 act assisted the speculator as much as the farmer and it did little to improve the prospects of English agriculture.

Repeal of the Corn Laws.—Because of preoccupation with parliamentary reform there was little direct pressure for a smaller fixed duty on grain or total repeal of the corn laws until the issue was raised again in 1838. A powerful new organization, the Anti-Corn Law league, operating from Manchester, mobilized the new wealth of industrial Britain. Its leader, Richard Cobden, was successful not only in stirring opinion in the country but also in influencing the Conservative prime minister, Sir Robert Peel. On his own initiative Peel introduced and carried in 1842 a new sliding scale of duties, better adjusted to current values, and inaugurated a program of fiscal reform and freer trade. The league claimed that only total repeal would settle at the same time the grievances of the manufacturers, hard hit by industrial depression, and the poor, burdened with the high cost of living. Although it was a self-proclaimed middle-class organization, it adjusted its economic arguments to suit its audiences and carried its campaign to tenant farmers in the countryside, attempting to differentiate their interests from those of the landlords. The landlord was depicted as the villain of society; he took the place of Adam Smith's middleman as the target of social criticism.

The propaganda of the league was so successful that Peel himself, although not a doctrinaire free trader, began to waver. He was always open to argument and by 1844 he found the main argument of the league incontrovertible. Finally, influenced by the failure of the potato crop in Ireland, he put an effectual end to the history of the corn laws by his famous act of 1846. The maximum duty on foreign wheat, when the price was under 48*s.*, was immediately reduced to 10*s.*, with lower duties as prices rose above the scale. From Feb. 1849 all duties on grain were to cease, except for a nominal impost of 1*s.* In 1869 even this nominal duty was abolished by Robert Lowe.

Repeal in 1846 split Peel's Conservative party, but it did not spell the ruin of British agriculture. The middle years of the 19th century were the golden age of English farming, and it was the improvement in international transport and the sharp increase in the imports of American wheat in the 1870s which effectively challenged Britain's cereal farming and destroyed the natural protection afforded not by legislation but by geography.

20th-Century Policies.—There was a late-century revival of protectionism. In 1902, for revenue-raising purposes, a registration duty of 3*d.* per hundredweight was imposed on imported grain and 5*d.* per hundredweight on imported flour, and although these duties were repealed a year later, Joseph Chamberlain, who became the leader of a tariff reform movement in 1903, considered them a desirable basis for increased protection of home-grown grain and preference for grain grown in the empire. He hoped, as did the prime minister of Canada, largest grain-growing country in the empire, that new corn laws would lead to increased reciprocal preferential trade between empire countries. "Free trade within the empire" was the new objective.

A closer union of the empire depended upon a fiscal revolution at home. The revolution was not forthcoming before 1914. Although the Unionist party split as Peel's party had split in 1846, loyalty to free trade principles proved strong. Measures of protection were given a greater stimulus by exigencies of 20th-century war and depression than by efforts of politicians.

Between 1914 and 1918 imports and exports were under strict government control and farmers' prices were guaranteed. This policy ended in 1920, for despite agricultural pressure politicians were still afraid to violate free-trade traditions and to tax foodstuffs. It was not until after the slump in wheat prices and world economic collapse that the National government, unwilling to give direct protection to wheat farmers, passed the Wheat act of 1932. By this time home wheat production represented only a small part of the total British demand and combination of producers could never have been effective in influencing the level of home prices. The Wheat act stabilized sharply fluctuating prices by imposing a virtual tax upon the consumer. All wheat growers had to inform the wheat commissioner of their sales and prices. If at the end of the year the average sales price on all transactions was less than a standard price of 10*s.* per hundredweight, each grower received the difference between his average and 10*s.*, multiplied by the quantity of his sales. The sums thus distributed were derived from a processing tax on all flour delivered for consumption in the United Kingdom. In consequence bread prices rose by as much as ¼*d.* on the 2*d.* loaf. A great expansion in wheat acreage was achieved only at the expense of dearer bread. In 1937 the principle of price guarantee was extended on slightly different lines to oats and barley growers, the subsidies being paid not directly by the consumer but by exchequer grants.

The return to producers' protection in 1932 was not reversed. After 1939, in war conditions, tight import restrictions were imposed, farmers' guarantees were given and strenuous efforts were made to increase the acreage of cereal production. Balance of payments difficulties after 1945 made the continuation of war policy imperative, and the Agriculture act of 1947 emphasized the need for developing "a stable and efficient agricultural industry capable of producing such part of the nation's food as in the national interest it is desirable to produce."

The phrase "national interest," which would have left Cobden and John Bright unmoved, recalled mercantilist arguments about the corn laws, but policy after 1945 was different both from that of the 18th century and from that of 1932 and 1937. Dependence upon foreign imports had to be acknowledged, though the imports were restricted and directed by long-term bulk-buying contracts. The price-insurance schemes themselves were designed not so much to save the farmer from keeping pace with the steady growth of technical progress overseas as finally to exorcise his fear of being squeezed by a slump in world prices. Protection was related to

national planning rather than to the interest pressure of a particular group of producers. (A. Bri.)

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CORN PICKER: *see* Harvesting Machinery.

CORN PLANTER: *see* Planting Machinery.

CORN SALAD or Lamb's Lettuce, *Valerianella olitoria* (family Valerianaceae), a weedy annual, native of southern Europe but naturalized in cornfields in central Europe and in various parts of the United States and Canada, and not uncommon in Britain. In France it is used in salads during winter and spring as a substitute for lettuce, but it is less esteemed in England. Principally grown are a round-leaved variety of *V. olitoria* and Italian corn salad, a distinct species, *V. eriocarpa*.

CORNUS is the genus name of about 45 species of shrubs and small trees of the family Cornaceae (*q.v.*) to which the name dogwood is applied. *See* Dogwood.

CORNUTUS, LUCIUS ANNAEUS, Stoic philosopher, flourished in the reign of Nero. He was a native of Leptis in Libya, but resided for the most part in Rome. He is best known as the teacher and friend of Persius, whose satires he revised for publication after the poet's death, but handed them over to Caesius Bassus to edit, at the special request of the latter. He was banished by Nero (in 66 or 68) for having indirectly disparaged the emperor's projected history of the Romans in heroic verse (Dio Cassius, lxii, 29), and disappears from history. He was the author of various rhetorical works in both Greek and Latin (*Rhetorikai technai, De figuris sententiarum*). His philosophical treatise, *Theologiae Graecae compendium,* is still extant; it is a manual of Stoic etymological interpretation of popular mythology (ed. by C. Lang, 1881). Simplicius and Porphyry refer to his commentary on the *Categories* of Aristotle, whose philosophy he is said to have defended against an opponent Athenodorus in a treatise *Antigraphe pros Athenodoron.* Excerpts from his treatise *De enuntiatione vel orthographia* are preserved in Cassiodorus.

In the middle ages several critical works were falsely attributed to him; *e.g.,* the so-called *Disticha Cornuti* (ed. by Hans Liebl, Straubing, 1888).

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CORNWALL, the southwesternmost county of England, is bounded on the northwest and west by the Atlantic ocean, on the south by the English channel and on the east by Devon. The area is 1,357 sq.mi., including the Scilly Isles (*q.v.*), which are administered separately.

Physical Features.—The form of Cornwall is that of a peninsula, 75 mi. long and 45 mi. broad across the base, Lizard point being the most southerly extension and Land's End (*q.v.*) the most westerly point of the mainland. It owes its main features to the folding movement of the Armorican system complicated by a series of granite intrusions. The latter form moorland bosses (small batholiths) decreasing in height from east to west. Dartmoor (*q.v.*) in Devon is the largest and highest; Bodmin moor reaches 1,375 ft. in Brown Willy; Hensbarrow Beacon is 1,026 ft.; Carnmenellis and the St. Just boss are lower; a further granite mass, now largely submerged, forms the Scilly Isles. The lower-lying regions are mainly of folded slaty rock of Devonian age, striking largely east to west, with some limestone; in the extreme northeast there are Carboniferous grits and shales. From

BEN DARBY

LAND'S END, CORNWALL, SHOWING UNUSUAL CLIFF FORMATIONS

Tintagel head northward to Hartland point in Devon the distorted strata form steep cliffs because of the rapid maritime erosion that goes on. The veins of ore are chiefly in the slaty rock near the granite masses which themselves give kaolin by decomposition of feldspar. A Tertiary, supposedly Pliocene, uplift and tilt apparently gave especially the south-flowing streams an additional impetus and led to the cutting of deep valleys in what the uplift had converted from a peneplain into a plateau or a succession of plateaus. Post-Pleistocene sinking gave rise to the sunken estuaries of south Cornwall, and the drainage lines are chiefly those between the granite bosses. The Tamar, which forms most of the boundary between Devon and Cornwall, drains between Dartmoor and Bodmin moor into its great southern estuary; between Bodmin moor and Hensbarrow Beacon the Camel drains northward to Padstow bay, and the Fowey southward into a long estuary; the Fal estuary is placed between the Hensbarrow and the Carnmenellis bosses; and there is a low line across from Mount's bay to St. Ives bay between Carnmenellis and the St. Just boss. In Mount's bay is St. Michael's Mount (*q.v.*), a precipitous granite island joined to the mainland at low tide by a causeway, the slaty rocks (called killas) having been washed away on all sides but the north.

The climate is mild and moderately sunny. High winds are common in autumn and winter and sea mists in spring and autumn. The average temperature for January is 43.4° F. at Bude and 44.5° at Falmouth. Rainfall is heavy and, though only 33.4 in. per annum at Bude, it reaches 43.6 in. at Falmouth and 49.4 in. at Bodmin. The vegetation in shelter is luxuriant and southern in type, and in some places along the southern coast, known as the Cornish Riviera, subtropical plants are grown. About 360 sq.mi. of the county have been designated as Areas of Outstanding Natural Beauty; with the exception of Bodmin moor, these areas are located along the coast. The beauty of the coast line, especially Land's End and the Lizard, and the little fishing towns such as St. Ives, Looe, Fowey, Polperro, Newlyn and Mousehole, attract many artists. The National trust owns 9,395 ac., with 1,742 ac. under restrictive covenant.

History.—The wind-swept moorlands and cliffs gave opportunities for early settlement, and when the use of metal was beginning to spread, or just prior to this, western Cornwall became important, as its wealth of megalithic monuments shows. They include dolmens such as those of Lanyon, Mulfra, Chun and Zennor. Monoliths have a wider distribution, those in the parish of St. Buryan being well known. The principal circles are the Hurlers, near Liskeard, the Boskednan, Boscawen-un and Tregeseal circles, and the Merry Maidens near Lamorna. All these, except the Hurlers, are in the Land's End district. There are also alignments on the moors near Rough Tor and Brown Willy. This culture formed part of a movement from the Mediterranean which brought Cornwall and the southwest into touch with Brittany. A few Early Bronze implements have been found. The coastal

promontories and river estuaries are protected by clusters of earthworks of presumed Iron Age date, but mining operations have destroyed so many that it is impossible to argue from their type and distribution. Roman occupation and Saxon colonization of the lands farther east caused westward pressure, and it is to these influences that must be assigned the emigration of Brythonic-speaking people into southwest England and from there to Brittany. Remains of Celtic Christianity in Cornwall include crosses dating from the 6th century onward, inscribed sepulchral stones, generally of the 7th and 8th centuries, and oratories. These have their parallels in Ireland, as the prehistoric contacts with Ireland and Wales and Brittany were maintained in early Christian times. In all these regions dedications to local saints are a feature. The oratory buildings are very small and rude, always placed near a spring. The best example is St. Piran's near Perranzabuloe, which lay buried in sand dunes until 1835. St. Piran, a missionary sent by St. Patrick in the 5th or 6th century, became the patron saint of the tin miners. Cornwall has many associations with the Arthurian legend.

Cornwall was the last portion of British territory in the south to submit to the Saxon invader. In 815 Ecgbert directed his efforts toward the subjugation of the West Welsh of Cornwall, and after eight years' fighting compelled the whole of Dyvnaint (west Wales, Cornwall) to acknowledge his supremacy. Assisted by the Danes, the Cornish revolted, but were again defeated in 838 at the battle of Hengestesdun (Hingston Down in Stoke Climsland). Ninety years later Aethelstan banished the West Welsh from Exeter and made the Tamar the boundary of their territory. By the time of Edward the Confessor nearly all the land in Cornwall was held by men bearing English names. As the result of the Norman Conquest less than one-twelfth of the land (exclusive of that held by the church) remained in English hands. Most (248) of the manors were assigned to Robert of Mortain and became the foundation of the earldom. Since a charter of 1337 the eldest son of the sovereign has been duke of Cornwall, this being the oldest dukedom in the kingdom. In the 15th century Cornwall strongly supported the Lancastrian cause, and its remoteness from the capital made it a potential field for revolt. This is seen in the support given to the Thomas Flammock (or Flamank) rebellion in 1497, to Perkin Warbeck in the same year and to the Humphry Arundell rebellion over the religious question in 1549. The king's Cornish troops led by Sir Bevil Grenville (*q.v.*) defeated Col. Ruthin on Bradock down, while Sir Ralph Hopton (*q.v.*, later Baron) triumphed over the parliamentarians at Stratton. The whole county was thereby secured to the king, but dissensions hastened the overthrow of the royalists. The 18th century was remarkable for the fervour shown by Cornishmen in the Methodist movement.

The old Cornish language survives in a few words still in use in fishing and mining communities, as well as in names of persons and places (*e.g.*, names with the prefixes Tre, Pol, Pen meaning "dwelling," "pool," and "summit or headland" respectively), but the last persons who spoke it died toward the end of the 18th century. The language belonged to the Cymric or Brythonic division of Celtic, in which Welsh and Breton are also included. Three miracle plays in Cornish are important relics of the language. (*See* CELTIC LANGUAGES; CORNISH LITERATURE.)

Cornish wrestling is confined to Cornwall and Brittany, where it was introduced from Cornwall in the 5th and 6th centuries A.D. It has been played in Cornwall since remote times, and there is a legendary account of a contest between a Cornish giant, Goemor, and a Trojan warrior, Corineus, said to have taken place about 1000 B.C. Cornish wrestlers fought at Agincourt under a banner that is still the symbol of the Cornish Wrestling association. The wrestlers wear special canvas jackets, fastened in front by cords, and no shoes. (*See* WRESTLING.) A full description of the sport is given in Richard Carew's *The Survey of Cornwall* (1602) and details of its history in the *Journal of the Royal Institution of Cornwall*, new series, vol. ii, part 2 (1864–).

Population and Administration.—The population at the 1961 census (including the Scilly Isles) was 341,746. In 1861 the population was 369,390 and had shown an increase up to that date. There are 12 municipal boroughs: Penzance (19,433), Falmouth (15,427), Truro (13,328), St. Ives (9,337), Saltash (7,420), Bodmin (6,209), Helston (7,085), Launceston (4,518), Liskeard (4,490), Penryn (4,448), Fowey (2,237) and Lostwithiel (1,954). Bodmin is the county town and the assizes and quarter sessions are held there, but the county offices are in the cathedral city of Truro. There are eight urban districts of which the largest are Camborne-Redruth (36,090), St. Austell (25,027) and Newquay (11,877), and ten rural districts, excluding the Scilly Isles which are under a separate council. The islands form one of the 22 petty sessional divisions. In addition, Penzance has a separate commission of the peace and court of quarter sessions.

The county court was held at Lostwithiel and the assizes at Launceston in the 13th and 14th centuries. In 1716 the summer assize was transferred to Bodmin and after 1836 both assizes were held there. Cornwall had its own bishop from the 7th century until 1018. In 1049 the see of the united dioceses of Devon and Cornwall was fixed at Exeter. Cornwall became an archdeaconry soon after and was reconstituted a diocese with its see at Truro in 1877.

Two members for the county were summoned by Edward I to the parliament of 1295, and two continued to be the number of county members until 1832. Six boroughs were granted the like privilege by the same sovereign. Between 1547 and 1584, 15 additional towns and villages received the franchise, with the result that, between the latter date and 1821, Cornwall sent no fewer than 44 members to parliament and became notorious for the number of its rotten boroughs (*see* BOROUGH). The allocation of members proportionately to the population continued irregular until 1885. There are now five parliamentary divisions, Bodmin, Falmouth and Camborne, St. Ives, North Cornwall and Truro, each returning one member.

Industries and Communications.—The main sources of income in Cornwall are agriculture, the tourist trade, quarrying, engineering, ship repairing, mining and fishing.

There are pasture and arable farms, and in the valleys the soil is frequently rich and deep. Oats and mixed grain form the main cereal crops; green fodder crops, turnips and swedes, potatoes and mangolds make up the bulk of the root crops. Cattle, chiefly of the Devon breed, sheep, pigs and poultry are reared. Excluding rough grazings, about three-quarters of the total area of the county is under crops and grass. Because of the favourable climate, fruit, flowers and vegetables are cultivated in the vicinity of Mount's bay (flowers, broccoli, early potatoes), the Fal valley (flowers, broccoli, early potatoes, vegetables) and the Tamar valley (top and soft fruit, flowers, vegetables). The Scilly Isles also share in the market gardening industry, notably for flowers. The care of woodlands and the planting of new areas are largely undertaken by the Forestry commission.

The fisheries of Cornwall and Devon are the most important on the southwestern coasts. The pilchard is in great measure confined to Cornwall and the neighbourhood of the Scilly Isles. Apart from a short interval in the spring, pilchards are caught all the year round by drift nets off the southern coast. They are mainly disposed of by canning, and surplus catches are cured and packed locally for export to Italy. Ray, skate, turbot, cod, conger and dogfish are caught by long lines, and sole, plaice, skate and whiting by trawls. The principal fishing stations are Newlyn, Mevagissey and Looe, but boats are employed all along the coast.

An important source of income, comparable with agriculture, is the tourist trade. Many of the small seaside towns, such as Bude-Stratton, Newquay, St. Ives, Falmouth and Looe, have become holiday resorts. Falmouth is the yachting centre, but Fowey and Penzance are among the many safe harbours. The principal ports are Hayle, Penzance, Truro and Penryn. Falmouth is a ship-repairing centre. A main railway line passes through the county to terminate at Penzance and there are 150 mi. of trunk roads in Cornwall. There is a civil airport at St. Just and another on St. Mary's, Scilly Isles.

Mining.—The tin of Cornwall has been known and worked from the Bronze Age. By ancient charters the tinners were exempt

from all jurisdiction (save in cases affecting land, life and limb) other than that of the stannary (tin mine) courts. A tax on the tin, after smelting, was paid to the earls and dukes of Cornwall. The smelted blocks had to be coined—that is, stamped with the duchy mark—before they could be sold. In 1838 the dues on coinage were abolished and a compensation awarded to the duchy instead. Cornish miners directed successful developments of mining in many parts of the world, and much emigration took place in the middle of the 19th century. The industry suffered from periods of depression (for example, before the accession of Elizabeth I, who introduced miners from Germany to resuscitate it), and in modern times the shallow workings, from which tin could be easily "streamed," became practically exhausted. The deeper workings are more costly and foreign competition is greater. There was a slight revival during World War I, but later mining greatly diminished. A rise in the price of tin during 1926–28 caused renewed activity especially in the Camborne-Redruth district, but production of tin ore has continued to decline, the surviving mines of importance being at Pool (Camborne) and Pendeen (St. Just), producing tin and arsenic. There was also a small wolfram mine at Castle-an-Dinas, near St. Columb. No mine seems to have been worked exclusively for copper before 1770. In 1718 John Coster drained the deeper mines and introduced an improved method of dressing ore. In 1851 the mines of Devon and Cornwall were estimated to furnish one-third of the copper raised in Europe. Iron (brown hematite) has been worked near Lostwithiel and elsewhere. The St. Austell district produces china clay (kaolin), and after its extended use for paper filling and the textile trade it became an important commodity. China stone is also quarried near St. Austell. Production after World War II exceeded 60,000 tons a year.

Igneous and metamorphic rocks are quarried mainly for road stone. The largest groups of quarries are Penlee (Penzance), St. Keverne (Lizard), Clicker Tor and Hingston Down (south-eastern Cornwall). Production of granite for monumental and constructional work accounts for less than 1% of total igneous rock production. Fine slate is quarried and largely exported, as from the Delabole quarries near Tintagel (worked since Tudor times), and serpentine is quarried in the Lizard district.

Camborne-Redruth, formerly the principal mining area, manufactures mining equipment and has a civil engineering plant. After World War II it attracted a greater variety of industries, including several textile firms.

See also references under "Cornwall" in the Index.

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(E. T. V.)

CORNWALL, a city of Ontario, Can., seat of the united counties of Stormont, Dundas and Glengarry, on the left (north) bank of the St. Lawrence river, about 70 mi. S.W. of Montreal, is a port of entry from the United States via the Roosevelt bridge and headquarters of the Canadian St. Lawrence Seaway authority. Founded as New Johnstown by United Empire Loyalists in 1784, opposite the Indian village of St. Régis, in 1797 it was renamed in honour of the duke of Cornwall, who became George IV. It was incorporated as a town in 1834 and as a city in 1945. Pop. (1961) 13,639. Manufactured products include paper, textiles, chemicals, lumber, furniture and castings. (F. G. R.)

CORNWALLIS, CHARLES CORNWALLIS, 1st Marquess (1738–1805), British general and statesman, whose most important service of a long and distinguished career was his term as governor general of India (1786–93), was born in London on Dec. 31, 1738, the eldest son of the 1st Earl Cornwallis (1700–62). He entered the army in 1757, serving in Germany during the Seven Years' War. After 1765 he took some part in politics, and was a firm opponent of the policy of taxation of the American colonies; despite this he went to America as major general in 1776, becoming second-in-command the next year. He was the best of the English generals in America, gaining some victories against the colonists. His southern expedition of 1780–81 began successfully, but on Oct. 19, 1781, he was forced to surrender at Yorktown, and the English cause was irretrievably lost. The defeat did little damage to his reputation in England; he was several times offered the post of governor general in India, and finally accepted it in 1786 on condition that the powers of the office were enlarged.

Cornwallis' government in India was notable for a series of administrative reforms, culminating in the set of regulations of 1793 known as the Cornwallis code (*see* India-Pakistan, Subcontinent of: *History*). His reforms were mainly based on the work of others, but their comprehensiveness and the smoothness with which they were effected were due to his tact and determination. The changes in the administration of justice and of the revenue have been criticized, especially the permanent revenue settlement for Bengal which Cornwallis recommended against the advice of experts. But his reform of the civil service introduced a spirit of disinterested administration in India, and the connection between commerce and government was finally broken. The aggression of Tipu Sahib forced Cornwallis to contravene the official policy of nonintervention in native states, and make an alliance with the Marathas and the nizam of the Deccan. In 1791 Cornwallis personally took command of the forces against Tipu, and by a successful campaign in which Bangalore was captured and Seringapatam beseiged, he forced Tipu to make peace.

Cornwallis returned to England in 1793, received a marquessate and was made master general of the ordnance with cabinet rank. He was viceroy of Ireland from 1798 to 1801, and ended the serious rebellion of 1798, proclaiming a general amnesty and defeating the French army of invasion. He strongly supported William Pitt's policy of union, and his popularity with both Roman Catholics and Orangemen helped carry it in Ireland. When George III refused to grant Roman Catholic emancipation in 1801, Cornwallis resigned. He was appointed plenipotentiary to negotiate the peace of Amiens in 1801. In 1805 he reluctantly returned to India to replace Lord Wellesley, but he died at Ghazipur on Oct. 5, 1805.

See also references under "Cornwallis, Charles Cornwallis, 1st Marquess" in the Index.

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CORNWALLIS, SIR WILLIAM (1744–1819), British admiral who, as commander of the channel fleet, 1803–06, maintained the vital blockade of Brest against Napoleon, was born in Suffolk on Feb. 25, 1744, son of the 1st Earl Cornwallis. He entered the navy at the age of 11 and was promoted captain at 22. During the American Revolution he served in the West Indies, taking part in the battles of Grenada (1779) and St. Kitts (1782). At the victory of the Saints off Dominica in 1782 he was critical of the conduct of Adm. George Rodney. In 1788 Cornwallis was sent as commodore to India, where his brother was governor general, and took part in the war against Tipu Sahib, being promoted admiral in 1793. Two years later he conducted a withdrawing action off Brest, in the face of a superior force, with the greatest skill, his 4 ships of the line being attacked by 12 under Adm. L. T. Villaret de Joyeuse. His most important service was when he succeeded Lord St. Vincent in command of the channel fleet blockading Brest in 1801, and again from 1803 to 1806, when he retired. These were the years of peril from the threat of Napoleon's invasion, and upon the close blockade of Brest in all weathers depended the safety of Great Britain. Cornwallis carried out his duty with great resolution, using Ushant as his rendezvous and keeping an inshore squadron to watch the French fleet under Comte Ganteaume. After Sir Robert Calder's action with

Adm. P. C. de Villeneuve on July 22, 1805, the former fell back on Cornwallis' fleet, but when this was reinforced by Nelson's ships after the chase was given up, Cornwallis sent Calder south again in order to prevent Villeneuve coming out of Corunna. Napoleon criticized this division of the main fleet as foolish, but Villeneuve never dared attack the fleet to the north of him and retired to Cádiz. Because of this, the invasion scheme collapsed. Cornwallis retired in 1806 and died in Hampshire on July 5, 1819.

Nelson, who was his lifelong friend, called Cornwallis "a gallant and good officer." He was reserved in manner, but popular with his men who invented many nicknames for him such as "Billy Go-tight" and "Billy Blue," because of his persistence in flying the Blue Peter flag to make sail, and "Coachee" or "Mr. Whip," from his florid complexion.

See G. Cornwallis-West, *The Life and Letters of Admiral Cornwallis* (1927); *The Blockade of Brest,* ed. by J. Leyland, Navy Records Society (1899). (C. C. L.)

CORNYSHE, WILLIAM (d. 1523), English composer, actor and favourite court musician of Henry VIII, came from a family closely connected with the Chapel Royal; an older William Cornyshe (d. 1502), possibly his father, was the first master of the choristers at Westminster abbey (1479–91). The younger William was actively associated with the production of court pageants, in which the boy choristers took part, from at least 1501, and in 1509 he succeeded William Newark as master of the children of the Chapel Royal. Under the young and pleasure-loving Henry VIII he continued to devise and perform in plays, masques and pageants. He accompanied the court to the continent on at least two occasions, being responsible for the English performances at the Field of Cloth of Gold (1520). He died in Oct. 1523.

Cornyshe's compositions show an outstanding lyrical gift allied to great versatility, equally at home in the elaborate counterpoint of Mass and votive antiphon and in the more pithy but no less subtle style in which he set the poems of John Skelton and others.

See J. Stevens, *Music and Poetry in the early Tudor Court* (1961). (J. J. N.)

CORO, the capital and principal city of Falcón state, Venezuela, is located on the Paraguaná peninsula near the isthmus which connects the peninsula and the mainland. Pop. (1950) 29,341; (1961) 44,757. The city is 105 ft. above sea level. Its climate is hot—mean temperature 83° F.—but not unhealthful. Coro is connected by rail and highway with its port, La Vela (pop., 1950, 2,086), located 7 mi. E.N.E. on the Carribean. There is a modern airport, and highways give ready access to the heavily populated regions of the nation. Irrigation helps to make agriculture profitable in the surrounding region. Tobacco, coffee, cocoa and castor beans are among the leading products. Soap, shoes and cigars are manufactured on a limited scale. The city is noted for the hammocks manufactured there. There are salt deposits and coal mines in the vicinity. Development of oil refineries on the peninsula have served to make Coro an important commercial centre.

Coro was founded in 1527 by Juan de Ampués (Ampíes) as part of a plan of the Spanish crown to suppress slave hunting in the area. Its original name was Santa Ana de Coriana, the latter part of the name being derived from the Coros Indians who inhabited the area. The settlement became the chief factory of the Welsers, the German banking house to which Charles V mortgaged western Venezuela in 1528. The Welsers retained control until 1546 and under them Coro became the centre of departure for numerous expeditions in search of Eldorado (*q.v.*).

The bishopric of Coro, the first in Venezuela (1531), was transferred to Caracas in 1581. The city was sacked by English pirates in 1567. Coro is celebrated in Venezuelan history as the scene of the first attempt, in Aug. 1806, by Francisco de Miranda, "the precursor of independence," to free the country from Spanish domination. Coro has many churches, including the oldest in Venezuela, and other historic monuments. (J. J. J.)

COROLLARY. The word *corollarium,* which meant in classical Latin a gratuity, appears in late Latin philosophical writings with the meaning of an additional inference or consequence. The word *corollary* is in common use in English with approximately this latter meaning.

In mathematics, a corollary in the strict sense is a proposition which was incidentally proved in the course of proving another proposition, and for which therefore no separate proof is required. However, mathematical writers now generally use the term more loosely to denote any consequence of an existing theorem (or existing proof) which is sufficiently obvious that in practice no proof need be stated for it, or at most a very brief proof.

For example, in elementary geometry, after it has been shown that when two sides of a triangle are equal the opposite angles are equal, it may be inferred as a corollary that if a triangle has all three sides equal, then all three of its angles are equal.

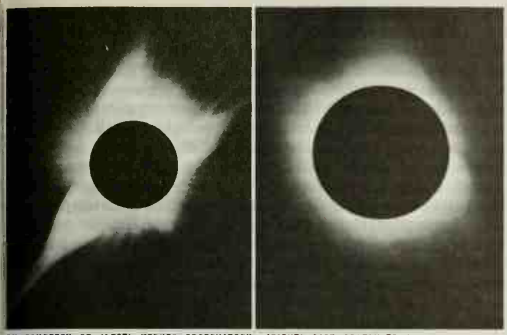
Euclid's *Elements* states no corollaries; the modern examples of corollaries of Euclidean propositions have been added by editors of, or commentators on, the *Elements.* *See* MATHEMATICS, FOUNDATIONS OF. (Ao. C.)

COROMANDEL COAST, a name formerly applied officially and later in a historical sense to the eastern seaboard of India approximately from Cape Calimere northward to the mouths of the Krishna river. The shore, which is low, has no good natural harbours and is at all times beaten by a heavy sea. Madras, about halfway along the coast, has been provided with an artificial harbour at great cost. The northeast monsoon, which lasts from October until April, is violent for the first months. From April till October hot southerly winds blow by day; at night the heat is tempered by sea breezes. The name Coromandel is said to be derived from Cholamandal, the *mandal* or region of the Chola dynasty. (L. D. S.)

CORONA. During the few minutes of totality of an eclipse of the sun there is seen surrounding it a halo, pearly white in colour, of irregular shape but roughly circular in form, about twice the size of the sun, with faint streamers extending several solar diameters from the limb of the sun. This is the solar corona. Although the phenomenon becomes perceptible only at the instant when the glaring light from the sun's disk is cut off by the dark moon, the corona must be supposed to be permanently surrounding the sun. Since Bernard Lyot's invention of the coronagraph, certain features of the corona can be observed and studied without an eclipse.

Forms and Changes.—Through an approximately circular, bright inner corona more or less extensive streamers proceed in a roughly radial direction; near the north and south poles of the sun the long streamers give place to shorter, plumelike rays, the "polar brushes." The forms observed can be classified into two main types occurring alternately: at times of minimum sunspot activity the polar brushes are short, and the long streamers tend to approach the direction of the equatorial plane; at times of maximum sunspot activity the polar rays are longer and the streamers show less preference for the equatorial plane, making the corona more circular in form. Over activity centres on the solar surface the inner corona often exhibits regions of excessive brightness and an intricate, archlike structure associated with the structure of underlying prominences. On the whole, the coronal phenomena show a close connection with the other phenomena adherent to the 11-year cycle of solar activity, and the general shape of the corona is in conformity with the rise and fall in latitude of sunspots and prominences in the solar cycle.

From this description it is evident that the corona is subject to considerable variation. Although no changes have been noticed during the short time of totality of an eclipse, observations with the coronagraph extended over longer periods reveal continuous change and movement in the inner corona, especially over disturbed areas on the sun. The duration of recognizable details is found to vary from about one hour to several weeks, the average lifetime of a streamer being one or two days. It should be noted that the apparent variations of the corona are a combination of real changes and the effect of a rotation. A statistical study of intensity distributions along the sun's limb clearly indicates a correlation of distributions observed at opposite limbs with an interval of 14 days, which means that the corona follows the solar rotation (M. Waldmeier). This has



BY COURTESY OF (LEFT) YERKES OBSERVATORY; (RIGHT) LICK OBSERVATORY

SOLAR CORONA: (LEFT) AT TIME OF MINIMUM SUNSPOT ACTIVITY; (RIGHT) AT TIME OF MAXIMUM SUNSPOT ACTIVITY

been confirmed by the observation of a small difference in wave length (Doppler shift) of lines in the coronal spectrum when measured alternately at the east and the west limb of the sun.

When discussing the forms and brightness of the corona, it should be remembered that, because of its extremely low density, the corona is completely transparent and, consequently, the light observed in any one direction is integrated from all different depths along the line of sight. In general, it is impossible to derive the shape of the corona in space from the appearance in projection which is observed.

Radiation.—The total amount of visible light emitted by the corona is approximately one-half that of the full moon, or one-millionth that of the sun, as shown by fairly consistent measurements at later eclipses. It is probably subject to variations, although the unavoidable uncertainty of the observations prevents definite conclusions. More accurate are the measurements of the relative brightness of different parts of the corona, for which various formulas have been proposed, usually expressing the intensity as a function of the distance from the centre. The intensity falls off rapidly near the limb, corresponding to a high inverse power of the distance; farther outward the decrease becomes gradually slower, approaching a value corresponding to the inverse 2.5th power of the distance. Generally, however, the brightness at the same distance from the limb is considerably greater near the equator than near the poles. In any case, with regard to the complex structure of the corona, any intensity formula assuming a spherically symmetrical distribution will give only a rough approximation. It was found by Erik Edlund in 1851 that the coronal light is partly polarized, the plane of polarization being in every point perpendicular to the sun's limb. Observations have shown that the degree of polarization is independent of the wave length of the light and that, after an increase from the limb outward, it reaches a maximum at a distance of about one-third of the sun's diameter and then slowly decreases outward. The maximum polarization is nearly 50% in the equatorial direction but considerably less at the poles.

The Spectrum.—The main part of the coronal light shows a continuous spectrum and the same distribution of intensity in different colours as sunlight. In the inner regions of the corona, however, the dark Fraunhofer lines, typical for the solar spectrum, are not present. A faint, broad depression in the violet part of the spectrum, where a large number of strong Fraunhofer lines should occur, suggests that these lines are effaced through some process by which each individual line is spread out over a wide range, covering perhaps 60 Å (W. Grotrian). Farther outward from the limb, from a distance of about one-fourth of the sun's diameter, the Fraunhofer lines gradually become visible and the spectrum of the outer parts of the corona exactly resembles the solar spectrum, except for a slightly reduced contrast in the dark lines. It is remarkable that these lines, as soon as they are visible at all, are quite sharp; the absence of any transition stages in the behaviour of the Fraunhofer lines indicates a superposition of two quite different components in the formation of the corona.

The Bright-Line Spectrum of the Corona

Wave length in angstrom units	Element; stage of ionization	Wave length in angstrom units	Element; stage of ionization
3328	Calcium XII	5302.86 (strong)	Iron XIV
3388.1 (strong)	Iron XIII	5694.42	Calcium XV
3454.1		6374.51 (strong)	Iron X
3601.0	Nickel XVI	6701.83	Nickel XV
3986.9	Iron XI	7059.62	Iron XV
4086.3	Calcium XIII	7891.94 (strong)	Iron XI
4231.4	Nickel XII	8024.21	Nickel XV
4567		10746.80 (strong)	Iron XIII
5116.03	Nickel XIII	10797.95 (strong)	Iron XIII

Superposed on the continuous spectrum of the inner corona are a small number of comparatively faint emission lines, of which the strongest is a green line with the wave length 5303 Å, discovered at the eclipse of 1869. These bright lines contribute less than 2% ot the visible coronal light and have no perceptible effect on the colour of the corona. Coronagraphic observations have extended knowledge of these lines, especially in the infrared. The table gives the data for the principal lines, a few faint or doubtful ones having been excluded. The intensities of the lines, though on the whole proportional to the intensity of the continuous light on which they appear, show larger fluctuations, and the intensity distribution around the limb or in radial direction may differ considerably for different lines. This is clearly shown on eclipse photographs taken with a slitless spectrograph, in which the corona is imaged separately in the light of each individual bright line. In particular, the two bright lines in the visible region, the green and the red line, which are both caused by iron in different stages of ionization, show conspicuously different distributions, which may be explained as the result of differences in the temperature and density of the coronal gas.

The origin of the coronal lines has been the subject of much speculation. They have finally been identified (Grotrian, B. Edlén) with radiations from atoms of iron, nickel, calcium and a few other common elements, all very highly ionized. The green line, for instance, is emitted by iron atoms which have lost 13 electrons, or one-half the number normally contained in the iron atom. The lines are moreover of the "forbidden" type, owing their appearance to the low density of the coronal gas, and are in that respect analogous to the nebular lines. The energies required to produce the various stages of ionization show a good correlation with the empirical classification of the lines according to their observed intensities in different parts of the corona.

Physical Interpretation.—Few astronomical phenomena have been so difficult to explain and therefore so open to speculation as the sun's corona. The basis for a consistent interpretation has been greatly improved, however, by advances from both the theoretical and observational side; *e.g.*, the identification of the origin of the bright coronal lines and, particularly, the solution of the problem of observing the corona without an eclipse. Continuous records of events in the inner corona are obtained by means of coronagraphs at several high-altitude observatories. At the same time the eclipse observations retain their full interest since many features, especially the outer corona, are still inaccessible without a total eclipse.

The Dust Halo and the Real Corona.—The conspicuous change of the spectrum and of other properties of the coronal radiation with the distance from the sun is interpreted as the effect of a superposition of two fundamentally different phenomena. The real corona, a luminous, extreme extension of the solar atmosphere, which shows its typical radiation in the inner regions of the corona, is seen through a halo of solar light diffracted by dust particles in the space between the sun and the earth. This dust halo is responsible for the Fraunhofer component of the coronal radiation, which contributes to the total intensity with an increasing percentage outward from the sun. Because of vaporization by the sun's heat, the space within a distance of, say, five solar diameters, which contains the real corona, is certainly free from any diffracting dust particles. The two components of the corona, therefore, although apparently mixed, need not have any direct physical connection.

The dust-halo theory was more soundly established through the recognition of the predominance of diffraction over reflection in this particular case of light scattering (H. C. van de Hulst, C. W. Allen). The theory permits conclusions regarding the size of the particles and the average density of matter in interplanetary space consistent with the observed frequency of meteorites and seems to explain the zodiacal light as an extension of the same diffraction phenomenon.

The main part of the light from the inner corona, showing a strong polarization and a continuous spectrum with the same colour distribution as the sun, has long been recognized as solar light scattered by free electrons (K. Schwarzschild, 1906). The electrons, because of their small masses, will have great thermal velocities, about 50 times greater than hydrogen atoms at the same temperature, and the Doppler effect caused by these high random velocities would cause a considerable widening of the Fraunhofer lines in the scattering process. The lines would be smoothed out and eventually vanish completely at a high enough temperature, as observed.

According to this interpretation nearly 99% of the coronal light is directly borrowed from the sun, one part being scattered by interplanetary dust and the other part, the main constituent of the inner corona, being scattered by the free electrons in a gaseous envelope, a coronal atmosphere of the sun.

Density.—That the coronal gas must be extremely thin was early concluded from the observation of comets passing at high speed through large distances in the inner corona without suffering any change or retardation. From the observed intensity of the corona and the known scattering coefficient of the electron it is possible to compute the number of electrons per cubic centimetre. As the negative charge of the electrons must be compensated by an equal amount of positive charge, the coronal gas must contain nearly the same number of protons, hydrogen being certainly the most abundant element and completely ionized at the coronal temperature.

In this way the density of the corona in its densest parts near the sun's limb is found to be approximately one-million-millionth that of air at atmospheric pressure.

With regard to the finer structures of the corona, the arches and streamers and the large-scale motions, one must remember that the coronal matter, as consisting exclusively of electrically charged particles, is strictly guided in its motions by the lines of magnetic force as soon as a magnetic field of any appreciable strength is present. The detailed coronal structures are therefore likely to reproduce the structures of the magnetic field around the sun.

Conclusions regarding the chemical composition can be drawn from the relative intensities of the bright coronal lines, giving the relative abundances of various metals, and from the intensity of the lines as compared with the intensity of the electron scattering, giving essentially the ratio of metals to hydrogen. There is no indication of any striking difference in composition between the coronal gas and the chromosphere.

Temperature.—The physical explanation of the coronal atmosphere presents unsurmountable difficulties if—as was long assumed as a matter of course—the temperature of the gas were of the same order as the surface temperature of the sun, about 6,000° C. Observed facts require for a logical explanation a much higher temperature. In the first place, the enormous extension of the corona can be understood only if the gravitational forces are balanced by great thermal velocities of the gas particles, corresponding to a temperature between 1,000,000° C. and 2,000,000° C. Contrary to older belief, the radiation pressure is not likely to play any role in this problem since the free particles, which are the main constituents of the coronal gas, do not absorb light. A similar temperature is derived from the observed profiles of the bright coronal lines, which are about one angstrom wide, and from a quantitative discussion of the disappearance of the Fraunhofer lines in the electron-scattering process. The high ionization of the metal atoms, as well as the remarkable fact that no hydrogen lines are observed in the coronal spectrum, also finds a plausible explanation at a temperature of the order of 1,000,000° C. The observed intensity of solar radio noise, which has been shown to originate in the corona, permits of similar conclusions regarding the coronal temperature.

Though the discovery of the high temperature of the coronal gas provides a consistent physical picture of the phenomenon, the mechanism by which the corona is heated remains a subject for speculation. Because of the low density the quantity of energy required to maintain the temperature is only a small fraction of the total solar radiation, the difficulty being to find a mechanism producing the required quality of energy. Particles of interstellar matter would be accelerated in the sun's gravitational field to velocities high enough to produce the observed high temperature, but it is questionable whether the density of interstellar matter is high enough to cover the thermal losses of the corona. Furthermore, the shape and detailed structure of the corona, being directly associated with the solar activity, would rather point to an energy source in the sun itself. It has been suggested that mechanical energy of the turbulent motions in the photosphere, which show as granulation, could be transformed into a special kind of wave motion, transported upward and absorbed in the corona by a mechanism which ultimately is a Joule heating through electric currents (Hannes Alfvén).

Extreme Ultraviolet Radiation.—As already mentioned, the main part of the light from the corona is scattered sunlight, while the specific radiation of the coronal gas, the bright lines, contribute only 1% or 2%. In the visible wave-length region the specific coronal radiation thus amounts only to about one-hundred-millionth of the radiation from the sun. Because of the great difference in temperature between the corona and the photosphere, however, the ratio of coronal to solar radiation will increase enormously as the wave length of the radiation decreases. For a rough calculation one may assume that the coronal gas radiates, with a certain dilution factor, as a "black body" at a temperature of 1,000,000° C. On this assumption one finds that the amounts of radiation emitted from the sun and from the coronal gas become equal in the wave-length region around 1000 Å, and that for still shorter wave lengths the photospheric intensity soon drops to a negligible amount in comparison with the coronal intensity. Spectra of the integrated sunlight taken from above the earth's atmosphere by means of rocket-borne spectrographs actually show, in consistency with this picture, that the continuous light from the sun's disk fades away below 2000 Å and gradually gives place to a bright-line spectrum characteristic of highly ionized matter. The extreme ultraviolet radiation is completely absorbed in the earth's upper atmosphere, producing ionization. It is likely that the ionized layers, which reflect radio waves, are at least partly caused by coronal radiation. Coronagraphic observations have therefore become of interest as a means of predicting conditions for radio communications.

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CORONADO, FRANCISCO VÁZQUEZ DE (1510–1554), Spanish explorer of the American southwest. He accompanied Viceroy Antonio de Mendoza to New Spain in 1535 as friend and protégé and soon gained distinction in subduing rebellious Indians. He was made a member of the town council of Mexico City, June 1538, and in August became acting governor of the province of New Galicia, an appointment which was confirmed the next year. Fray Marcos de Niza's exploration of 1539 into the northern interior, telling of the rich Seven Cities of Cibola—the present Zuñi, N.M.—led Mendoza to send a great expedition under Coronado to conquer them. Accompanied by more than 300 Spanish cavalry and 1,000 Indian allies, plus Fray Marcos, Coronado conquered the Seven Cities in July 1540, but found no riches. He sent Pedro de Tovar to explore the Hopi villages, García López de Cárdenas the Grand canyon country, and Hernando de Alvarado the Rio Grande, where Coronado followed and set up headquarters at Tiguex, the centre of a populated area north of modern Albuquerque. Here the army spent the winter of 1540–41, conquered some rebellious pueblos and reconnoitered the

surrounding country. At Pecos the Spaniards found an Indian who told of a country farther east more wonderful than the Seven Cities. News of this land, called Quivira, led Coronado to explore the Great Plains in the summer of 1541. When he reached Palo Duro canyon in Texas, bewildered by the vastness of the country, he sent the main force back to Tiguex, while he led 30 horsemen to the great bend of the Arkansas river in Kansas in search of the mythical kingdom. But Quivira, inhabited by Wichita Indians, was not rich in gold or silver, and Coronado returned to Tiguex dispirited. The following winter he suffered a blow on the head while jousting. When he recovered, the expedition left New Mexico, returning the way it had come.

For his conduct of the expedition, Coronado underwent an official inspection, as the law required, and was indicted, but the *audiencia* of Mexico, in Feb. 1546, declared him innocent. He was not so fortunate in the official *residencia* of his governorship, for which he was indicted and fined on several charges, and lost some of the Indians he held in encomienda. But he continued to serve as a member of the council of Mexico City and retained the friendship of Viceroy Mendoza, being one of the chief witnesses for his defense in the official *residencia*. Coronado died on Sept. 22, 1554.

See Herbert E. Bolton, *Coronado, Knight of Pueblos and Plains* (1949). (G. P. Hd.)

CORONARY THROMBOSIS (Coronary Occlusion or Myocardial Infarction), a condition in which a plug or clot forms in a branch of the coronary arteries, which supply blood to the heart muscle itself. *See* Arteries, Diseases of; Heart, Diseases and Defects of.

CORONATION, a solemnity whereby sovereigns are inaugurated in their office. From the earliest historical times in Europe the king or chieftain, on his election, was inaugurated by some public ceremony. He might be raised upon a shield, placed upon a sacred stone, presented with a spear, or invested with a distinctive robe or headdress. Whatever the particular ceremony might be, however, it was essential that it should take place in the sight of the assembled people. When Europe became Christian, though some of the older customs lingered on, they were grafted onto a religious service derived from the biblical accounts of the anointing of Saul and David by Samuel. Once the biblical precedent of anointing with oil had been introduced into western Europe the whole idea of kingship was altered. The ruler attained a new status. Whatever might be its exact significance—and this was disputed throughout the middle ages—it could not be denied that the anointed person was a man in some sense set apart with a special relationship both to God and to his people. By virtue of the unction he was peculiarly fitted to receive the crown and other insignia, and it was almost inevitable that he should receive them from the clergy by whom he had been anointed. In western Europe the first king specifically recorded as having been anointed was Vamba, the Visigothic king of Toledo, in 672.

England.—The English coronation service traces its descent from the *ordo* drawn up by Archbishop Dunstan for the coronation of King Edgar at Bath in 973. This was based on two earlier models, known as the Leofric and Egbert services, which appear to date from the early 10th century. Neither of them seems to have originated in England, but they were used by Dunstan, who added many of the coronation ceremonies in use on the continent at the time. In the Edgar *ordo* all the essential features of a modern coronation appear in a primitive form—the oath, the anointing, the investiture, the enthronement and the homage. It was subsequently often revised, notably in the 12th century under Archbishop Anselm and again in the 14th (the *Liber Regalis*). English took the place of Latin after the Reformation, but the coronation remained a service of election, of confirmation of the people's choice, of self-dedication and of consecration. There is no doubt, too, that it was deliberately molded on the service for the consecration of a bishop. Also, after 1689, reverting to much older usage, both the coronation service and the service for the consecration of a bishop were incorporated in the communion service.

The English coronation service now consists of four distinct parts, one leading on to the other and forming a coherent whole: (1) the introduction, consisting of the entry, the recognition and the oath; (2) the consecration of the sovereign by anointing; (3) the investiture of the anointed sovereign with the royal robes and insignia culminating with the crown; and (4) the enthronization and homage followed by the communion service. The recognition is historically the ratification by the people of the former ceremony of election in Westminster hall, when the sovereign was placed on the king's bench in the sight of all. At the recognition the people are asked if they wish the service to proceed, and it is made clear that the monarchy is based upon the people's will and consent. Assured of this, the archbishop can proceed to administer the oath, which ensures that the sovereign will respect and govern according to the laws and will uphold the Protestant Reformed religion of England and Scotland and preserve the Church of England. The recognition and the oath form the contract between the sovereign and the people and are the foundations of the whole service. The archbishop can now consecrate the sovereign, who is thereupon anointed on the palms of both hands, the breast and the crown of the head. This is the central moment of the service, for it is only when the sovereign has been anointed that investiture with the royal robes and insignia can follow. Finally the crown of St. Edward is placed on the head of the sovereign, who then moves from the coronation chair to the throne and is lifted up into it by the archbishop, bishops and other peers. Historically, this is the moment when the sovereign enters into his inheritance, and for the first time is clearly seen by all to have been duly anointed, invested and crowned. The homage of his subjects naturally follows. When the lords spiritual and lords temporal have paid their homage there is a threefold acclamation by which the people present, representing the third estate, complete the act of homage and thus end the solemnity of the sovereign's coronation. If there is a queen consort, her coronation follows at this point. Otherwise the communion service is resumed at the offertory and proceeds to its close.

For many centuries the English coronation service was followed by a banquet in Westminster hall. During the course of this the king's champion in full armour entered the hall on horseback and, throwing down his gauntlet, three times challenged anyone to deny the sovereign's right to the crown. The office of king's champion is attached to the manor of Scrivelsby, and has been held since the 14th century by the Dymoke family as owners of the manor. The challenge was the most picturesque of several personal services, of which some are still performed during the coronation ceremonies. The banquet was last held, and the challenge made, at the coronation of George IV in 1821. The king's champion, however, now has the duty of bearing the standard of England during the coronation service.

France.—The Frankish kings originally began their reign by being raised on a shield and acclaimed. The legend of the anointing of Clovis (*see* below) refers to his baptism, not to his accession. Pepin, first king of the Carolingian dynasty, partly in order to sanctify his superseding the Merovingian kings, was twice anointed, first possibly by St. Boniface, then by Pope Stephen III (II). With his successors in the 9th century unction became an established part of the ceremonial. Eventually the form of coronation in France, in its general features, closely resembled the English coronation service on which, it is believed, it was originally based. From the 11th century onward it customarily took place at Reims. The unction was given, first on the top of the head in the form of a cross, on the breast, between the shoulders and at the bending and joints of both arms. Then, standing up, the king was vested in the dalmatic, tunic and royal robe, all of purple velvet, sprinkled with fleurs-de-lis of gold, and representing, it was said, the three orders of subdeacon, deacon and priest. Kneeling again, the king was anointed in the palms of the hands, after which the gloves, ring and sceptre were delivered. The peers were then summoned by name to come near and assist, and the archbishop of Reims, taking the so-called crown of Charlemagne from the altar, set it on the king's head. After this the enthronement and the showing of the king to the people took place. Mass was then said, and at its conclusion the king communicated in both kinds.

In connection with the anointing of the kings of France there was a legend that the Holy Dove had descended from heaven, bearing a vessel (afterward called the Sainte Ampoule), containing holy oil, and had placed it on the altar for the coronation of Clovis. A drop of oil from the Sainte Ampoule mixed with chrism was afterward used for anointing the kings of France. Similarly, the chrism was introduced into English coronations, for the first time probably at the coronation of Edward II. To rival the French story another miracle was related that the Virgin Mary had appeared to Thomas Becket and had given him a vessel with holy oil, which at some future period was to be used for the sacring of the English king. A full account of this miracle, and the subsequent finding of the vessel, is contained in a letter written in 1318 by Pope John XXII to Edward II. The chrism was used in addition to the holy oil. The king was first anointed with the oil and then signed on the head with the chrism. In consequence of the use of chrism the kings of England and France were thought to be able to cure scrofula, hence called king's evil (*q.v.*), by the imposition of their hands.

Napoleon I in 1804, having brought Pope Pius VII to Paris to anoint him in the cathedral of Notre Dame as emperor of the French, placed the new imperial crown on his own head.

The Holy Roman Emperors and the German Kings.—The custom whereby the Holy Roman emperors were crowned by the popes dates from the coronation of Charlemagne on Christmas Day 800 (*see* HOLY ROMAN EMPIRE for this controversial incident). The anointing of the emperor by the pope was instituted at the coronation of Louis I the Pious in 816. The last Holy Roman emperor to go to Rome for coronation was Frederick III in 1452; Charles V, however, was crowned by the pope but at Bologna, not in Rome.

Otto I, Otto II and Otto III were crowned as German kings at Aachen (where Charlemagne had been crowned king of the Franks), and from Henry III's to Ferdinand I's time Aachen was the customary place for the German coronation, being recognized as such by the Golden Bull (1356). Charles V's successor Ferdinand I, however, who had been crowned German king at Aachen in 1531, was crowned as Holy Roman "emperor elect" in 1558 at Frankfurt am Main, and thenceforward Frankfurt was the place of coronation for the emperors till the dissolution of the Holy Roman empire. After preparatory ceremonies and prayers the emperor was consecrated and anointed, then clothed in the imperial and pontifical robes and presented with the regalia and the sword of Charlemagne and finally crowned by the three archbishop-electors jointly.

After the dissolution of the Holy Roman empire, the later Habsburg emperors of Austria were crowned only as kings of Hungary in Buda.

Hungary.—The crown of St. Stephen was first used for the coronation of Stephen I (*q.v.*) of Hungary in A.D. 1000 or 1001. Thenceforward the place of coronation varied, the chief places being Székesfehérvár, the oldest royal residence; the coronation church in Buda; and, during the Turkish occupation of central Hungary, Pozsony (Bratislava). The crown was always placed on the king's head by the archbishop of Esztergom, the primate of Hungary.

Poland.—The first Polish coronation took place in 1025, at the Gniezno cathedral, when Boleslaw I was crowned king of Poland. From 1320 to 1734, all coronations were held at the Wawel cathedral in Cracow, except that of Stanislav I Leszezynski in Warsaw in 1705. The bishop of Cracow had the right of placing the crown on the king's head. The last king of Poland, Stanislav II Poniatowski, was crowned in Warsaw in 1764.

Russia.—The first coronation of a Russian tsar (*venchanie na tsarstvo*) took place in Moscow in 1547, when Ivan IV the Terrible was crowned in the Kremlin, at the Uspenski cathedral, with the so-called "Monomakh hat," alleged to have been sent by a Byzantine emperor to Vladimir Monomakh (1113–1125), grand prince of Kiev (this hat is still in the Kremlin, and the workmanship of the original part of the crown appears to be of the 12th or 13th century). The hat was placed on the tsar's head by the patriarch of Moscow, after the anointing. Peter I the Great, however, assumed the title of emperor (*imperator*) and abolished the patriarchate. Thereafter the coronation ceremony was known as *Koronovame imperatorskoe* and was conducted, still at the Uspenski cathedral, by the four Russian metropolitans, those of Moscow, Kiev, Novgorod and St. Petersburg. Unction remained, but the emperor put the new imperial crown on his own head and also crowned his empress. The first coronation according to the new ceremonial took place in 1724 when Peter I crowned his consort, who as Catherine I succeeded him in 1725.

Spain.—During the middle ages in Spain the kings of Asturias, León and Castile were anointed and crowned by a bishop (though Alfonso XI put the crown on his own head). After John I of Castile, however, the ceremony died out and the accession of the Castilian kings was marked simply by an act of acclamation or proclamation in all the cities and towns of the kingdom. In Aragon kings were always anointed and crowned until, with the union of the Spanish kingdoms, the ceremony was replaced by a solemn entry into Madrid.

Sweden and Norway.—The kings of Sweden used to be anointed and crowned originally at Uppsala, later by the archbishop of Uppsala in the Storkyrka in Stockholm, those of Norway at Trondheim by the bishop. Gustav V of Sweden, however, and Olaf VI of Norway, dispensed with these ceremonies.

See CROWN AND REGALIA. *See* also references under "Coronation" in the Index volume.

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CORONEA (CORONEIA), **BATTLE OF** (394 B.C.). In this battle of the Corinthian War (*see* GREECE: *History*) the Spartan king Agesilaus II was checked by the combined forces of the Thebans, Athenians, Argives and Corinthians, although he was technically victorious. While the offensive by the coalition was being stemmed at the battle of Nemea (*q.v.*), Agesilaus was on his way back overland from Asia Minor to the defense of the homeland, having broken off his campaign against the Persian power on the urgent summons of the ephors. After passing safely through Thessaly and gathering reinforcements, he was faced at the gap of Coronea in Boeotia by the main forces of the coalition. As before at Nemea each right wing overlapped and smashed the opposing left. Agesilaus, however, while the victorious Theban right pressed on to attack the Spartan camp, wheeled his victorious right inward against the Theban centre. Nonetheless the Thebans succeeded in forming a new front to meet this menace and eventually forced their way through to join the rest of their army.

See Xenophon, *Hellenica*, iv, 3, 16 *et seq.*

CORONEL, Chilean coal mining and shipping centre on the Gulf of Arauco, and seat of Coronel department in Concepción province. The city, pop. (1960) 60,234 (mun.), is located about 18 mi. S. of Concepción, to which it is linked by rail and surfaced highway. The community was founded in 1851 and received city status in 1875. Its growth has reflected the development of coal mines in the vicinity, for Coronel functions as a shipping as well as a commercial centre. Local soft coal production represents about 30% of Chile's output and modern methods of mining and loading coal are employed. The operations extend under the floor of the gulf. Company-owned pine and eucalyptus plantations supply mine and construction timber and some lumber for commerce. There are foundries and shops and planned company housing areas. The city of Coronel has a congested and spontaneous appearance. (J. T.)

CORONEL, BATTLE OF, a notable German naval victory of World War I, was fought on Nov. 1, 1914. Evidence had reached the British admiralty early in Oct. 1914 that the East Asiatic squadron of the German navy, under Vice-Adm. Graf Maximilian von Spee, was moving toward the west coast of South America, where its presence would threaten vital supply-lines from Chile to Great Britain. Rear-Adm. Sir Christopher Cradock, with

a hastily assembled squadron consisting of the outdated cruisers "Good Hope" and "Monmouth," the light cruiser "Glasgow" and the armed merchantman "Otranto," was instructed to "search and protect trade" along the Chilean coast. With the exception of "Glasgow," these ships were manned largely by old reservists and partly trained boys. At 4:25 P.M. on Nov. 1, the British met the German squadron, consisting of the first-class cruisers "Scharnhorst" and "Gneisenau," and the light cruisers "Leipzig," "Dresden" and "Nürnberg," all manned by long-service complements. Cradock signaled the attack two hours later, but his situation was already hopeless, for in addition to superior strength, range and speed, von Spee had secured the shoreward position, so that twilight cloaked the German ships while the British were silhouetted against the setting sun. Within an hour the flagship "Good Hope" blew up with the loss of her entire complement, "Monmouth" was burning fiercely, "Otranto" had withdrawn and only "Glasgow" could continue the battle. "Monmouth's" captain ordered "Glasgow" to make her escape, and just before 9 P.M. "Monmouth," having refused to surrender, was sunk with all hands by "Nürnberg."

Von Spee won his victory at negligible cost, but the British were fully revenged five weeks later, in the battle of the Falkland Islands (*q.v.*).

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CORONER, a public official whose principal duty in modern times is to inquire, with the help of a jury, into the cause of any death that appears to be due to unnatural causes.

The office originated in England and was first referred to as *custos placitorum* ("keeper of pleas") in s. 20 of the Articles of Eyre (1194). It is believed by some, however, that the office was first mentioned in the Charts of Privilege, granted by King Aethelstan to St. John of Beverly in the year 925. The name was originally known as "crowner" or "coronator," derived from *corona*, meaning crown. The coroner's dignity and power were second only to the king. He was originally charged with the duty of safeguarding the king's property and served as a check on the sheriff in the royal interest. Other powers already obsolescent were expressly taken away by s. 44 of the Coroner's act of 1887, which, interestingly enough, re-enacted the provision of Magna Carta (1215) that prohibited both sheriff and coroner from holding pleas of the crown. The medieval coroner was no longer a militant figure.

The office was always elective, the appointment being made by the freeholders of the county assembled in the county court. The first Statute of Westminster (1275) enacted that none but lawful and discrete knights should be chosen as coroners. Afterward, lands of the value of £20 (the qualification of knighthood) were considered sufficient.

The Coroners Amendment act, 1926, requires that a coroner shall be a barrister, solicitor or legally qualified medical practitioner of not less than five years standing in his profession, no property qualification being required. The practice of the London county council is to appoint persons possessing both legal and medical qualifications.

The judges of the high court of justice are ex officio sovereign coroners; they may (but, in fact, do not) exercise their jurisdiction in any part of the realm. Under the 1926 act, the duties of a coroner are limited to an inquest into the cause of all deaths occurring within his district by violent or unnatural means or from some unknown cause, or of the death of anyone who has died in prison or under such circumstances as to require an inquest in accord with other legislation. The coroner must view the body, but the jury need not. If any person is found guilty of murder, manslaughter or infanticide, the coroner commits him to trial, but in practice he seldom has to do this, since s. 20(1) of the act provides that if the coroner is informed before the jury has given its verdict that some person has been charged with any of these crimes, he shall adjourn the inquest until after the conclusion of the criminal proceedings.

By the City of London Fire Inquests act, 1888, the coroner for the city of London holds inquests in cases of loss or injury by fire in the city of London and its liberties situated in the county of Middlesex. In Scotland, the duties of a coroner are performed by an officer called a procurator fiscal. In Canada, all coroners are appointed by order in council, signed by the lieutenant governor of the province. As a judge of a court of record, he is not liable to civil action for anything done by him in his judicial capacity if he acts indiscretely or erroneously.

United States.—In the United States the office is usually elective, but in some states it may be appointive. In a few states the coroner's staff is composed of a number of employees representing varied scientific departments of medicine, such as pathology, toxicology and chemistry. In some jurisdictions, the coroner has police power equal to that of the sheriff in all cases where the latter is incapacitated or has a personal interest in the case before him. The coroner of a county may issue a warrant for the arrest of persons who have caused the death of another by criminal means, and the warrant may be executed in any part of the state. In some states, pathologists are coroners and must be graduate physicians; in others, a layman may be authorized as coroner, with the power to employ a physician to conduct the autopsy. The only person who can definitely give the cause of death is the coroner or one deputized to perform the duties of his office. Unless this is the case, it is usually impossible to establish the corpus delicti, *i.e.*, the basic facts necessary for the commission of the crime.

The coroner's office is operated differently in many states. About half of the states have a coroner's system; in some of the others the sheriff or the justice of the peace takes over, while in others the coroner's office has been replaced by a medical examiner. There are also other arrangements, including a combination system with both a coroner and a justice of the peace having jurisdiction. In most states, the power to issue warrants is confined to homicide cases, but in such cases the coroner possesses all the powers of a magistrate to take testimony and issue warrants. (J. L. Do.)

COROT, JEAN BAPTISTE CAMILLE (1796–1875), one of the most notable French landscape painters of the 19th century, was born in Paris on July 16, 1796. His father was a draper, his mother a very successful milliner of Swiss origin. Educated at the Lycée at Rouen, Corot dutifully followed his father's trade for some years, but in 1822 was allowed to leave commercial life and study painting. He rewarded the financial support that his parents gave him with complete dedication to his art.

As a young man Corot sought to establish himself in the tradition of neo-classical landscape painting exemplified by P. H. de Valenciennes (1750–1819). He had met and had lessons from two of Valenciennes' disciples, A. E. Michallon (1796–1822) and J. V. Bertin (1775–1842), but it was the actual experience of going to Rome in the autumn of 1825 that was decisive in the formation of Corot's style. He stayed until 1829, painting the city and the Campagna, and also making excursions to Naples and Venice.

Following the custom of his day, Corot spent these years making small oil sketches which he planned to use later in large landscapes painted in the studio according to classical rules of composition. He was building up a repertory of forms, and regarded these sketches as documents, not as finished works of art, never exhibiting them. They are among the first French paintings done entirely out-of-doors, and are the most personal (and now the most admired) part of Corot's work; they show an immediate response to nature, a readiness to experiment with the oil medium and a sensuality in the handling of paint that he was soon to lose entirely.

On his return to Paris in 1829 Corot set about painting in earnest the large landscape compositions that he regularly showed at the Salon. Most of them included small figures, which sometimes give a flavour of the Bible—"Hagar in the Desert" (Salon, 1835), "Christ in the Garden of Olives" (Salon, 1849), "Saint Sebastian" (Salon, 1853); of literature—"Homer and the Shepherds" (Salon, 1845), "Macbeth and the Witches" (Salon, 1859; Wallace collection, London), "Dante and Virgil" (Salon, 1859; Boston, Mass.); of antiquity—"Diana Surprised by Actaeon"

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"CHARTRES CATHEDRAL" BY COROT, 1830. IN THE LOUVRE

(Salon, 1836), "Biblis" (Salon, 1875); or of an ideal rustic life—"Souvenir de Mortefontaine" (Salon, 1864; Louvre, Paris).

Corot traveled widely in search of landscape material, returning to Italy in 1834 and in 1843, visiting Avignon and the south of France in 1836, Switzerland in 1842, Holland in 1854 and London in 1862. He made regular summer tours, collecting material that he worked up in his studio in Paris during the winter. Among his favourite regions were the forest of Fontainebleau, Brittany, the Normandy coast, the family property at Ville d'Avry near Paris, and, later in life, Arras and Douai in the north of France.

Corot also painted straightforward, almost topographical landscapes, like the "Chartres Cathedral" (1830), the "Château de Rosny" (1840), or the "Beffry at Douai" (1871), all of which are in the Louvre. There is little development, but the particular quality of sweet romantic melancholy that he cultivated in the Salon pictures soon permeated his work. His self-consciously poetic and idyllic landscapes with their sensitive tonal effects and delicate range of silvery colours won Corot great popularity, but these pearly gray mist-enveloped twilight scenes now appear exceedingly artificial and formula-built by the side of Impressionist landscape painting. The portraits and figure pieces of the last 20 years of Corot's life, as "L'Atelier" (several versions, *c.* 1865) and "La Perle" (1868–70, Louvre), are much less artificial, and witness to Corot's innate classicism and his absolute mastery of tonal painting.

Corot never lacked admirers and his work was well received in the salons. He was rewarded with medals, purchases by the state and by the emperor, and with membership in the Legion of Honour. He was friendly with the slightly younger painters of the Barbizon school, and his influence can be seen in the painting of A. Chintreuil, S. Lépine and Camille Pissarro. A dedicated man with simple tastes, he never married; he had a reputation for saintliness and great charity when he died in Paris on Feb. 22, 1875. *See* also PAINTING: *Baroque Through Impressionist Painting: France: 19th Century.*

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CORPORATE INCOME TAX: *see* CORPORATION TAX.

CORPORATE STATE. Corporativism or the corporate state is a view of society that sees the community as composed of diverse economic or functional groups rather than of discrete individuals; in theory it would make the basic governmental unit the group or corporate body rather than the individual. Members of the central governing body would represent specific functional groups (estates) rather than localities. In actual practice, however, as put into effect by various fascist regimes between World Wars I and II, the so-called corporate state usually reflected the will of a dictator rather than the adjusted interests of groups. It provided an ideological cloak for a policy of comprehensive control of all industry and labour by the government and ruling party.

Corporativism was an important feature of Italian Fascism (*see* FASCISM) and continued to play a role in the dictatorship of Salazar in Portugal. In Germany's national socialism (*q.v.*) the corresponding pattern of bureaucratic centralism was embodied in the German Labour Front, set up under the slogan of "coordination" (*Gleichschaltung*). The idea also played a considerable role in the Fascist ideology of Austria and its *Heimwehr*.

Theory.—Historically, the ideology of the corporate state harks back to ideas developed by Christian conservatives in reaction to what they considered the excessive individualism of the French revolutionary ideology. To the allegedly mechanistic notions of the Industrial Revolution they would oppose the organic concepts of what they maintained was the corporate character of medieval society. These ideas found authoritative expression in an encyclical of Leo XIII, *Rerum Novarum* (1891), and were reaffirmed in *Quadragesimo Anno* (1931) by Pius XI.

It deserves attention, however, that much of this thought was radically at variance with actual Fascist practice, because of the latter's bureaucratic centralism, for medieval corporativism was built upon the autonomy of the constituent corporate bodies. It constructed a multicentred organic whole in terms of the self-sufficiency (*Eigenständigkeit*) of the constituent groups. Thus the medieval town was seen by its latter-day admirers and theorists as a co-operative union of guilds, whereas the Fascist corporate state entailed the total eclipse of such autonomy by the radical extension of governmental control and direction to all spheres of social life and activity.

Italy.—Behind this murky façade of ideology, the Fascists and National Socialists erected their ruthlessly totalitarian apparatus of economic controls. Indeed, the corporate organization evolved out of the peculiar Fascist unions, or syndicates, unions which were actually developed in competition with the free socialist unions and gained ascendancy after the Fascists had seized power. Their original socialist syndicalism (*q.v.*) was soon superseded. It was replaced by corporations which comprised both employers and employees who would, for the sake of "unity," operate under the direction and control of the state, *i.e.*, the bureaucracy. The corporative system was initiated in Italy by the Charter of Labour, on April 21, 1927, adopted by the Grand Council of Fascism as a party measure. It was afterward transformed into a governmental system. Under it, workers lost all rights and privileges for which their unions had fought. The key passages of the charter asserted that "since the private organization of production is a function of national concern, the organizer of the enterprise is responsible to the state for the direction of production. . . . The employee is . . . an active collaborator in the enterprise, the direction of which belongs to the employer who bears responsibility for it."

The charter contained some commendable social welfare features, such as health protection, scholarships for the children and insurance against disability, illness and old age, as well as governmental control of minimum wages, holidays and vocational education. But these provisions ought not to deceive anyone about the basic totalitarian concept; strikes, it was asserted, "are criminal offenses," and both labour and management were placed at the dictator's bidding. However, as a result of the partnership of government and industry, organized through the Institution for Reconstruction, management was recompensed for its loss of effec-

tive control by a scheme which guaranteed profits and thus eliminated risk, whereas free labour was turned into industrial serfdom.

Germany.—The German copy of this scheme, adorned by some turgid metaphysics about the "community" of the factory, also was embodied in a Charter of Labour, Jan. 20, 1934. It went further than its Italian prototype in sanctioning compulsory work assignments, and outdid it by describing the control of leisure time activities as "strength through joy" rather than merely prosaic *dopolavoro* ("after work") activities. By applying the "leadership principle" throughout the organization, it revealed the true nature of the corporate state: the total bureaucratization of the entire economy under one-party government. *See* also NATIONAL SOCIALISM.

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CORPORATION, a group of persons authorized by law to act as a unit. It may be a public body, as is commonly the case in Great Britain, or a business enterprise, as is usually the case in the United States. It may also be an educational institution such as a college or university, a labour union or a charitable foundation. A public corporation is an agency of government established to carry on certain functions of a business nature, such as the Reconstruction Finance corporation in the U.S. The present article deals with the business corporation in the U.S., first discussing its history and then its legal aspects. For coverage of related British practice *see* COMPANY.

A corporation is a fictitious legal person and as such has a corporate name, followed by the word "Incorporated" or the abbreviation "Inc." In this name the corporation may sue and be sued, and may hold and transfer property. In the eyes of the law, therefore, the group has an existence independent of its individual members. It may long outlive any one of them. This continuity of existence gives the corporate form of business enterprise a clear advantage over a partnership (*q.v.*), which comes to an end with the death of a partner.

Business corporations divide their capital stock into shares. Shares are often purchased by a large number of investors, each subscribing a relatively small sum. This divisibility of the corporation's capital facilitates the accumulation of the large sums required by modern industry. Another factor facilitating capital accumulation is the limited liability of shareholders for the debts of the corporation. In the event of bankruptcy they may lose their investments but all their other property is safe from attachment.

Such advantages go far to explain the predominance of the corporate form in modern American economic life, particularly in manufacturing. But they have little relevance to the period of its origins in either Europe or the United States. Indeed, to understand how the business corporation came to be used in the United States, and the purposes it served, requires some attention to its European background.

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I. HISTORICAL DEVELOPMENT

A. EARLY HISTORY

1. European Background.—Corporations existed long before they were used for business purposes. Some scholars trace their origins to such groups as the family, clan or tribe, which are found in the most primitive societies. The more complex societies of the ancient world developed towns, guilds and colonies; churches and universities appeared in medieval Europe. The notion that the legal authority of the state is necessary for the formation of corporate bodies is also very old. For cases where the state did not create the corporate group, or no record of its origins could be found, there arose the theory that some associations might come into existence by prescription derived from custom. Both Roman and English law made use of this theory. It is safe to say, however, that prescriptive corporations were confined to forms of association older than the business corporation.

In England, the authority of the crown was essential from the first for the formation of the business corporation. After the revolution of 1688 the authority of parliament was necessary in any case involving a grant of monopoly or other special privilege. In the 16th and 17th centuries it was business corporations in the form of great trading companies that made possible the English voyages of discovery, commerce and colonization. These culminated in the early 17th century in the first permanent English settlements in Virginia and New England.

To suggest that the Virginia company or Massachusetts Bay company was created primarily as a profit-making association would be highly misleading. It is true that the great trading and colonizing companies did seek profits. It is also true that they divided their capital into transferable shares to ease the problem of raising capital. But the achievement of neither of these objectives required that a corporation be formed. These ends might have been realized by utilizing the unincorporated joint stock company, a form of enterprise that was currently in use in some branches of English overseas trade. In the eyes of the law these unincorporated companies were large partnerships, but this fact did not prevent them from amassing and managing large capital sums. The basic reason the government granted charters of incorporation to some joint stock companies was to encourage private capital to promote ends that were regarded as public or semi-public in nature.

The public policies of many European governments between the 16th and later 18th centuries were often those of mercantilistic writers, advisers and officials who sought by means of vigorous governmental action to promote the internal unity, power and self-sufficiency of the state (*see* MERCANTILE SYSTEM). Charters of incorporation that bestowed exclusive privileges upon a group of joint-stock investors were looked upon as means to these ends. Within spheres of operation defined by their charters the great trading corporations of the 16th and 17th centuries were usually granted a commercial monopoly and the power to enforce it by means of regulations bearing the force of law. These business corporations of the early modern period were far more than mere instrumentalities of private profit. The charters they received bestowed upon them a semi-public status.

2. Colonial Period.—These conclusions, as we shall see, are fundamental to an understanding of the nature of most of the corporations created during the long colonial period of American history (1607–1783) and for nearly 50 years thereafter. As the colonies increased in population corporations sprang up in the form of towns, boroughs and cities. Before the end of the colonial period a large number of corporations had also been created for ecclesiastical, educational and charitable purposes. But business corporations were few in number and relatively unimportant. In the 17th century these included the water company of Boston and William Penn's Free Society of Traders in Pennsylvania. During the 18th century there appeared the New London trading society, two groups of wharf proprietors (in New Haven and Boston), three small water companies in Rhode Island, and a mutual fire insurance society in Philadelphia. The local and public service character of these corporations is self-evident.

One main reason so few business corporations developed in colonial America was that the spheres of activity in which they were required were subject to the disposition of crown and parliament rather than of local colonial governments. Under the unwritten British constitution, the terms of which were to be vigorously debated during the years of crisis between 1764 and 1776, internal matters alone were subject to the control of colonial governments; imperial concerns belonged to the jurisdiction of London. Colonists had therefore nothing to do with those larger interests of empire which required for their development both large sums of capital and a delegation of governmental powers. England looked to the East India company and other chartered joint-stock companies for the development of imperial commercial interests. Prevailing mercantilist doctrines did not favour encouraging colonists to be self-sufficient. Colonies were looked upon as sources of supply for raw materials to be manufactured in the mother country and as markets for manufactured goods.

The objects of concern on the part of the colonial governments were therefore small and local in nature, seldom requiring services or facilities beyond the tax-yielding capacities of local communities. While the size of both foreign and domestic markets expanded during the 18th century the capital required for their supply was easily amassed by individual proprietors or partnerships. Unincorporated joint-stock companies raised by transferable shares the capital required for mining, manufacturing and land speculation. Commercial banks did not exist in the colonies, although merchants performed some banking functions. Marine insurance was almost always obtained from English underwriters. Travel and shipping by sea reduced the need for north-south roads, while the existence of east-west rivers that were navigable to the fall line, together with British discouragement of settlement west of the Appalachians, narrowed the need for improved east-west routes of travel.

3. Early Years of Independence.—Many elements of this situation began to change soon after the achievement of independence. Between 1776 and 1800 about 250,000 migrants settled west of the mountains, or in the mountain valleys, thus increasing sharply the need for improved routes. State governments created more than 300 business corporations between the end of the American Revolution and 1801, and the provision of inland navigation, turnpikes and toll bridges was the purpose of two-thirds of them. No longer debarred from trade with the far east, American merchants expanded both the geographic area and volume of their foreign commerce, particularly after the outbreak of European war in 1793 opened up the commercial world to their neutral vessels. Risks of loss increased correspondingly and English underwriters were usually not disposed to be generous with the claims of American neutrals. To meet this problem the states chartered a number of American insurance companies between 1786 and 1800.

The expanded volume of trade created at the same time a need for the short-term credit facilities of commercial banks, with the result that no fewer than 34 were incorporated between 1781 and 1801 (27 of them between 1790 and 1801). Commercial expansion increased the size of cities and increased their needs for public services. Thirty-two corporations for the supply of water and four for the erection of docks were created between 1795 and 1801. The need of cities for protection against fire losses was reflected in the organization of nearly a dozen mutual fire insurance companies between 1786 and 1800. The large majority of the 32 insurance companies chartered during this same period, moreover, were privileged to write either fire or marine insurance.

The predominance of highway and other public-service associations among the joint-stock companies chartered in the early national period points clearly to the expanded sphere of responsibility on the part of American political communities following the Revolution. These business corporations were no more exclusively profit-seeking associations than were the chartered joint-stock companies with which the English had pioneered in the settlement of America. They were, in fact, quasi-public agencies of the state. "Be it enacted by the Senate and House of Representatives in General Court assembled," reads a Massachusetts statute of 1818, that the following named individuals "hereby are constituted a corporation *and body politic*" for the purpose of erecting a flour mill. As "bodies politic" these corporations, like their predecessors, were accorded certain exclusive privileges in order to encourage the devotion of scarce private capital to public ends. Among these privileges were monopoly rights of way, tax exemption, the right of eminent domain and the right, granted to many nonbanking corporations, to facilitate the raising of needed capital by engaging in banking operations and holding lotteries.

At the same time banks and insurance companies were incorporated to meet the needs created by the growth of American business enterprise. Except for fire insurance, these institutions served the business component of the community chiefly, although by no means exclusively. One bank, it should be noted, received its charter from the national government rather than from the states. The Bank of the United States, chartered by congress in 1791 for a period of 20 years, was a notable public-service institution. While four-fifths of its capital stock of $10,000,000 was subscribed by private sources, and only one-fifth by the federal government, the institution served important public purposes by acting as a depository for federal funds, making short-term loans to the federal government, transferring federal funds from one part of the country to another and helping maintain a sound and uniform banknote currency. The bank owed much to Alexander Hamilton's view that public fiscal ends could best be promoted by enlisting private capital in their support. On the whole, however, the character of most early American corporations reflected the very old view that charters should be issued only to those associations formed to serve the public interest.

During approximately the first third of the 19th century public service continued to dominate the purposes for which business corporations were chartered. This is evident both from the economic and other circumstances of the time and from the kinds of corporations that received charters. Capital was scarce in relation to the needs of a population that was growing rapidly, settling increasingly in cities and moving westward. The American people had numbered only about 4,000,000 when the first census was taken in 1790; by 1830 the total was nearly 13,000,000. Urban centres had totaled 24 to 1790; by 1830 their number was 90. Corporations to supply water, construct bridges, operate ferries and steamboats and provide insurance and banking facilities received charters in increasing numbers from state governments. It is difficult, moreover, to exclude from the category of public service the manufacturing corporations chartered in the early years of the century. During the troubled years preceding and during the War of 1812 the stream of imports of manufactured goods declined to a trickle. In this situation some state governments appear to have adopted the view that the chartering of domestic manufacturing associations was a matter of patriotism. Between 1808 and 1815 New York issued more charters (165) to joint-stock companies engaged in manufacturing than to all public utilities combined (164). This phenomenon appears not to have reoccurred in any other period before the American Civil War.

4. Internal Improvements.—The most enduring and costly

requirement in the first half of the 19th century lay in the field known to contemporaries as that of "internal improvements." These were turnpikes, canals, railroads and other transportation facilities, required in both the settled areas of the east and in the growing west. Lured by cheap land and constantly expanding urban markets for agricultural produce, settlers poured westward in a torrent following the War of 1812. The resulting need to bind the newly settled areas of the west to the economy of the seaboard states became the nation's primary economic problem.

Two main obstacles impeded the development of transportation routes. Despite the fact that foreign trade had made possible important accumulations of commercial capital, serving for example as the chief means of producing about a half-dozen millionaires by 1815, over-all supplies of capital were scarce. Perhaps equally important was the fact that local supplies of capital were meagre along the lines where turnpikes, canals and railroads were projected to run. The second main impediment lay in the developmental nature of internal-improvements projects. Few could promise quick returns on investment capital. Indeed, almost all projects looked for most of their returns to the settlement and economic activity that their own construction was designed to promote. Profits would necessarily be deferred and widely diffused.

The chartering of public-service corporations was one answer to these obstacles and to an extraordinarily keen public interest in internal improvements. State governments granted tax exemptions and other privileges to corporations engaged in improving transportation facilities. They also floated bond issues to raise funds to subscribe to the stocks of the enterprises and in many cases joined with local governments in granting outright gifts of money. Not private capital alone but public as well—federal, state and local—joined hands in a characteristically mixed enterprise to create the "social overhead capital" that was so essential to the development of the nation's resources.

5. Opposition to Privileged Corporations.—These halcyon days were not destined to endure. As capital accumulated, the line between public interest and private advantage became more sharply visible to critics of the privileges enjoyed by corporations. It was certainly true that abuse crept easily into the prevailing system of obtaining charters. With a few exceptions, such as New York and Connecticut, which in 1811 and 1817 respectively passed general laws permitting qualified incorporators of certain kinds of manufacturing concerns to apply to the secretary of state for a charter, incorporation by special act of the state legislature was everywhere the rule before the late 1830s. Lobbying expenses, delay and bribery often attended appeals to state legislatures for acts of incorporation. It was to the advantages which incorporators under this system were often able to wring from lawmakers that Andrew Jackson referred when he complained in a presidential message of the multitudes of corporations with exclusive privileges which businessmen had succeeded in obtaining in the different states. Jackson, like Jefferson before him, was a man of fundamentally agrarian temperament who deplored the rapid economic and social changes which were subordinating older and simpler modes of life to urban business values.

Agrarian critics were not alone among the opponents of specially privileged corporations, particularly banking corporations. The supporters of President Jackson included businessmen as well as farmers. These business critics of existing modes of procuring charters wished to put an end to special privilege; they wanted the profit-making opportunities presented by the burgeoning economy opened on equal terms to all. Jackson's secretary of the treasury, Roger B. Taney, well typifies this attitude in his remark: "There is perhaps no business which yields a profit so certain and liberal as the business of banking and exchange; and it is proper that it should be open, as far as practicable, to the most free competition and its advantages shared by all classes of society." Under President Jackson's leadership in the early 1830s men of agrarian and entrepreneurial persuasion joined in a successful assault on the second Bank of the United States. Successor to the first bank, which had passed out of existence in 1811, the second bank (1816–1836) had affronted both rural philosophies and the urban economic interests of state banks in its successful management under Nicholas Biddle of the nation's currency and credit. By curtailing loan expansion on the part of state-chartered institutions Biddle had restricted their profits. With the central regulatory agency gone after 1834 (when the federal government ceased making deposits in the bank), the number of state-chartered banks rose from 506 in 1834 to 901 in 1840. At the outbreak of the Civil War they numbered 1,601.

It was Taney who, as treasury secretary, had presided over the beginning of the bank's end by removing federal deposits from it. Four years later, as chief justice of the U.S. supreme court, he struck an even more telling blow in favour of free, competitive enterprise. In the *Charles River Bridge* case (1837) Taney severely modified an earlier ruling by chief Justice John Marshall concerning the sanctity of contracts. The issue involved was the claim by a Massachusetts bridge company that its corporate charter gave it exclusive, monopolistic business rights by implication. Taney rejected the contention, holding that no corporate charter could confer implied powers beyond the specific terms of the grant. His decision thus freed new businesses from the fear of claims of monopoly on the part of older corporations with ambiguously phrased charters.

These attacks upon enterprise restrictions had two important consequences. First was Michigan's passage of a free banking act in 1837 that served as an important precedent for similar laws in other states. More than a half-dozen states, moreover, passed general incorporation laws before the Civil War. But while an increasing number of charters were taken out under general laws the lure of special advantages from special acts led most incorporators to prefer the older method until about 1875. The second important consequence was a tendency to seek charters of incorporation in expanding fields of enterprise. Paralleling this development was a shift of emphasis in the business corporation from public service to private profit.

The attacks upon enterprise restrictions coincided with the gathering strength of forces pushing the nation's economy to new levels of achievement. At the centre of these forces were continued population growth together with increases in national income which more than kept pace with the expanding population. In consequence, an American nation whose numbers rose from 17,000,000 in 1840 to 23,000,000 in 1850 and to 31,500,000 in 1860 constituted an effective domestic market for both agricultural and industrial goods. New miles of railroad track knit together the producing and consuming centres of expanding regional markets. To meet the rising demand required a gradual abandonment of older methods of production. Farmers first worked longer hours, then added to their output by using such mechanical aids as threshers, mowers and reapers. Industrial output was increasingly expanded by means of the factory system of production. Appearing first in cotton textiles, then spreading to carpet manufacture and to the making of arms, clocks, watches and sewing machines, factory methods developed rapidly after 1840. The clearest indication of the rise of factories is the great increase in the rate of urban growth in the two decades before the Civil War. The number of cities rose from 131 in 1840 to 236 in 1850 and to 392 in 1860. By 1860 the factory system was rapidly becoming important everywhere in industry.

B. Emergence of the Business Corporation

A rapid increase in charters granted in the 1850s heralded the dawn of the age of the business corporation. Yet it was only the dawn. Industrial techniques that required large capital investment were of recent origin in important fields and made their way but slowly among constituent firms. Not until after 1835 did expensive metallic textile machinery come into general use. Not until 1839 were the first successful coke-smelting furnaces built in the United States. As late as 1869 nearly half the mechanical power used in manufacturing came from water wheels and turbines rather than from steam engines. But it is not so much the first appearance of new techniques as their spread that matters in economic growth. Imitation is more important than innovation. Among the important explanations of imitative lag must be set not only the inertia of traditional and less-costly

methods. Ignorance also counted for much, as did the scarcity of technical journals, trained engineers and cost-accounting techniques. The gradual overcoming of these obstacles contributed in the post-Civil War years to a wider dissemination of mechanized production methods. But on the eve of that conflict individual proprietorships and partnerships rather than corporations were able to amass the capital required for the control of most of the resources devoted to manufacturing.

The second half of the 19th century is marked by three principal developments in the life of the business corporation. First, there was a phenomenal expansion in the use of the corporate form, especially in such fields as iron and steel, nonferrous metals, textiles, chemicals and liquor. Indeed, manufacturing corporations constituted a large percentage of all charters granted each year after 1875. Second, there was a notable growth in size of the individual unit of enterprise. Finally, during the 1880s there began such remarkable changes in administrative organization as to justify the conclusion of a leading student of these developments, Alfred D. Chandler, Jr., that the decade saw the emergence of the modern corporation.

While these three major developments point to marked growth in the economic role of the corporation it should be made plain that partnerships and sole proprietorships continued to play important roles in economic life. Paralleling the growth of corporations were the towering figures of individual businessmen, and it is they, rather than the corporation, who left their stamp upon these years. In the forefront of industrial expansion stood such men as Andrew Carnegie (iron and steel), Gustavus Swift (meat packing), John D. Rockefeller (oil), James J. Hill (railroads) and J. P. Morgan (investment banking), men whose business organizations during at least the first flush of their rapid growth often took the form of partnerships. Called variously "robber barons" and "giants in the earth" their exploits make up the last great saga of economic individualism in the U.S. In the main their later careers and those of their successors were engulfed by the collectivism of the corporate age.

1. Growth of Urban Markets.—What mainly accounted for the expanded use of the corporate form was the rise of a national urban market. Railroads forged the transcontinental links of this market. In 1869 the first transcontinental line was completed, and from 1870 to 1914 railroad builders laid an astounding total of 200,000 mi. of track, nearly half of it west of the Mississippi river. The spreading railroad net made possible the settlement of the farmer's last frontier. During the half-century following the Civil War farmers occupied more land than in all the previous years of American history. The agricultural output of new and fertile lands, increased by wider use of machinery and scientific techniques, quickened the growth of such older cities as New York, Philadelphia, Cincinnati, Cleveland and St. Louis and helped create such new ones as Chicago, Indianapolis, Atlanta, Kansas City, Dallas, Minneapolis and St. Paul. Between 1840 and 1880 the urban proportion of the total population rose from 11% to 28%; between 1880 and 1900, from 28% to 40%.

This rapid urban growth intensified the demand for the products of industries manufacturing consumer goods. Between 1880 and 1907 incorporation for the manufacture of food and kindred products, textile mill products and other consumer goods bulked large among total incorporations. Indeed, it was the consumer-goods industries, the researches of Alfred D. Chandler, Jr., show, that were the first to become dominated by great business enterprises. By the beginning of the 20th century, however, a swelling number of companies were engaged in the manufacture of machinery for the use of producers rather than of goods for consumers or farmers.

2. The Corporation and the 14th Amendment.—Paralleling the rise of a national urban market were noneconomic forces which both paved the way for corporate expansion and augmented its scale. Following the Jacksonian attack on privileged corporations several states, as noted above, had in the 1840s adopted constitutional provisions requiring incorporation under general laws. By 1875 these provisions had become so common that special charters were virtually a thing of the past for most fields of enterprise in most states of the union. Since the new system opened incorporation on equal terms to all, it was considered more democratic than the old. Incorporation was no longer looked upon as a privilege but as a right. Symptomatic of the change in the climate of values, and itself a great spur to incorporation, was the U.S. supreme court's decision in the case of *Santa Clara County* v. *Southern Pacific Railroad* (1886) stating for the first time that the word "person" in the 14th amendment included corporations in some instances. Since the 14th amendment specified that no "person" might be deprived of life, liberty or property without "due process of law" this and subsequent decisions protected corporations from discriminatory taxation by the states. Not surprisingly, the corporation developed a personality. According to Thomas C. Cochran the great company came to be personified as a kind of frontier folk hero, with the successful corporation executive a symbol of American achievement.

Incorporation came to be used in large numbers of cases in which it would be difficult to justify resort to it in terms of large capital needs. Indeed, since about 1875 it has generally been true that small incorporations (less than $100,000) have constituted a large percentage of total charters granted, medium-sized incorporations (less than $1,000,000) a much smaller percentage, and large incorporations the smallest of all. A major exception to this generalization is supplied by periods of intense incorporating activity, such, for example, as Colorado experienced during a mining boom in 1895–96. The predominance of incorporation among firms of relatively small authorized capital stock can often be explained on the ground that many small companies have grown big without abandoning their original charters. Many large companies, that is to say, were first incorporated as small ones. But whether or not originally incorporated as a large firm, the great modern corporation dominates the field of American industry, and justifies emphasis upon the reasons for its rise.

3. Advances in Technology.—The spread of a changing technology is one of the chief factors in the rise of big business. The use of heavy machinery and larger plants required firms of larger size. Despite the fact that the number of manufacturing establishments remained virtually unchanged during the 1870s the amount of capital invested in them rose by two-thirds and the value of industrial output by more than half. And since these increased capital costs could most conveniently be raised by dividing the total sums into small shares for sale to numerous investors, technological change also abetted the rise of the corporation.

Technological change, however, is not self-generating. Given a society possessing the necessary knowledge and skills, and with no legal or entrepreneurial obstacles to innovation, technological advance depends primarily upon two conditions. The first of these, scarcity of labour, has been a perennial, if sometimes overstated, factor in American economic growth. The second is an increased demand for goods. Substantial gains in the real earnings of labour and in incomes per person indicate that both factors were operative during the second half of the 19th century. Increased mechanization and an enlarged scale of production were in the nature of responses to them. What happened was that the mass demand of a national urban market called forth mass production, together with the technological and other means necessary to its achievement.

4. Competitive Position.—Turning out large quantities of standardized goods, the large firm achieved efficiencies that lowered the unit cost of production. In competition with small firms, the large corporation had many advantages. It could hire a more highly skilled management, could market its goods more effectively and could finance itself more cheaply by using profits retained in the business. At the same time, the large firm also had to bear high overhead costs on its fixed capital investment in plant and machinery. This erosion of capital by depreciation, interest and obsolescence charges helped create a portentous situation, for railroads as well as large-scale manufacturers. In times of falling prices business managers tended to maintain production and compete vigorously for sales at any price in preference to allowing their heavily burdened plants to remain idle. Sales at low

prices provided some income, which was better than none at all. Given a long period of falling prices, this was a situation in which not only smaller firms but also larger ones of lesser efficiency could have little hope for survival.

The years from 1873 to 1896 constitute precisely such a period of long-term falling prices. In this setting the American business arena became a jungle in which many failed to survive the bitterly competitive price wars and ruthlessly sharp business practices. With prices (and railroad rates) being forced down close to cost, it became evident that two paths to survival might be open. Ways would have to be found to (1) keep prices up and (2) keep costs down. Both involved some form of combination. To keep prices up businessmen entered into "horizontal" combinations of varying kinds with their competitors in the same stage of production or distribution. "Combinations, syndicates, trusts—," Andrew Carnegie frankly admitted, "They are willing to try anything."

Vertical combination (integration), on the other hand, did not involve direct restrictions upon competition. Indeed, the firm that practised vertical combination, by bringing under its control the successive stages of production from raw materials to end product, was enabled to compete more vigorously, because the practice lowered marketing and other costs and assured supplies of raw materials.

5. Business Combinations.—The first attempt at combination among competitors usually took the form of a "gentlemen's agreement." In the main, this was a verbal agreement to set and maintain prices, although it sometimes also included common policies regarding cash discounts and other trade practices. When the object of combination could not readily be agreed upon in an informal manner business managers favoured a written contractual agreement known as the "pool." Pools were formed for various purposes. Sometimes, as in a patent pool, the use of a new device or process was thereby confined to a restricted group. Sometimes, as in a profits pool, profits were paid into a central fund and then divided up on the basis of the percentage of total sales in a given period. Probably the main use of the pool was as a device to restrict output. This was effected by dividing the total market and assigning each producer a portion of it. Sometimes division was made on the basis of output, with each producer being assigned the sale of a given number of units; sometimes a territorial division was made, in which case each was assigned a designated sales area. While pools had not been unknown even before the Civil War, they were comparatively little used until after 1875. In the 1880s and 1890s they were to be found in such important industries as those making whiskey, salt, meat products, explosives, steel rails, structural steel, cast-iron pipe and tobacco products. Comparable to the European cartel (*q.v.*), the pool differed from its counterpart in this key respect: under the English common law, recognized in every U.S. state except Louisiana, it was regarded as an illegal, and hence unenforceable, restraint of trade.

Both gentlemen's agreements and pools may be said to have "worked," if only temporarily. Indeed, there can be no doubt that both forms of combination continue in use in the United States. But these relatively loose forms of collusion had serious disadvantages. For one thing, to the degree that they were successful in raising prices and achieving a "monopoly" profit, they encouraged new firms to enter the field. Furthermore, one of the main aims of collusion was the maintenance of prices during periods of deflation. But it was precisely at such times that the temptation to violate agreements was strongest. A firm might exceed its assigned output or sell in forbidden territory, in which case other pool members had no legal way of compelling it to adhere to its agreement. Some better system was required, and business managers found it in various closer-knit arrangements.

C. Trusts and Antitrust Legislation

The first and most famous of these was worked out in the depression-ridden 1870s by C. T. Dodd, a business associate of a man who was perhaps the shrewdest business manager in a generation of shrewd men. The man was John D. Rockefeller and the idea was the trust. The device of trusteeship is a very old one, but Rockefeller's Standard Oil company put it to a new use. Employing ruthlessly competitive business practices, Rockefeller and his associates had succeeded during the 1870s in gaining control of more than 90% of the oil-refining capacity of the country. In 1882, three years after they had formed the Standard Oil trust under the laws of Ohio, they induced the stockholders of 40 oil companies to turn their shares over to nine trustees. The trustees thus acquired voting control of the 40 companies. In place of the stock, its former owners received "trust certificates" entitling them to dividends. So profitable did this device prove, and so successful as a means of centralizing control of an entire industry, that it was soon widely imitated. During the 1880s trusts were formed to control production in the tobacco, sugar, whiskey, cotton oil, linseed oil and lead industries.

The fatal defect of the trust form of combination was that the agreements were a matter of public record. Since, in the eyes of common law, conspiracies in restraint of trade or attempts to gain a monopoly were illegal, the prospects of longevity for trusts would not be good once suits were brought against them in state courts. A number of suits were begun in the 1880s, and in consequence of one of them the supreme court of Ohio ordered the Standard Oil company to withdraw from the trust on the ground that it was attempting to create a monopoly. It was clear that some other form of combination would have to be used in place of the trust. The solution to this problem was a form of business organization which some states had previously created by special act.

1. Holding Company.—In 1888–89 the state of New Jersey revised its general incorporation laws to allow corporations to purchase and hold the securities of one or more subsidiary corporations. It proved relatively easy for the resulting "holding company" to bring a number of previously independent firms under unified control. It was not necessary even to consult the nonvoting preferred stockholders and bondholders. Indeed, voting common stock often was so widely distributed that it was possible to exercise effective control by purchasing less than 50% of it. New Jersey's Holding Company act proved so successful in bolstering that state's finances with revenues from incorporation fees that other states soon "liberalized" their corporation laws in an effort to induce businesses to seek charters from them. Few state laws at that time required corporations to divulge significant information to the investing public, and it was only after much mulcting of unprotected investors, stock watering and other abuses by large corporations that the states, at about the turn of the century, abandoned their liberal attitudes and began requiring increased publicity.

The widespread legalization of the holding company did more than provide a device enabling competitors to form horizontal combinations (at least until the U.S. supreme court's decision in the *Northern Securities Company* case in 1904); it also gave firms a means of integrating vertically. The nature of the need for some such legal device can more clearly be seen by considering the specific case of the consumer goods industries. Prior to the rise of a national market the individual firm in these industries generally relied upon commission agents for the procurement of its materials, as well as for the sale of finished products whenever markets were located more than a few miles from the factory. Their first reaction to the emergence of a national market was to enter into agreements with firms performing one specific function, such as marketing or distribution. As in the case of early forms of horizontal combination (gentlemen's agreements and pools) these agreements proved hard to enforce, and resources were not effectively utilized. What was needed was a tighter control of the stream of resources than could be provided by a mere federation of firms, as well as a legal form of business organization that would permit operations on a national scale. Men like Gustavus Swift in meat packing, and others with relatively new products, moved toward vertical integration by creating nationwide sales and distributing systems, enlarging their processing facilities, and then building their own purchasing organizations. The holding company provided the necessary legal form, and in

other enterprises this kind of vertical integration followed its adoption.

No matter what the sequence, however, the arrangement of all operations under the control of a single, centralized management raised, in turn, the problem of how to make that control as efficient as possible. This was a problem in business administration, and the successful solution of it produced the modern corporation. The problem had two parts: first, the need for methods to manage operations that were geographically dispersed; second, the need for co-ordination of all operations to the optimum advantage of the firm as a whole. The fulfilling of these needs required not only a clear distinction between functions of the field and headquarters offices but also a careful allocation of responsibilities at both levels.

2. Form of Corporate Organization.—The headquarters of business enterprises had been slow in developing. In the early 19th century the typical business figure had been the merchant in foreign trade. His headquarters was his countinghouse, and there he supervised the routine tasks of a bookkeeper and a clerk or two, besides giving thought to investment opportunities by which his house might prosper. Needing no large force of permanent employees, he relied mainly on the services of commission agents. Early 19th-century industrial enterprises similarly purchased their raw materials and sold their finished goods through commission agents, although sometimes they utilized the selling services of wholesalers. Their headquarters, too, were small. Many large textile mills employing hundreds of workers were run with practically no office force at all. As markets expanded from local to regional dimensions, however, some pre-Civil War firms, particularly in the railroad industry, began to departmentalize their headquarters. The vertical integration movement, which was so accentuated by competition in postwar national markets, not only accelerated this process of departmentalization but also obliged businessmen to work out problems of co-ordination between headquarters and field. This the modern corporation proceeded to do by providing a separate administrative department for each major activity: production or purchasing of raw materials, manufacturing, marketing and finance.

At the head of each department was placed a specialist in the activity for which that department was given responsibility. Normally a vice-president, and supreme in his own sphere, he was given a managing director to handle departmental routine. Each vice-president fulfilled two main duties: he had the responsibility for the broader development of his department and he had to co-operate as a member of an executive committee composed of all department heads, together with the president and the chairman of the board of directors. The executive committee, in turn, had three functions. It co-ordinated the various activities of the enterprise, both interdepartmentally and between headquarters and field offices, for the purpose of assuring a steady flow of product from raw materials to ultimate consumer. It made plans for the maintenance and expansion of the enterprise as a whole. And it appraised the performance of the entire organization.

In doing these things, the executive committee came more and more to rely on accounting and statistical information in regard to costs, output, purchases and sales. The extensive operations of the modern corporation thus permitted specialization in the performance of various managerial functions, and specialization usually meant greater proficiency in each of them. Only from such specialization could there have emerged expert accounting techniques that permitted the substitution of scientific procedures for rule-of-thumb methods of operation. The work of Frederick W. Taylor in scientific management, which a number of modern corporations were soon to make use of in their continued drive for cost-reducing efficiencies, was a natural by-product of the trend toward specialization and cost accounting.

The modern corporation, appearing first in the railroad industry in the 1850s and in the consumer goods industries in the 1880s, transformed the leading firms in those industries by the early years of the 20th century. Its first major appearance in industries making goods for producers dates from the 1890s. Combining functional specialization with administrative centralization, it gave to firms adopting its procedures such competitive advantages as to compel their adoption by other leading firms in the same industry. Smaller companies, unable to compete except in small and specialized markets, tended to be absorbed or forced into bankruptcy. Competitive pressures in national markets thus served as an important factor in company growth, sometimes in conjunction with technological compulsions making for the same end, sometimes independently of them. The upshot was an even greater tendency for national markets to be dominated by a lessening number of large firms.

3. Sherman Antitrust Act.—These developments by no means escaped the notice of the general public. Indeed, court actions against trusts, together with newspaper attacks upon them, whipped public opinion to a high pitch of resentment. The very word trust became a synonym for monopoly, and by the mid-1890s about 17 states had passed antitrust laws. Antitrust sentiment was probably strongest in the middle west, with its hard core of embittered farmers, but it was found throughout the country, especially among small businessmen who had been bankrupted by the harsh methods of the trust-builders. Huge increases in agricultural production, without accompanying increases in foreign and domestic demand, had brought low prices to farmers ever since 1869. The prices that farmers had to pay for goods and services, however, did not undergo a comparable decline. In this bleak age for agriculture (it lasted till 1896) high interest charges, high freight and grain storage rates, and high prices for industrial goods induced farmers and their editorial and political spokesmen to lash out against railroads, banks and other middlemen, and against industry generally. Evidence of collusion in the form of trust agreements only increased their burning anger. In this situation, a congress alert to the political strength of agriculture passed, with almost no debate and even less opposition, a law destined to become one of the most controversial in U.S. history, the Sherman Antitrust act of 1890.

The key sentence in the Sherman act was the declaration that, "Every contract, combination in the form of trust or otherwise, or conspiracy in restraint of trade among the several states, or with foreign nations" was illegal. The act went on to say that, "Every person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons to monopolize any part of the trade or commerce among the several states, or with foreign nations, shall be deemed guilty of a misdemeanor . . ." What the sweeping and undefined terms of the act would mean would depend upon their application to specific cases by the federal courts. The act had elevated to statutory form ancient rules of common law against acts in restraint of trade and attempts to monopolize. For example, common law had prohibited forestalling (buying goods outside of town in order to resell them at a higher price) and engrossing (buying large quantities of goods in an effort to establish monopoly control of the market). During the colonial period courts had declared unlawful agreements between associations of employers and employees to restrict output or raise prices. It was clear enough, then, that certain kinds of restraints of trade were harmful to the public interest and hence unlawful. One major common law tradition held that only the injurious kind were unlawful. Unfortunately, from the point of view of clarity, a second major tradition maintained that restraints were unlawful whether injurious or not. Senator Sherman himself referred to this dual tradition and also to an expectation shared by some of the leading sponsors of the Sherman act, when he said that the courts must distinguish between "lawful combinations in aid of production and unlawful combinations to prevent competition and in restraint of trade . . . It is the unlawful combinations, tested by the rules of common law and human experience, that is aimed at by this bill." Most congressmen appear to have been more than willing to leave the imprecision of the act to the courts. They had wanted to enact a law so sweeping in its provisions as to render it unenforceable, and hence harmless. What really concerned them was not antitrust legislation at all but a protective tariff, which the farmers opposed. They regarded the Sherman act as a minor measure of appeasement to the farm group.

Despite the hue and cry against the trusts congress probably reflected the nation's predominant mood of laissez-faire. Until 1903 it was neither willing nor compelled by public opinion to vote the extra funds that would have eased the tasks of antitrust enforcement. National administrations read the times in the same way, for the government brought only 23 cases under the act before 1903. One attorney general, Richard Olney (1893–95), frankly said he had taken the responsibility of not prosecuting because he believed the Sherman act "no good." The U.S. supreme court all but made it a dead letter by ruling in the *E. C. Knight* case (1895) that it was inapplicable to manufacturing because that process was antecedent to commerce and only incidentally involved in it. In the *Addyston Pipe and Steel Company* case of 1899, however, it unanimously ruled that it was the sale and delivery of a product rather than its manufacture that was the material portion of a commercial contract, and that a sale for delivery beyond the state made the transaction a part of interstate commerce.

4. Merger Movement.—The Addyston decision was also important for other reasons. The case involved price and marketing agreements between the members of a pool of cast-iron pipe manufacturers. When the court declared such agreements void, business managers correctly took this to mean that pools and other forms of loose-knit combinations would be held illegal under the Sherman act. They then proceeded incorrectly to assume the obverse, namely that close-knit combinations would be considered legal. Acting on this assumption they turned with enhanced enthusiasm to a merger movement that was already under way. Probably the Addyston decision, therefore, elevated the peak of a giant wave of mergers which came at the turn of the century. When that wave receded it left in its wake the United States Steel company, American Tobacco company, International Harvester company, Du Pont company and other giants of the 20th century. Its effects on the U.S. economy were therefore widespread and enduring.

A merger is a combination into a single firm of two or more previously independent enterprises. There are two ways in which mergers may occur: via consolidation and via acquisition. In the great turn-of-the-century wave the consolidation process brought into existence new firms, but the acquisition process did so only rarely. Consolidation was resorted to when large capital sums appeared to be required, as for example, in the case of U.S. Steel, capitalized at $1,400,000,000, the first billion-dollar corporation in American history. Acquisition sufficed when the sum needed was not beyond the capital sources of an already extant firm. Most of the mergers in the great wave of 1898–1902 were accomplished by consolidation, and the effect of the Addyston decision (1899) may be seen in the number occurring in different years. According to Ralph L. Nelson, in 1895 and 1896, five were consummated each year; the numbers rose to 10 and 26 in 1897 and 1898. Then in 1899 the greatest number in any single year in U.S. history—106—took place. In that year 1,028 previously independent firms disappeared into mergers.

The New York Stock exchange played an important part in facilitating these mergers. The new firms brought into being for the purpose of effecting the mergers had been incorporated as holding companies. Often the technique for gaining control of previously independent firms was to exchange holding company stock for a controlling number of shares in operating companies. Promoters were most likely to initiate consolidations when stock market values were rising, for the prospects of profitable stock sales served as an important inducement to the stockholders in firms to be merged. The state of the stock market was also important when the technique of control involved the purchase of firms for cash, for new capital issues were often required to raise the cash.

The need to raise gigantic sums brought to the foreground of American business men who specialized in the marketing of securities. Unlike the first two post-Civil War decades of manufacturing growth, in which the financing of firm expansion had largely been carried out by industrialists themselves, investment bankers like J. P. Morgan had the leading parts in the merger movement of the 1890s. Investment bankers had gained valuable experience in huge reorganizations of railroad corporations in the 1880s and early 1890s—reorganizations of capital structures which sought the easing of burdens of fixed charges by such devices as increasing the proportion of stocks, which required no interest payments, to bonds, which regularly required them. Indeed, the marketing of railroad stocks in connection with these reorganizations had developed the New York capital market to a point where it could play an important role in the financing of industrial mergers in the late 1890s.

The prominence of the New York Stock exchange, of investment bankers and of promoters in the great merger movement lent strong support to the hypothesis that the desire for profits from sales of stocks on a rising market had much to do with producing that movement. The desire for scale economies apparently had little to do with it: except in the primary metals industries the overwhelming number of mergers was horizontal in nature rather than vertical. Some of these mergers, however, were followed by the achievement of scale economies from administrative reorganization. Profits from sales of stocks did not exhaust the motives of participants, however. The desire to protect and enhance profits from sales of goods by achieving a higher degree of market control and by weakening competition was also important. One of the easiest ways to eliminate competition is to buy out competitors. Certainly a substantial number of mergers enabled surviving corporations to enjoy a leading and often dominant position in their respective markets. The degree in which control was concentrated rose markedly. In 1905 the census reported a total of about 216,000 industrial establishments in the United States. About 24,000 of these, or approximately 11%, controlled 81% of the capital, employed 72% of the wage earners, and accounted for 79% of the value of the product. Between 1870 and 1905 the output of the steel industry increased tenfold in volume, but the number of establishments declined from 1,808 to 606. The average capital investment in an iron and steel plant amounted to only $150,000 during the 1870s. Thirty years later the average was $1,500,000.

Investment bankers as well as industrialists wished to protect profit margins by narrowing competition. Excessive competition among the railroads had led to their financial intervention in that field. When they turned in the 1890s to industrial firms they saw the same threat of small returns and of bankruptcy from cut-throat competition. Unless purchasers of industrial securities were protected from this threat their own profits from securities sales would be placed in jeopardy. As in the case of railroads, therefore, an investment banking house insisted that one or more of its representatives have a seat on the board of directors, and that the house act as fiscal agent for the corporations whose securities it handled. In a position to veto costly and unwise plans, these representatives gave to investment bankers a potentially high degree of control over the operations of industrial firms. Usually the only positive aspect of that control, however, was a frequent selection of the firm's chief executive and perhaps other leading officers. What investment bankers wished to be sure of was that the "right" men were in, men who were willing and able to run the business in line with an understood over-all policy and with profit.

Investment banking control was nevertheless of high significance and during this brief era of "finance capitalism" it ramified to the outer edges of the American economy. By acting as fiscal agents for industrial firms investment bankers became their depositaries, using the sums deposited to invest in their securities business generally. To serve the capital needs of the largest corporations they acquired control of insurance companies and other main customers for securities, as well as sources of credit. By purchasing controlling shares of stock or forming interlocking directorates with insurance companies and commercial banks with funds to invest, investment bankers became the pivot wheel for a large area of economic activity. Morgan was said to have exerted a powerful influence upon banks and trust companies whose resources amounted to $723,000,000. The colourful but exaggerated report in 1912 of the Pujo committee of the house of

representatives, which followed its investigation of the "money trust," disclosed that 18 financial institutions had interlocking directorates with banks, railroads, industrial corporations and utilities. They controlled 746 directorships in 134 corporations with total resources of approximately $25,000,000,000. This revelation of concentrated financial control not only led to the enactment of the Federal Reserve act in 1913 but also to the prohibition of interlocking directorates by the Clayton Antitrust act of the next year.

5. Policies of Theodore Roosevelt.—The great merger wave ebbed during 1903 and 1904. In the latter year the U.S. supreme court handed down another major antitrust decision in the *Northern Securities Company* case. The Northern Securities company had been incorporated as a holding company for the purpose of uniting the Northern Pacific and Great Northern railroads. To the great surprise of the business community, which had believed close-knit combinations "safe" under the Sherman act, the court ruled that the acquisition by a holding company of stock control of competing carriers constituted an illegal monopoly. The case had been dramatically pushed forward by Pres. Theodore Roosevelt, whose best-known sobriquet, perhaps, was "trust-buster," though his ambivalent role in antitrust matters hardly qualifies him for the title.

Roosevelt did not believe uncontrolled competition either possible or desirable. Modern technology had created big business, and any effort to restore competitive conditions as they had existed in the early 19th century was "just as foolish as if we should go back to the flintlocks of Washington's Continentals as a substitute for modern weapons of precision." Distinguishing between "good" and "bad" trusts, Roosevelt favoured setting up a Bureau of Corporations (1903) which would investigate and give publicity to the abuses committed by bad ones. Yet he appears to have had little intention of permitting anyone in government other than himself to designate the "bad" trusts, and he seems chiefly to have been motivated by a desire, as he expressed it, "to teach the masters of the biggest corporations in the land that they were not, and would not be permitted to regard themselves as, above the law." Those masters who, like Morgan and George W. Perkins, agreed with his regulatory approach, he refused to allow the government to molest. Thus the International Harvester company, in which Morgan interests were prominent, was not prosecuted, while Standard Oil, which "antagonized me before my election," became the subject of one of the most notable of antitrust prosecutions. In its 1911 decision in this case (and in that of the American Tobacco company the same year), the supreme court adopted its famous "rule of reason."

Converting the Rooseveltian distinction between "good" and "bad" trusts into a distinction between behaviour that was "reasonable" and "unreasonable," the court inquired into the business behaviour of both firms and ordered them dissolved. That the court had made use of governmental power under antitrust legislation to dissolve two industrial giants was significant enough. In 1906 the Bureau of Corporations had reported that about 91% of the refining industry of the country was directly or indirectly under Standard's control. By 1900 American Tobacco produced from 50% to 90% of every type of tobacco product except cigars. Even more significant was the fact that the court had not based its dissolution order upon the size of the firms in relation to their respective markets. What concerned the court was not the fact of near monopoly control but the question of whether monopoly had been the *intent* of the companies. Evidence as to intent it had found in such Standard business practices as the compelling of railway rate discrimination, local price-cutting, and territorial allocation of markets to member companies. These, the court said, were unreasonable practices; they constituted undue restraints of trade, and the purpose of the Sherman act was to protect the public from their consequences.

Support for this viewpoint, it will be recalled, lay in that tradition of common law which distinguished between harmful and reasonable restraints of trade. Senator Sherman and others of his colleagues had had this distinction in mind in 1890; it was one which Theodore Roosevelt approved. To be sure, bigness itself restrained trade, but if it were achieved by fair means, by the practice of superior competitive efficiency, it could hardly be condemned as illegal. This was a viewpoint which logic required on the part of anyone who believed in competitive free enterprise. But logic was not enough. For President Wilson, as well as for increasing numbers of other Americans, it was difficult to believe as a matter of conviction that the path to bigness was typically marked by the pursuance of competitively fair business practices. During the opening decade of the 20th century the "muckrakers" had filled the pages of popular magazines with exposures of the malefactions of big business. Then the findings of the court in the Standard Oil and American Tobacco company cases had been made public. The truth seemed to be that competition was threatened by unfair business practices, and that it was these that led to monopoly, or near monopoly. The way to preserve competition, therefore, was to nip monopoly in the bud by outlawing unfair practices. A deep sense of public misgiving made antitrust policy a major issue in the presidential campaign of 1912. Under the leadership of the victorious President Wilson, congress in 1914 responded to this view of the matter by passing two new laws in an attempt to strengthen and clarify the Sherman act.

6. FTC and Clayton Acts.—Declaring that "unfair methods of competition in commerce" were illegal, the Federal Trade Commission (FTC) act set up a five-man commission to maintain a vigilant watch over the American economy (*see* FEDERAL TRADE COMMISSION). The act vested power in the commission to investigate the organization, business conduct and management of any corporation engaged in interstate or foreign commerce, except banks and common carriers. In addition, its other duties included that of assisting in the enforcement of the Clayton act. The Clayton act outlawed specific business practices when their "effect . . . may be to substantially lessen competition or tend to create a monopoly." In an effort to prohibit large firms from bankrupting small ones by selling below cost the act declared price discrimination illegal. It prohibited the use of tying contracts by which firms required their customers to purchase certain commodities as a prerequisite to being supplied the goods they desired. It forbade interlocking directorates among competing firms. Finally, it forbade firms to buy stock in other corporations where the effect might be a lessening of competition.

For all its specificity, the Clayton act added little to the government's power to enforce competition. In part, this was due to the fact that all laws must be applied to specific cases by the courts. Once the existence of listed illegal practices had been determined, the courts still had to decide whether their effect was to lessen competition. The definition of competition and of the relevant market in which to measure it is difficult, and congress provided no guidance in the matter. Perhaps the most notable development in recent years has been the increasing reliance of the courts upon the concepts and measurements provided by economists. In part, also, the language of the act was insufficiently precise. Firms forbidden to buy stock in competing corporations soon discovered they could accomplish the same purpose of restricting competition by purchasing their assets instead. Court interpretations of the act legalized this practice and it was not until 1950 that the Celler amendment plugged up the loophole. The Clayton act, therefore, did not provide an effective means of stopping monopolization at an incipient stage. It was a giant who was hauled before the courts, when any hauling was done, and until 1945 the courts took no notice of his size. In 1920 the supreme court resoundingly affirmed the rule of reason in the *U.S. Steel* case: "The law does not make mere size an offense," or the "existence of unexerted power an offense." In short, the position of the court by 1920 was that such loose-knit combinations as price agreements were illegal per se, but that a merger, regardless of its size in relation to the market, was permissible so long as its actions were reasonable.

7. Mergers in the 1920s.—Encouraged by judicial doctrine and by lax enforcement of the antitrust laws during the prosperous 1920s a second merger wave swept over the U.S. economy between the end of World War I and 1929. In the latter year

alone approximately 1,200 were consummated. Unlike the first great merger wave, in which combinations had attained very high percentages of the output of their industries—seldom less than 50%—merged firms during the 1920s generally secured much smaller percentages. The explanation is that mergers generally took place among firms which were smaller than the dominant one in the industry. The effect was a gradual lessening of the dominant firm's share of an industry's production. Steel, petroleum, agricultural implements and automobiles were among industries in which the structure of the market changed from near-monopoly to oligopoly (few sellers). Some industries which had enjoyed a notable degree of competition, such as dairy products and packaged foods, also emerged with oligopolistic markets. By 1932 the 200 largest nonfinancial corporations controlled nearly 50% of total corporate wealth, and received nearly 50% of total corporate income. Since corporations produced in 1929 more than 90% of all manufactured goods, the leading 200 dominated U.S. industry. Mining and transportation also made wide use of the corporate form, but it was rare in agriculture, service, finance and trade. Consequently, the 200 largest received only 22% of the total national income, a substantial proportion nevertheless.

8. Antitrust Enforcement.—After a period of virtual suspension of the Sherman act under the National Industrial Recovery act (1933–35), a vigorous program of antitrust enforcement was begun in 1937 by Thurman W. Arnold, head of the antitrust division of the department of justice. More prosecutions were begun between 1937 and 1948 than in the entire history of the Sherman act before 1937. Actions were brought mainly against established oligopolies, but although the government won most of the major cases, the courts as a rule imposed only mild penalties. The issuance of drastic dissolution orders would have made for firms of uneconomic size, and the courts were reluctant to take this step. The aftermath of a circuit court ruling in the *Alcoa* case of 1945 illustrates the modern problem of antitrust: how to ensure the largest number of sellers in industrial markets consistent with the economies of mass production. In this case Judge Learned Hand rejected both the rule of reason and the distinction between loose-knit and close-knit combinations. It did not matter that the recent history of Alcoa disclosed no evidence of predatory business practices. Evidence of intent to monopolize was to be sought not in predatory practices but in normal business activity which culminated in monopoly power. But although Alcoa made over 90% of the virgin aluminum manufactured in the United States the court refused to order either dissolution or divestiture of assets.

9. Conglomerate Mergers.—After World War II a third merger wave occurred. In the 1951–55 period the total number of mergers was substantially higher than for any other five-year period in the preceding quarter century. Many of these mergers were of a type known as "conglomerate," the acquisition by one enterprise of another engaged in a noncompetitive field, as a means of diversifying its interests. The diversification movement has probably been the outstanding corporate development of the 20th century. Beginning about 1904, it gathered momentum following World War I and became widespread after World War II. This development, together with the very important administrative changes to which it has given rise, is of such significance that it seems hardly too much to say that they are the main characteristics by which the contemporary corporation may be distinguished from its "modern" predecessor.

Because it turns out many products instead of only one, the typical large corporation has had to work out a more complex administrative structure to replace the simple one used by its recent predecessors. As Alfred D. Chandler, Jr., has shown, the older functional departments proved unable to handle problems arising from the engineering, production and marketing of entirely different goods. In consequence, as the corporation moved into new lines of products, a multifunctional unit called a division was set up for each major product line or large geographic area. Each division has a central office that administers a number of departments, responsible for the administration of a major function, such as manufacturing, sales, finance or research and development. Each of the departments, in turn, has a departmental headquarters that co-ordinates, appraises and makes plans for a number of field units. Field units are at the lowest administrative level of the corporation, each of them running a plant or works, a district sales office, a purchasing office, an accounting office or some other similar unit.

Over all of these administrative levels, at the top of the corporate pyramid, is the general office, where executives and staff specialists co-ordinate, appraise, plan goals and policies, and allocate resources (funds, equipment or personnel) to the various divisions. Each division tends to be quasi-autonomous and fairly self-contained. Because of this fact, and because it is the divisions that handle the various products the corporation turns out, the contemporary corporation is decentralized in its administrative structure. Nevertheless, the power of final decision-making rests with the executives in the general office. Their power derives from the fact that it is they who define the strategic, long-term goals of the enterprise and decide the purposes for which its resources are to be used. As Fritz Redlich and Alfred D. Chandler, Jr., have pointed out, these executives are the key men, the entrepreneurs of the enterprise. Those whose decisions must be made within the confines of the executives' over-all policies and allocations of resources are managers.

The men at the top who determine the goals of corporate enterprise are professional entrepreneurs, who have only a very small ownership interest in their enterprises. Ownership of voting stock is so widely scattered among tens of thousands of shareholders, however, that it is extremely difficult for a dissident minority to dislodge a management in power. The effort is not often made, partly for this reason and partly because the great majority of stockholders are indifferent to management decisions so long as dividends on their stock are paid regularly and without diminution. Forming a cohesive group, these top executives seek to perpetuate themselves indefinitely by moving into new and profitable product lines. Oligopolistic market power provides substantial insurance against loss from declining prices or uncontrolled production, and management's control of dividend policy provides ample funds for expansion into new areas, into which the corporation may move either via internal research and development or via the acquisition of other firms. While the latter process seems to have won favour in recent years it is improbable that the degree of concentration in industry has thereby increased. The number of mergers has increased but so too has the number of enterprises in a growing economy.

10. Pros and Cons of Antitrust Laws.—This fact helps explain why some observers do not regard the large size of the contemporary corporation as a major problem. They do not consider the antitrust laws to be of great importance, especially because congress from time to time has specifically exempted from their operation agricultural co-operatives, export trade associations, labour unions and other groups. The Robinson-Patman act (1936) put a greater emphasis upon preserving small-business competitors than upon preserving competition. Some point to the existence of a "new competition" in service, in new products and processes, and in advertising, and urge that it fosters consumer interests in ways which the old price competition failed to do. Some argue that the old competition among sellers on the same side of the market has given way to a "countervailing power" from the other side of the market, with mass buyers and large trade-unions arising to share the gains of oligopolistic sellers. Others point to the existence of interindustry competition, arguing, for example, that competition from television, sporting events and other forms of entertainment would make it impossible for a monopoly in the motion-picture industry to exploit the public. Still others, finally, point to the emergence of a sense of social responsibility on the part of corporate managers, and depict their contemporary role in terms of efforts to effect a just balance between the claims on corporate earnings of workers, investors, consumers, suppliers, the local community and the nation.

On the other side of the question are those who value the an-

titrust laws. Many view them as a "big stick," the occasional exercise of which will deter excessive concentration. Few are sure where to draw the line between big and bigger, but most believe that one must be drawn somewhere, and that the government must draw it. For one thing, they fear the great economic power of the giant corporation. Excessive concentration inhibits efficient allocation of resources and impedes economic growth. The separation of ownership from control they acknowledge to be as old as the use of the corporate form in business, but such is the contemporary prestige of large size that they fear professional entrepreneurs may use their control of dividend policy to keep earnings in the business for the purpose of financing unwise expansion. Decisions to move a huge plant to another area for the sake of tax or other cost advantages may result in the deterioration of older communities. They fear, too, that the edge of entrepreneurship will be dulled in the soft routine of bureaucratic processes. Obviously, some of these apprehensions also have social and political overtones. Some men are concerned over the power of great corporations to mold the tastes and shape the values of Americans. Perhaps their most fundamental concern is the extent to which American democracy, which evolved in a society made up of comparatively small and competing enterprises, is threatened by higness and by agreement. In some, no doubt, there is nostalgia for an older and simpler age, a nostalgia which is reminiscent of the Jacksonian mood when industries and cities first began to grow rapidly. Many now as many then find themselves pulled in two directions. On the one hand they applaud the high standards of living which big business has done much to bring about. On the other, they feel some or all of the anxieties mentioned. The ambivalence of the American people themselves in regard to antitrust legislation goes far to explain the ambivalence of their government. (S. By.)

II. CORPORATION LAW

The major innovations in corporation statutes since the start of the 20th century have been: (1) the authorization of shares without par value; (2) the adoption of more detailed and specific provisions with regard to the funds legally available for distributions to shareholders either by way of dividends or of purchase by a corporation of its own shares; (3) the broadening of directors' powers, particularly in connection with the issue of shares; (4) the imposition of restrictions on shareholders' suits in a number of important jurisdictions; (5) the inclusion in the statutes of broader provisions for the amendment of certificates of incorporation by majority vote of the shareholders; (6) some further catering to the desires of promoters of combinations of corporations by permitting corporations to merge even if they have widely different powers or are organized under the laws of different states; and (7), largely since 1950, the validating of provisions inserted in articles of incorporation and bylaws for restricting share transfers and requiring unanimous, or more than the normal statutory percentage of, shareholder or director votes for a quorum or for action at meetings of close corporations or "incorporated partnerships."

More important in their aggregate effect than these changes in the statutes under which corporations are organized was the invasion of the field of corporation law by other statutes, both state and federal, which regulate a variety of matters including public offerings of corporate securities, solicitation of proxies in large corporations, accounting methods, security issues and consolidations of railroads and public utilities, and which establish a national statutory system for the reorganization of insolvent corporations. There were also important developments in that part of business-corporation law which is not of legislative origin but has been evolved by the courts. Such judge-made business-corporation law, which was in a rather embryonic state in 1850, had attained a considerable degree of maturity by 1900, but it was modified and amplified in many important respects during the succeeding 60 years.

A further legislative development of indirect bearing on the law of corporations has been the enactment of statutes permitting partners to sue and be sued and to hold title to property in the partnership name, to make agreements for the disposal of partnership interests on the death of any partner so as to preserve the continuity of the business in the survivors, and even to elect under certain circumstances to be taxed as a corporation for federal income-tax purposes. These statutes have tended to reduce most differences, except the difference of limited liability of shareholders and unlimited liability of partners, between the two forms of association and to make such differences depend more upon the particular provisions of the articles or bylaws of the corporation or the partnership agreement of the partnership.

1. Organization of Stock Corporations.—Most business corporations in the United States are organized under a general corporation act of some state which provides that the interests of the members shall be represented by transferable shares of stock. Such statutes usually authorize a group of three or more persons to form such a corporation by signing and filing in one or more public offices a document, officially called by some such name as "certificate of incorporation" or "articles of incorporation," but commonly referred to as the corporation's charter." The Delaware act, typical of many of these statutes, specifies that the certificate of incorporation state the corporate name, the place in the state of Delaware at which the corporation is to have an agent on whom legal process may be served, the nature of business to be carried on, the number of shares which are authorized, the amount of capital (not less than $1,000) with which the corporation will begin business, the names and residences of the incorporators, and the limit, if any, on the duration of the corporation (which is now almost invariably organized for a "perpetual" duration). The liability, if any, of shareholders for corporate debts may be set forth, but it is rarely, if ever, provided for. If there are to be several classes of shares, with different dividend or other rights, these rights must be stated in the certificate of incorporation unless that document authorizes the directors to determine them from time to time as the shares are issued. A large measure of freedom of contract is provided by authorizing the insertion of additional provisions relating to such matters as the powers of the directors and shareholders and the extent to which shareholders shall have pre-emptive rights to subscribe to new issues of shares. In some states, such pre-emptive rights exist at common law unless expressly limited or denied in the certificate.

It not infrequently happens that, through carelessness or otherwise, business is transacted in a corporate name without complete compliance with the statutory conditions precedent to incorporation. Although the statutes of several states contain some provisions relating to this situation, such statutes rarely indicate whether the shareholders of such "corporations" incur full individual liability for the debts of the enterprise. Generally speaking, the courts have relieved them from such liability where the failure to comply with the statute has been unintentional and not of a flagrant character.

It is implicit in the statutes that no one can effectively act for a corporation before it has been legally organized. But these same statutes make it possible for any person who can pay a small organization tax to form a corporation by getting two other persons besides himself to sign the incorporation papers. It often happens that such a person, knowing that he can at any time create a corporation and provide it with a board of directors who will do as he wishes, makes promises about what the corporation will do when it has been formed or obtains from other persons what purport to be subscriptions for the proposed corporation's shares. Confronted with situations of this sort, the courts have evolved a theory by which, if the corporation accepts the benefits of the promoter's agreement with knowledge of its terms, it will be held to have "adopted" that agreement as a corporate contract. Conflicting answers have been given in different states to the question whether a preincorporation subscription can be effectively revoked by the subscriber before the corporation has been formed and is in a position to accept it.

2. Powers of the Corporation; Shareholders; Directors and Officers.—The legal powers of a corporation are those given it, expressly or by implication, either by the corporation law or by

its charter, which, in order to be valid, must be drafted in conformity with the corporation law. In exercising these powers the business corporation functions, to use political terminology, like a representative government rather than a pure democracy. The shareholders elect a board of directors, on which the statutes of virtually all states confer the power to "manage" the business. Under the Delaware statute, typical of many, the only powers expressly given to the shareholders are powers to elect directors, to enact bylaws (although the certificate of incorporation may confer that power on the directors) and to approve or disapprove directors' resolutions proposing charter amendments, reduction of capital, merger, consolidation, sale or lease of all the corporate property, or dissolution. Additional powers may be conferred on the shareholders by the certificate of incorporation, and the shareholders have implied power to ratify certain voidable acts of the board. They usually also have implied power to appoint an auditor and power to remove a director if, but only if, he has been guilty of misconduct.

In corporations whose boards of directors are composed of a large number of persons it is usual to delegate broad powers to executive or other committees, and many statutes expressly authorize such delegation. On the other hand, although it is impractical to carry on business effectively without delegating broad powers to individual officers, the statutes are usually silent as to the extent to which this may be done. Most statutes merely provide that corporations shall have at least three officers, a president, treasurer and secretary, without stating the functions of such officers except so far as these may be implied by the titles of their offices.

Unfortunately, the word president is ambiguous. When it is used to describe an officer of a business corporation, the word might mean a mere presiding officer or might mean the chief executive, as it does in the case of the president of the United States. Although some courts do not agree, there has been a tendency in the 20th century to hold that a person who deals with the president of a business corporation is entitled, in the absence of contrary information, to assume that the president is the chief executive and has rather broad power to bind the corporation by contracts and other business transactions entered into on its behalf. Furthermore, there is no doubt that broad powers may in all states be conferred on the president or any other officer, either expressly, by bylaw or directors' resolution, or implied, by tacit acquiescence by the board in the officer's exercise of such powers. That authority may thus be created by acquiescence is well settled, although it seems somewhat difficult to reconcile that result with another well-established principle, that directors cannot usually act except by formal resolution at a board meeting.

Even with regard to directors' acts, however, there has been a recent trend in the decisions to validate informal action not taken at formally convoked meetings, especially where all directors know of the action, the shareholders have acquiesced in such informality by directors, and no minority interests are adversely affected. This trend is an indication of the gradual cleavage between two branches of the law which were at one time substantially identical—the law of public corporations, such as cities, and the law of incorporated business enterprises. Generally speaking, the acts of a city official are not binding on the city unless his authority has been conferred upon him with proper formality and unless, in exercising that authority, he observes all the formalities provided for by law. In the 18th and early 19th centuries most courts were no less insistent on the necessity of strict observance of the rules if acts done in the name of a business corporation were to be treated as legally binding. But U.S. businessmen are notoriously impatient of formalities, which they tend to regard as unnecessary "red tape," and the courts have become increasingly reluctant to permit business corporations to repudiate obligations incurred in their name because of informalities in the authorization or execution of the instrument in which the obligation is embodied.

Judicial tolerance for irregularities does not extend, to the same extent, to action which is *ultra vires* in the sense that it is either inconsistent with some provision in the certificate of incorporation or is not reasonably related to the purpose of the corporation as stated therein. Even in this area, the doctrine of most of the older cases that an *ultra vires* contract cannot under any circumstances be treated as a corporate act has been rejected by the courts of many states, which will not allow a corporation to repudiate such a contract if the corporation has received substantial benefits as a result of its performance by the other contracting party or if there has been part performance of the contract by either party. This modification of the more rigorous doctrine fails to prevent a corporation from engaging in a business not authorized by its certificate of incorporation, making contracts for future delivery or purchase of goods in connection with that business and then repudiating those contracts if the price level changes, leaving the other contracting party, who was probably justifiably ignorant of the provisions of the certificate, entirely without remedy. Consequently, the statutes of many states have now been changed to abolish the defense of *ultra vires* altogether in actions between the corporation and outsiders.

3. Voting Rights and Voting Control.—Although the shareholders have little or nothing to do with the day-to-day management of the business, they are the ultimate source of authority. Most statutes require an annual meeting of shareholders to be held, at a time usually provided for by the bylaws, and special meetings may be held on such call and notice as the bylaws prescribe. The shareholders, or those of them who have voting shares, elect the directors, and the consent of the holders of at least a majority of shares is necessary in order to liquidate a solvent corporation, merge it with another enterprise or amend its certificate of incorporation. Although the statutes make it impossible to divest the entire body of shareholders of voting power with respect to these matters, most state statutes do permit the creation of classes of shares which can be largely—in some states entirely—stripped of all voting rights by the insertion in the certificate of incorporation of provisions to that effect. In this area, however, the freedom of contract permitted by state corporation laws is greatly curtailed for some important types of corporations by a series of federal statutes. Some of these statutes forbid investment corporations and corporations which are being reorganized pursuant to the federal Bankruptcy act to issue any nonvoting shares. Others give supervision over the issue of shares by certain types of corporations to federal commissions, which are unlikely to approve the issue of nonvoting shares.

In corporations which have only one class of shares, voting power is ordinarily proportional to share ownership, each shareholder being entitled to cast one vote for each share held, but statutes or corporate charters frequently provide methods by which minority groups may obtain some representation on the board of directors. The most usual method is that of cumulative voting, by which, if there are five directors to be elected, a holder of a voting share may, if he chooses, cumulate his votes by casting five votes for one director instead of one vote each for five.

Directors cannot vote unless they attend meetings in person, but shareholders can vote either in person or by proxy. Most proxies are in fact given to persons connected with the management, but the shareholder may give his proxy to any one he chooses, subject to the practical limitation that the proxy will be ineffective unless the proxy holder attends the meeting. In the first 15-year period after World War II, a number of highly publicized proxy contests were waged between management and insurgent groups of large, publicly held corporations, and in some contests, notably the contest for control of the New York Central Railroad company, the slate of management directors was defeated and the insurgent group took control of the company.

It has been a not uncommon practice for the management to solicit proxies from shareholders without giving the latter adequate information about facts which they may need to know in order to determine whether the resolutions for which it is proposed to vote the proxies are compatible with the shareholders' interests. Here again federal law has intervened, in this case by providing that anyone who solicits proxies relating to the shares

of any corporation whose shares are listed on a stock exchange, of any electric or gas utility holding company or its subsidiary, or of any investment company must conform to regulations made by the Securities and Exchange commission—regulations which provide for a full measure of disclosure.

Since the directors of most corporations are elected for a term of one year and shares of voting stock are ordinarily transferable to new owners without restriction, there is sometimes serious risk that the membership of the board of directors may be changed so frequently as to make continuity of policy impossible. In order to secure greater continuity of management, or for the less defensible purpose of enabling persons with little or no financial stake in the enterprise to obtain long-term control over it, all or a majority of the voting shares of a corporation are sometimes turned over to voting trustees, who issue voting trust certificates in exchange for them. The effect of a voting trust is to give the voting trustees the sole power to vote the shares of which they become the legal but not the beneficial owners, while the holders of the voting trust certificates continue to be entitled to any dividends declared on the shares of which they remain the equitable owners. Statutes frequently restrict the maximum length of such trusts, usually to a period of ten years.

A possible alternative to the voting trust is a voting contract, by which the original owners retain their shares but agree to vote them in a particular way. Such contracts are regarded as valid by most courts if they amount merely to agreements to combine rather than to agreements to sell one's vote for cash or some similar consideration and if they are limited to voting at shareholders' meetings rather than at directors' meetings.

There are means other than the voting contract or the voting trust whereby the holders of less than 51% of the voting shares may secure control of, or what is called a controlling interest in, a corporation. (1) A considerable minority of the voting stockholders, such as the insider management group, may be closely organized and in agreement to vote together on certain questions, or at an election. The remainder may be unorganized and their votes divided in several ways, some of them even voting inadvertently with the organized minority. (2) A minority of all the stock may constitute a majority of the stock actually voting, as it is very unusual to have more than 75% of the stock represented at a meeting. (3) A minority group may be regularly successful in securing from other shareholders proxies to vote an aggregate of more than 51% of the shares. (4) Sometimes stock votes by classes and a minority class may be given the privilege of choosing a majority of the board of directors. In such a case, the majority of the preferred stock might elect a majority of the directors and thus control. (5) Stock with a strict vetoing power exerts a strong negative control over various affairs. A certain class of stock may be classified as nonvoting for ordinary purposes, and yet the certificate of incorporation may provide that certain things may not be done without the consent of the majority of this class. In such a case, the holders of the majority of this stock can block action. (6) Where statutes do not prohibit it, certificates of incorporation sometimes provide that more than a majority of the total vote shall be required to perform certain acts, such as the election of directors. In such cases a minority once in power can remain so by blocking elections and other actions requiring the larger vote.

4. Fiduciary Obligations of Directors and Officers.—It is the duty of directors and officers to exercise their powers for what they believe to be the best interests of the corporation. This does not mean that a director or officer can never put himself in a position in which his economic interests are to any extent adverse to those of the corporation—contracts by which a director agrees to buy from or sell to his corporation are sometimes desirable or even necessary for the corporation's economic welfare. It does mean that transactions between a director and his corporation will be set aside if the corporation so desires, unless the director is found to have acted with scrupulous fairness. Most courts have held that, unless the certificate of incorporation provides otherwise, a director's contract with his corporation must have the approval of a majority of the board at a meeting at which the interested director is not counted either as part of a quorum or as part of a voting majority. There is a tendency to relax this latter rule—but not the requirement of fairness—in the case of a contract which is not between a director and his corporation but between two corporations having interlocking directors.

It is impossible to give a precise definition of what the courts mean by fairness in this connection. It normally includes a duty of full disclosure, not only of the director's adverse interests but of facts known to him which affect the desirability of the proposed agreement. Where, as is not infrequently the case, two contracting corporations are represented in the transaction by identical or nearly identical boards of directors, disclosure is meaningless and fairness must be determined by other criteria. Some courts have said that in such a case the question is whether the proposition submitted would have commended itself to an independent board, a test which is adequate in theory but difficult to apply if the subject matter of the contract is something which has no determinable market value.

One of the most difficult types of interested-director situations to deal with satisfactorily by judicial decision is that in which directors who are also officers of the corporation fix the compensation of the officers. Many corporations adopt the policy of electing boards composed wholly or chiefly of persons who hold executive positions. In such a situation the majority of the board have direct personal interests in the executive salary scale. Either the function of determining such salaries must be transferred from the directors as managers to the shareholders' meeting—a body not ordinarily well qualified to decide matters of that kind—or the courts must make an exception to the rule that directors' action is not binding unless there is a disinterested majority and must sustain the salaries voted by the board if it finds them to be fair. A number of states have enacted statutes permitting interested directors to fix their own compensation as officers if the amount of the compensation is fair and reasonable.

Another area of uncertainty in the law involves the permissible degree of conflict between the corporation and its officer, whether or not a director, who has an interest in a seller to or purchaser from the corporation, or in some other way stands to make a direct or indirect personal gain from a corporate transaction. The trend of the law to validate such transactions if deemed "fair" would indicate that a profit by the officer would not be struck down if the corporation received the same profit or advantage, and paid the same charges and costs, that it would have in the absence of such a conflict. The question remains, however, whether disclosure of such a conflict to the board of directors should not be required, and if the officer is a director, and especially if an important or dominating director, a disclosure by the board to the shareholders; and if so, whether a vote ratifying the propriety of such a conflict under the circumstances disclosed should not also be required.

The directors' fiduciary duty of loyalty to the interests of their corporation is not limited to cases in which directors are dealing with the corporation or are acting for two corporations that are dealing with each other. It is applicable to many other situations, including that in which the director intercepts a corporate "opportunity" by acquiring property for himself instead of for the corporation. The law does not forbid a director ever to purchase for himself anything which the corporation might wish to have bought. It does compel him to turn over to the corporation at cost property which, but for his interference, the corporation would probably have been able to obtain for itself and also property which he acquired while director, knowing that it was vitally needed by the company and not essential to his own outside interests. Some of the older cases tended to restrict the term corporate opportunity to these two situations, but the later trend of the cases has been to take a broader view of the director's obligation, treating as significant though not necessarily as conclusive such factors as whether the corporation was already in the market for the property, whether the information that the property was available came to the director by reason of his official position, whether its acquisition would put him in a position adverse to the

corporation, whether the corporation was financially able to buy, and whether the corporation would have had a normal business interest in purchasing or taking advantage of the property or opportunity in question.

In addition to their duty not to allow the decisions which they make as managers to be warped by self-interest, directors owe the further duty of reasonable care and prudence. The courts differ a good deal in the language which they use in describing the degree of care which directors are legally bound to exercise, but the language used to describe the duty is less significant than the results actually reached.

Imprudent management by directors is of various kinds. It may result from failure to attend meetings, from failure to keep well enough informed about corporate affairs to act intelligently at meetings, from failure to supervise or to provide for adequate supervision of subordinates, or from reckless or incompetent business judgment. Directors who are not also executive officers are rarely highly paid. Individual directors are frequently elected members of the board for reasons other than their business skill. Courts tend to treat them more leniently than full-time salaried officers with respect to their duty of care. Nevertheless, failure to attend meetings with some degree of regularity and failure to make any substantial effort to keep informed about corporate matters will be condemned as negligence, although a director whose negligence is judicially criticized will sometimes escape liability because of the difficulty of proving that his negligence was a substantial cause of the loss for which it is sought to hold him liable. Failure by the directors to provide for the supervision of subordinates has resulted in legal liability in a number of cases relating to banks whose assets have been looted by dishonest employees, and, much less frequently, in cases relating to other kinds of business. Legal liability for errors of business judgment has generally been denied, although here again there is a tendency to treat bank directors somewhat differently and to insist that the directors of such institutions, which purport to be places of safekeeping for depositors' funds, will be liable if they embark the bank upon disastrous ventures of a highly speculative character. The legislatures have, with few exceptions, left questions relating to directors' duties of loyalty and care to the courts.

On the other hand, there have been very important statutory additions to the law governing the conduct of a director who is not acting for the corporation but is purchasing some of its shares from a shareholder. Most of the earlier judicial decisions in this field permitted a director to buy without disclosing any inside information which he might have. The reason given for this lenient rule was that, although the director was a fiduciary for the corporation, he was not a fiduciary for its individual members. The practical effect of the rule was to enable a director, in dealing with individual shareholders, to take advantage of information which he had obtained by reason of the position to which he had been elected by the shareholders, acting as a body. Many courts have repudiated this view and have either required full disclosure in all cases or insisted on it in cases where the situation is such as to make purchases without such disclosure peculiarly inequitable.

The broadest of the three rules—that requiring full disclosure under all circumstances—is required by sec. 10 of the Securities Exchange act of 1934 and the rules which the Securities and Exchange commission has promulgated pursuant to that section for cases in which the director brings himself within the regulatory powers of congress by using the mails or some other instrumentality of interstate commerce. Although the language of both statute and rule is rather vague, it imposes a requirement of full disclosure on directors, officers and other "insiders" who purchase shares or any other kind of corporate securities, regardless of whether the purchase is made on their own behalf or on behalf of the corporation. Other federal statutes provide that, if the securities are shares of stock listed on a stock exchange or shares of a corporation to which either the Public Utility Holding Company act of 1935 or the Investment Company act of 1940 is applicable, a director, officer or large shareholder who purchases and resells (or who sells and repurchases) the shares within a six-month period is liable to the corporation for any profits derived from the transaction. This latter provision, which gives no remedy to the seller of the shares, is designed to discourage the practice of short-term market trading by corporate officials.

5. Legal Obligations of Promoters and Controlling Shareholders.—It is possible to promote a corporation and to dominate its original board of directors without becoming, in any formal sense, its official representative. A promoter who organizes a corporation in this manner is in a position to make highly inequitable contracts with the corporation and to obtain large profits from it which will seriously lessen the value of the securities it issues to other people. The courts have attempted to cure this evil by obliging the promoter either to permit rescission of the transaction or to surrender his secret profit. Promoters have frequently found means of evading these obligations successfully, and judicial remedies for the recovery of promoters' secret profits have in practice proved much less effective than the requirement of full disclosure at the outset made by the Federal Securities act of 1933, a statute applicable to most situations in which corporate securities are offered to the public.

A majority shareholder, or a group of shareholders who act in concert and together constitute a majority, can, like a promoter, make use of the power of control over the corporation to make contracts with it which deplete its assets and cause loss to its other shareholders. A compact minority group will often be able to achieve similar results if the majority have no effective means of uniting. Since shareholders have not, like directors, undertaken to act for the corporation's benefit, they are not subject to all the legal disabilities which are applicable to directors. For example, like voters in a political election, they are not disqualified from voting because of any adverse economic interest which they may have. Nevertheless, they will not be permitted to use their voting power to achieve results which are clearly designed to harm the corporation, and it is immaterial whether they attempt to achieve such results through control over the directors or by exercising their power as shareholders to vote on such questions as the dissolution of the corporation. Furthermore, some recent cases have thrown doubt on whether a shareholder bloc constituting effective control of the corporation may sell the controlling shares at a price paid in part by the purchaser to secure a corporate advantage arising out of control, unless the seller accounts to other shareholders for that part of the selling price which constituted a premium paid by the buyer to secure the corporate advantage or other concomitant of control.

6. Shareholders' Suits.—Officers, directors and controlling shareholders would, as a practical matter, often be able to violate their duties to the corporation with impunity if it were not for the invention by courts of equity of what is called the shareholders' derivative suit. The power to bring suit on a corporate cause of action is ordinarily vested in the directors, who will not exercise that power if they are themselves the wrongdoers. If the majority shareholders are not themselves participants in the wrong, they can, in theory and sometimes in practice, elect a new board of directors composed of persons who can be relied upon to bring suit if the corporation's interests require it. But if the shares of those who have not participated in the wrongful action are owned in small lots by a large number of people, replacement of the wrongdoing directors will be difficult to achieve. Unlike the situation which usually prevails in politics, there is rarely in the business corporation any organized party of the "outs" competing at each election with the party of the "ins," and to create one for a particular purpose is often impracticable.

To meet this situation, the courts developed the shareholders' derivative suit, by means of which one or more shareholders are permitted to sue on a corporate cause of action for the corporation's benefit, if the board of directors unreasonably refuses to sue, or if, because the directors are the alleged wrongdoers, they are not proper persons to have charge of the litigation as representatives of the company. Such suits have often served a very salutary purpose. They have also led to serious abuses. An ill-founded shareholders' suit against directors may cause the corporation serious loss, because the litigation may interfere with

the conduct of the business and because the corporation will in many states be obliged to reimburse for their legal expenses directors who have successfully defended themselves. Moreover, there is danger that the shareholder's real purpose may not be victory for the corporation but his own individual gain. If the shareholder wins the suit, it is the corporate treasury, not the shareholder's pocketbook, which is directly enriched, and the shareholder will not even participate substantially in the fruits of victory indirectly, through enhancement in the value of his shares, unless those fruits are very large or the shareholder owns a substantial percentage of the corporation's shares. On the other hand, if the wrongdoers can, by settling with the litigating shareholder, avoid any serious risk of being sued later on by anyone else, it may be worth their while to make a direct payment to the shareholder of a much larger amount in settlement of the suit than the amount by which the value of his shares would be enhanced if he won it for the corporation whose champion he purports to be.

Two very different kinds of remedies for these evils have been attempted. One kind, of which the federal courts have been the chief exponents, seeks to make it difficult for the shareholder to make the derivative suit a source of personal gain by providing that, once suit has been brought, it cannot be dismissed or compromised without court approval, on such notice to all the other shareholders as the court may direct, and also by treating anything which the shareholder is paid for abandoning the suit as in law the property of the corporation.

This line of attack on so-called "strike" suits has not been wholly successful, and several states have followed the lead of New York in adopting statutes which impose restrictions of a very different type. Many statutes do away with the possibility of purchasing shares for the purpose of bringing suit by limiting the right to sue to those who owned shares at the time of the acts complained of. In addition, on the theory that small shareholders, who have little to gain from a corporate victory, are particularly likely to bring suit for purposes other than achieving such victory, shareholders whose holdings are relatively small are required in a few states to give security for and ultimately to pay the reasonable legal expenses of the corporation and any of its directors, officers or employees who are defendants in the suit and succeed in establishing their freedom from legal liability. It is legally possible for a group composed wholly of small shareholders to avoid the effect of this provision if a sufficient number of them join together as coplaintiffs, but such united action in large corporations has proved practicably difficult, with the result that the number of derivative actions brought in states having such statutes has been very sharply reduced. A California security-for-costs statute avoids the necessity for such united action by making the requirement for security depend not on the size of the shareholder's holdings but on whether the court finds that there is no reasonable probability that the suit will benefit the corporation.

A shareholder who seeks to bring suit on behalf of the corporation would be greatly handicapped if he were unable to obtain reliable information about corporate affairs. The courts have come to his assistance by holding that he has the right to inspect the books and papers of the corporation for any purpose reasonably related to his interests as a shareholder, including the purpose of determining whether his suspicions that there is an adequate basis for a shareholder's suit are well-founded. This right usually includes the right to inspect and copy the list of shareholders' names and addresses preparatory to circularizing them in a proxy contest.

Generally speaking, a shareholder has no legal right to obtain information except in this manner. It may seem surprising that there are only a few states in which it is the legal duty of management to send the shareholders an annual financial report, but it should be borne in mind that corporation laws are intended not merely for corporations whose shares are widely distributed but for those which have only a handful of shareholders.

Most large corporations are required by federal statutes to make periodic public reports of their assets and earnings and, in certain cases in which proxies are being solicited by the management, to furnish financial reports to their shareholders.

7. Types of Corporate Securities.—The principal types of corporate securities are common shares, preferred shares, bonds and debentures. Preferred shares and bonds may be convertible into other types of securities, and the corporation may also have warrants outstanding. Warrants are transferable options, of unlimited or limited duration, to purchase shares of the corporation at a specified price, and they are usually issued initially attached to bonds or preferred shares as an added inducement to buy. All corporations have common shares; they may or may not have securities of one or more of the other types. As a general rule, all types of securities are transferable, bonds and debentures by mere delivery, preferred and common shares by delivery of the share certificate accompanied by a transfer power, which is generally embodied in a separate instrument. Preferred shares have priority over common shares with respect to dividends at a limited rate and, under some types of preferred-share contracts, participate with the common shares in such additional dividends as may be declared. They are usually preferred and limited also in their rights in corporate assets in case of dissolution.

Bonds and debentures, which are long-term debts, are rarely dealt with to any great extent in corporation statutes, the rights of the holders of such securities being determined for the most part by the law of contracts and, in the case of bonds secured by an indenture of trust, by the law of security and the law of trusteeship. The word debenture, which is not a technical legal term, is generally used in financial circles to mean an unsecured bond. Bonds and debentures that are publicly offered for sale must, with certain exceptions, conform to the requirements of the federal Trust Indenture act of 1939, which contains some provisions of rather limited scope for the protection of the holders of these types of securities. (*See* also STOCK; INVESTMENT PAPERS; BOND [IN FINANCE].)

8. New Issues of Shares.—In the absence of any provision to the contrary in the certificate of incorporation, each shareholder has under the law of most states the right to subscribe for his proportionate part of any new issue of shares of his corporation in order that he may preserve his proportionate interest in the assets and earnings of the corporation and his proportionate voting power.

This pre-emptive right is subject to various exceptions. It does not, for example, apply to shares which are issued for property or to so-called "treasury" shares (shares previously issued and subsequently reacquired by the corporation). In cases in which no pre-emptive right exists, the directors ordinarily have power to select the persons to whom shares shall be issued, but that power is subject to their duty as fiduciaries not to issue shares at less than their fair value (unless they are issued to all shareholders in proportion to their previous holdings) and not to issue them for the purpose of giving some particular group voting control over the corporation.

The public sale of new issues of securities which are fraudulent or are offered without sufficient disclosure of essential facts about the enterprise has engaged the attention of state legislatures. A large majority of the states enacted so-called blue-sky laws, which require that the persons who sell the securities and, subject to certain exceptions, the securities themselves, be licensed by some state administrative agency.

The statutes of a few states, including New York, instead of requiring licences for the public sale of securities, authorize the attorney general to investigate fraudulent practices in connection with such sales and to institute injunction proceedings.

The Federal Securities act of 1933 differs radically from most of the state laws in that its sole purpose is to compel full disclosure. It provides that, with limited exceptions, no corporate security can legally be offered to the public by mail or by means of any instrumentality of interstate commerce unless the issuer has filed with the Securities and Exchange commission and made public a registration statement containing full information about the security and the issuing corporation. The commission is given power to institute proceedings to prevent sale of the securities if no such statement has been filed or if it finds that the statement is in any material respect false, misleading or incomplete. Most of

the information included in the registration statement must be included also in a prospectus, which must be given to each original purchaser at or before the time of delivery of the security.

In the case of railroads and other public utilities a different kind of administrative regulation of security issues, designed as much to safeguard the general public against unsound financing of essential utilities as to protect buyers of securities, is provided for by various federal and state statutes. (*See* SECURITIES REGULATION.)

9. Shareholders' Individual Liability.—Shareholders whose shares are paid for in full are, generally speaking, immune from any other substantial liability for corporate debts, although some corporation laws make them personally liable for wage claims in case of corporate insolvency. The special liabilities imposed on shareholders of national and state banks had been abolished almost everywhere by mid-20th century.

If a corporation's shares are what is known as par-value shares, full payment for shares means, as between the shareholder and corporate creditors, payment of the par value in money, property or services. The statutes of many states provide or are construed as providing that the judgment of the directors as to the value of any consideration other than money is conclusive in the absence of fraud. When there are no par-value shares issued for cash, the shareholder assumes no liability, either to the corporation or its creditors, except to pay the agreed consideration. When such shares are issued for property, it is necessary to put a dollar valuation of the property on the corporation's books. The law at mid-20th century was still unsettled as to circumstances under which a shareholder would be treated as a participant in such valuation and held liable to creditors if the valuation was not based on an honest business judgment. But since most shareholders know the dollar valuation (or "stated value") fixed by the corporation for its no par shares when it issues them, a shareholder or seller who conveyed property known by him to have been taken and put on the books at a valuation higher than the stated value of the no par shares issued to him for the property may well be liable for the difference.

A shareholder who is in control of a corporation is sometimes subject to more drastic liabilities. Immunity from individual liability is not forfeited by acquiring a majority or even all of a corporation's shares, but a sole shareholder, and, less frequently, a controlling shareholder, has been held liable for corporate debts or damages where he or it (for liability has most often been imposed where the controlling shareholder is a "parent" corporation) fails to keep the corporation's business transactions clearly separate from his own and where he gives those with whom he deals the impression that the corporation's debts are his own obligations. Furthermore, a person who does business mainly at the risk of his creditors by forming a corporation with very little capital and then expanding the scope of its operations by furnishing additional funds, ostensibly in the form of loans, is likely to have his claim subordinated by the courts to those of the other creditors if the corporation becomes insolvent. Although a corporation is treated for most purposes as a legal person which is separate and distinct from its members, the courts will not, generally speaking, permit a person or group of persons to evade a statute or a contract by causing their corporation to do what the statute or contract forbids them to do in their individual capacities.

10. Dividends and Other Distributions.—Distributions of corporate assets by corporations are mostly in the form of dividends. Most corporation statutes restrict the funds available for dividends to surplus or to some types of surplus. In the case of par-value shares, surplus ordinarily means any excess of net assets over the aggregate par value of all outstanding shares. In the case of no par-value shares, it ordinarily means any excess of such assets over that part of the consideration paid for the shares which has been designated as capital by the board of directors.

Some statutes forbid the payment of dividends out of surplus derived from an increase in the value of such fixed assets as buildings and machinery, and some greatly restrict the use for dividend purposes of surplus contributed by shareholders as part of the purchase price of their shares and which has been designated on the corporate books not as capital but as some form of unearned surplus, such as "paid-in surplus."

The statutes of a few states expressly authorize corporations to pay dividends out of current earnings without applying those earnings to eliminate a deficit from operations of prior periods, and those of several other states are so worded as to make a similar interpretation of them not unlikely. Such current earnings can be made available for dividends in other states in one way only—by having the shareholders vote to reduce the amount of legal capital to an extent sufficient to eliminate any deficit from prior operations and thus turn the current earnings into surplus.

Purchases by corporations of their own shares constitute another method by which corporations may distribute part of their assets to a shareholder or shareholders. If payment for the shares is made out of capital and the shares are not resold, the effect on the corporation's financial status is the same as though it had paid dividends out of capital. In most states the law applicable to such purchases is substantially identical with the law of dividends, but a few states still have very lax rules relating to such purchases.

The practical application of legal rules relating to the funds legally available for dividends or for purchases of shares often raises difficult questions of the proper accounting methods for determining such matters as surplus, earned surplus or current earnings. In most states, directors are immune from liability for declaring improper dividends if they have acted with due care, and shareholders who have received dividends or other distributions in good faith are not required to refund them if the corporation, despite the impairment of its capital, was solvent at the time of distribution.

11. Amendment of Corporate Charters.—A corporate charter is, for purposes of federal constitutional law, both a contract between the corporation and the state and a contract between the corporation and its shareholders.

Most states have, by a provision in the state constitution or by legislation, reserved power to amend corporate charters. Although there is considerable conflict in the decisions as to the scope of such reserved power, many courts have held statutes which give wide powers of amendment to majority shareholders constitutional, even as applied to corporations created prior to their enactment.

The amending powers granted majority shareholders in most states include not only power to change the nature of the business but power to change the dividend, voting, or other special rights of a particular class of shares. Changes of the latter sort usually require the affirmative vote of at least a majority of the class of shares affected. Where a majority has voted for the change, some courts treat the question as one of business judgment and refuse to interfere, at the request of the minority, unless the unfairness of the amendment is so gross as to justify the inference of fraud. This view allows pressures to be brought to bear on preferred shareholders to induce them to consent to an inequitable modification of their rights.

12. Merger and Consolidation.—Another method by which shareholders' rights may be radically changed is by the merger or consolidation (the distinction between the two, in many contexts, is of little importance) of two or more corporations. If each corporation has only one class of shares, the effect of the merger is to modify the individual shareholders' rights only to the extent of making him an investor in a substantially different enterprise. But if one or more of the corporations has several classes of shares, the merger agreement may validly provide for such changes in class rights as the substitution of common shares of the combined enterprise for preferred shares of one or more of its constituent companies. Some courts have permitted a corporation, by creating a subsidiary company and then merging with it, to make changes in preferred shareholders' rights which could not be made by direct amendment of its certificate of incorporation. Under most merger statutes, however, dissenting shareholders are given the right to withdraw from the enterprise and to be paid the appraisal value of their shares in cash.

13. Dissolution, Bankruptcy and Reorganization.—A solvent corporation may be dissolved and its business wound up as a result of the voluntary action of its shareholders. The winding up of an insolvent corporation may be either voluntary or involuntary. The usual, although not the only possible, procedure by which the affairs of insolvent corporations, other than banks, insurance companies and railroads, are wound up is by proceedings in a federal court of bankruptcy.

Insolvency does not, however, necessarily result in liquidation. A corporation may be insolvent, either in the sense of having insufficient current assets to pay its debts as they mature or in the so-called "bankruptcy" sense of having liabilities which exceed the fair value of the assets, both current and fixed.

Despite insolvency of either type, it may have a substantial going-concern value, and the best or even the only way in which that going-concern value can be realized by its creditors may be through a reorganization, by which the assets are not sold to outsiders but the old creditors become the principal or the sole owners of the reorganized company.

Congress amended the Bankruptcy act in 1938 to provide for the reorganization of most types of corporations by means of proceedings in a federal court. The plan of reorganization, which usually involves the exchange by the creditors of all or part of their debt claims for shares of stock, must, generally speaking, be assented to by the holders of two-thirds of each class of debts.

Unless the corporation is found to be insolvent in the bankruptcy sense of that word or its junior shares are found to be worthless, the plan must also be assented to by the holders of a majority of each class of shares. In addition, it must be found by the court to be fair and equitable and financially feasible.

A study of reorganization under an earlier form of procedure, made under the auspices of the Securities and Exchange commission, produced impressive evidence that creditors, because of ignorance, inability to organize effectively for common action, or eagerness to have the reorganization completed without long delay, had frequently agreed to reorganization plans which were unduly favourable to junior interests. The U.S. supreme court endeavoured to prevent plans of that type from being approved by the lower federal courts by admonishing them that, regardless of how large a percentage of any class may have assented to the plan, the judge must not approve it as fair and equitable if it fails to eliminate the holders of worthless junior securities entirely, or if, where such junior interests are found to have some value, it fails to give senior security holders a substantial equivalent for any rights which they give up.

In the reorganization of most types of corporations under federal law, the Securities and Exchange commission was given a purely advisory role. That agency has much broader powers if the corporation is a gas or electric holding company or a subsidiary of such a company and is being reorganized either because of insolvency or because its security structure is not in conformity with the requirements of the Public Utility Holding Company act of 1935.

The Interstate Commerce commission was given somewhat similar powers in connection with the reorganization of railroads, both when the railroad is being reorganized under the Bankruptcy act and when the directors of a solvent railroad, acting in accordance with the provisions of a 1948 amendment of the Interstate Commerce act, seek to induce the holders of 75% of each class of its securities to consent to a modification of what the directors consider an unsatisfactory security structure. (*See* also BANKRUPTCY.)

14. Other Types of Business and Private Corporations.—The most important types of nonstock business corporations in the United States are mutual insurance companies and savings banks. The members of mutual insurance companies are the policyholders. Although most agricultural and other co-operative associations are stock corporations, they are usually organized under statutes which narrowly limit the amount of stock which any member can hold and provide that, after a limited dividend has been paid, any additional earnings shall be divided among the members in proportion, not to their stock ownership, but to the amount which they have bought from the association, or have sold through it, if it is a co-operative marketing association.

The statutes of most states contain separate provisions for the organization of religious, charitable, educational, social and other nonbusiness types of private corporations, which are usually designated collectively as corporations not-for-profit. These vary in type from small clubs or societies to large educational institutions. Both the statutory and the judge-made law applicable to such corporations is much less complicated than that applicable to incorporated business enterprises. Judges are very reluctant to take jurisdiction over controversies relating to their internal affairs where, as is often the case, such controversies are not primarily disputes about property but about whether the views or actions of some member are compatible with the tenets, objectives or traditions of the society.

See also COMPETITION, ECONOMIC; CARTEL; MONOPOLY; STOCK; and references under "Corporation" in the Index volume.

(E. M. D.; G. T. FR.)

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CORPORATION TAX. Almost every industrially developed country recognizes, for business and taxation purposes, entities resembling the U.S. and British corporation, but few universally valid generalizations can be made about corporate taxation because of the wide variety of hybrid entities and the diverse approaches to taxation. Since World War II, taxes on corporations have provided an increasingly substantial part of the national revenues in most countries.

In the United States, in the second half of the 20th century, the corporation income tax was second only to the individual income tax as a source of federal revenue; and in most of the states as well, taxes on corporations had long made important contributions to the support of government activities. In Great Britain local taxation is of minor importance because of greater centralization of financial responsibilities in the national government. But the proportionate contribution of corporation taxes to total government revenues is roughly the same as in the United States. In both countries corporations were subject to heavy excess-profits taxes during war periods (*see* EXCESS-PROFITS TAX).

History.—In the United States the practice of taxing corporations as such began during the middle of the 19th century when a number of states found the general property tax to be an inadequate instrument for the taxation of corporate wealth. Pennsylvania introduced a capital-stock franchise tax in 1840, and Massachusetts devised the "corporate excess" tax in 1864. Although only 12 other states had followed Pennsylvania's lead by

1900, nearly three-quarters of the states had capital-stock franchise taxes by 1960. Taxes on the "corporate excess" (*i.e.*, the excess of the market or fair value of the capital stock above the value of property locally assessed or located outside the state) were levied by 16 states in 1912, but by only 2 in 1960. Other taxes paid by corporations are many and varied, though not limited to corporate taxpayers. These include taxes based upon property as well as many forms of excise taxes, principally customs duties on imports, taxes on transactions involving transportation, communication and other services, and excises on the privilege of manufacture, storage, and the sale or purchase of commodities.

Except for a brief period during the Civil War, federal income taxation of corporations began in the United States with the imposition of a 1% tax in 1909. This levy, which was merged with the new individual income tax in 1913, was for several years little more than a withholding tax on corporation stockholders. Shortly after World War I, however, the corporation income tax became more and more widely regarded as a tax on the corporate entity; and by 1936, when dividends for the first time became fully taxable in the hands of the individuals receiving them, the corporation tax had become truly a levy upon earnings of the corporation as such. Meanwhile, the corporation rate had been rising gradually from 10% in 1920 to the peak 52% which prevailed after 1951. From 1911, when Wisconsin introduced the first successful corporation income tax, more and more states made this tax their principal instrument of corporation taxation. By the 1960s corporation income taxes had been enacted by over three-fourths of the states and some cities, and accounted for substantial tax revenues.

Besides the wartime excess-profits taxes, the U.S. government experimented with several other types of corporation levies. During 1936–37 it imposed a tax on undistributed corporate profits at rates ranging from 7% to 27%. Although this tax was proposed as a substitute for the corporation income tax, it was enacted as a supplementary levy. Opposition to it was great, and it was repealed after only a two-year trial. From 1933 to 1945 corporations were taxed on the "declared value" of their capital stock. At the same time, a complementary excess-profits tax on earnings exceeding stated rates of return on the "declared value" had the effect of discouraging underdeclarations. Thus, the burden of the combined tax depended on the stability of the income and the accuracy of the forecast. Because of this unsatisfactory dependence on an estimation of earnings and in view of the increase in the regular corporation tax, these taxes were repealed in 1945.

In Great Britain, corporations and individuals alike are subject to income tax at the so-called standard rate. The corporation's payment of tax on its income at the standard rate satisfies all liability for that tax on the income. When the income is distributed as a dividend, tax at the standard rate is not imposed on the shareholder in respect of the dividend. Thus a corporation's income, whether distributed or not, bears but one tax at the standard rate. However, the shareholder is treated as though he has received, besides the dividend, the amount of that tax attributable to the dividend, and the combined amount has then to be included in his income for the purpose of calculating the graduated surtax imposed on individuals whose incomes are above the level at which surtax begins to be chargeable and for the purpose of computing total income by which various personal allowances are measured.

After 1937, Great Britain levied an additional tax on the income of corporations. Originally called the national defense contribution, this tax was levied at the flat rate of 5% of income. During World War II, an excess-profits tax was imposed in lieu of the national defense contribution wherever the excess-profits tax was the greater amount. Upon repeal of the excess-profits tax in 1946, the national defense contribution was renamed the profits tax and shortly thereafter its structure was changed so as to provide a deterrent against dividend distributions.

Special Problems and Policies.—In any system of corporate income taxation, there is the problem of interrelating the corporation's tax with the tax on the individual stockholders who own the corporation. There has been much concern over the so-called "double taxation" resulting when stockholders are taxed on dividends received from corporate earnings despite the fact that the corporation may previously have paid taxes on the earnings. Great Britain, as stated above, has completely eliminated the double taxation effect as regards the standard rate. Australia, on the other hand, has imposed a highly progressive rate of tax on income received by corporations without any such mitigation, while Canadian policy has been to make some tax concession to dividends representing income upon which the corporation has paid a tax. Beginning in 1954 the U.S. congress made a limited concession to the argument for reducing the combined corporate and individual income tax levy on dividend income by adopting a $50 dividend exclusion for individuals plus a credit against the individual income tax of 4% of dividends received. But in the case of intercorporate dividends, received by a corporation from another corporation, a very substantial exemption from income tax has long been the U.S. policy, resulting in a maximum rate of 7.8% in 1961.

In the United States and some other countries, one of the main problems regarding rates stems from the fact that the corporation tax is at a flat rate of approximately one-half the net income, whereas the individual income tax is at a steeply graduated rate up to 91%. Thus, for high-bracket taxpayers the corporate device has been used as a shield against the high-bracket income tax rates by allowing most of the corporate net earnings above taxes to remain undistributed year after year. Sometimes the individual stockholder will receive the accumulated earnings later by a sale of the stock, or through other devices, resulting in a tax at the lower capital gains rates instead of the much higher rates applicable to ordinary income (*see* CAPITAL GAINS, TAXATION OF). If the individual does not sell or liquidate the corporation until his death, the corporate earnings may even be passed on to his heirs without ever being subjected to the income tax rates for individual taxpayers. Two main statutory devices are used to curb this use of the corporation by high-bracket taxpayers: (1) an additional tax, known as the "accumulated earnings tax," upon the undistributed income of corporations used for the purpose of accumulating earnings to avoid the income taxes upon individual shareholders; and (2) a "personal holding company tax," which, in general, is imposed upon family corporations or other closely held corporations, 80% of whose income is from certain sources such as investment or personal services.

In order to permit small businesses greater choice of the corporate or noncorporate (partnership or individual proprietorship) form without overemphasis upon tax consequences, congress has permitted certain closely held corporations to elect, under limited conditions, the same tax treatment as if the stockholders were doing business as individual partners. A limited provision permitting certain unincorporated businesses to elect to be taxed as corporations had already been enacted in 1954.

The corporate income tax has international ramifications in its application to foreign corporations doing business within a particular country and also with respect to the treatment of income earned abroad by domestic corporations or their subsidiaries. Not least among policy considerations are the encouragement of foreign investment and the reduction of the impact of double taxation stemming from the power of two or more countries to tax. Quite generally, foreign corporations doing business within a country are exempted from local taxation, or are taxed only upon income earned in the country. International treaties and conventions are widespread between the United States and Great Britain and numerous foreign countries. Several mechanisms found in the income tax statutes of the United States reduce substantially the income earned abroad by domestic corporations. These include: (1) a tax credit for foreign income taxes paid by domestic corporations; (2) a tax credit for taxes paid by foreign subsidiaries; and (3) a lower income tax rate accorded "western hemisphere trade corporations."

Other important matters of policy relate to the types of charitable, educational and other corporations which are to be exempted from the corporate tax; and to the detailed treatment of the tax consequences, both to the corporation and to its stockholders, of such events as the transfer of property to the corporation upon

its formation and to the stockholders upon liquidation or partial liquidation of the corporation, as well as various exchanges of stock when the corporation is changed in form or reorganized. Important objectives are equality of treatment of taxpayers and prevention of tax avoidance. The technical aspects in devising corporate tax patterns are complicated, and many countries have been guided by United States and British experience. *See* also INCOME TAX; TAXATION.

(E. G. K.; S. S. S.; W. W. Bo.; F. W. W.)

CORPSE, a dead human body. In every age, the public interest has commanded a disposition of human remains in a manner consonant with existing mores. The dictates of modern western civilization require that a body must have burial, both for the sake of public health and in accord with the sentiment that the dead should be disposed of decently. However, cremation or burial at sea, where necessary, are permissible, as is delivery of bodies for dissection and study in accordance with the provisions of local anatomical acts.

In England, from the time of the Norman Conquest until the 19th century, the right of possession and disposition of a dead body was vested in the church and was solely the subject of ecclesiastical jurisdiction. The holding of the English common law, that a body after burial was the property of no one, encouraged the grisly practice of body snatching—rifling the grave—to which the overcrowded condition of London churchyards and the need (and the lack of legal provision) for cadavers for anatomical study contributed. This practice was ultimately ended by the passage of anatomical, burial and other statutes making it a criminal offense to remove a dead body from the grave and making legal provision for cadavers for anatomical study. These statutes also protect the rights of the next of kin to bury their dead and to prevent the mutilation of the corpse through medical autopsy, or exhumation of a previously interred body, except where public exigency demands otherwise.

In the United States, the courts have uniformly refused to treat a dead body as property in a material sense. However, the need, in particular controversies, for equitable results led to distinguishing between the material property right in the body and the right of survivors' dominion over it. By designating the latter a "quasi-property" right, the courts have been able to protect the sentiments of the survivors from violation arising from undue interference with their right of possession and control of proper disposition of the corpse.

See also DEATH (LEGAL ASPECTS); CEMETERY; FUNERARY RITES AND CUSTOMS. (P. E. JA.)

CORPULENCE: *see* OBESITY.

CORPUS CHRISTI, a city in subtropical south Texas, U.S., a port of entry and seat of Nueces county, overlooks Corpus Christi bay which is separated from the Gulf of Mexico by Mustang and Padre islands. Called the "Naples of the Gulf" because of its shore-line drive at two levels and its T-shaped peninsulas extending into the bay, the city resembles a Mediterranean town. It is an industrial as well as a tourist city. The Corpus Christi standard metropolitan statistical area includes Bishop, Port Aransas, Portland and Robstown, all built generally on the same economy as Corpus Christi. The population of Corpus Christi in 1960 was 167,690 and that of the standard metropolitan statistical area was 221,573 according to the federal census.

The history of Corpus Christi falls into four economic periods: (1) ranching under Spanish rule; (2) frontier trade; (3) ranching and farming; and (4) the rise of the petrochemical industry. Prior to 1839 the area was a smugglers' den among Karankawa Indians who were undisturbed by the first serious Spanish explorations. Some ranching activities existed by 1794 and by 1839, when Henry L. Kinney of Pennsylvania established the trading post which became Corpus Christi, Capt. Enrique Villareal endeavoured to hold his ranch by force. Pirate, promoter and smuggler, Kinney served as Gen. Zachary Taylor's quartermaster from Corpus Christi to Monterrey during the Mexican war (1846). From this vantage Kinney bought army surplus goods and began a boom with trade to Chihuahua. Kinney's Trading post became an important station on the route to the California gold field via Chihuahua but the bubble soon burst to be followed by a disastrous outbreak of yellow fever in 1854. Corpus Christi, so named by 1841, remained a small town from 1854 until about 1920, interrupted chiefly by skirmishes during the Civil War, three severe hurricanes (1874, 1916, 1919), the coming of railroads (1881–1909) and a land boom backed by New York and Boston capital (1888–93).

Discovery of natural gas in 1913 and its later exploitation, opening of the port by a deeper dredged channel in 1926 and discovery of the Saxet oil field in 1939 (the first of several such discoveries in the area) laid the foundation for a city. Population grew from 10,522 in 1920 to 57,301 in 1940, and to 167,690 in 1960, according to the federal census. Continued development of ranching plus new agricultural products (vegetables and sorghum grains), discovery of new raw materials, development of commercial fishing (fish, shrimp and oysters), a growing tourist business, location of a large U.S. naval air station there in 1942, the World War II search for synthetic rubber which stimulated chemical industries, extensive use of government funds for a protective sea wall, a channel and harbour 40 ft. deep with a bridge towering 235 ft. over the turning basin to permit its enlargement and sufficient water for the foreseeable future insured by the Wesley E. Seale dam all contributed to the growth of the city as well as the flat, fertile prairie soils, long growing season (260 to 330 days), rainfall (near 30 in.), and uniform climate. Other raw materials and economic activities include dairying, poultry raising, oyster shell and salt (piped in as brine from an underground dome 60 mi. to the west). From these various raw materials the following are produced: butane, naphtha, other petroleum distillates, formaldehyde, methanol, acetaldehyde, other organic chemicals, carbon black, starch, sugar, caustic soda, soda ash, chlorine, oil well additives and cement. The use of imported ores, permitted by the deep-water port, include bauxite, zinc and cadmium to produce aluminum, refined zinc and cadmium, and sulfuric acid as a by-product.

In the population a strong Mexican influence is mingled with the old south, the north and the Texas range and with strong strains of Irish, German, Bohemian and Czech. Incorporated in 1852, the city adopted the city-manager form of government in 1945. The public school system includes Del Mar junior college (founded 1935) with separate liberal arts and technical divisions. There are a number of private and parochial schools and a denominational college. La Retama public library, study groups (art, music, literature, drama), a Civic Music association, the Corpus Christi Symphony orchestra, numerous playgrounds and parks, a yacht basin, the Junior museum, Exposition hall, Memorial coliseum and Centennial Art museum provide opportunity for recreation and cultural activities. (N. M. T.)

CORPUS CHRISTI, FEAST OF, a festival of the Western Christian Church in honour of the Real Presence of Christ in the Eucharist, observed on the Thursday after Trinity Sunday. The institution of this feast is due to Blessed Juliana, prioress of Mont Cornillon near Liège, whose veneration for the Blessed Sacrament was intensified by a vision, and who persuaded the bishop of Liège to order the festival for the diocese in 1246. It did not spread, however, until 1264, when Pope Urban IV ordered the whole church to observe the feast, for which a new office (still in use) was written by St. Thomas Aquinas. Because perhaps of Urban's death soon afterward (Oct. 2, 1264) his order was ignored in most countries until after its confirmation by Clement V at the council of Vienna in 1311. By the middle of the 14th century the festival had found general acceptance, and in the 15th century it became in effect the principal feast of the church. The procession of the Host, its most prominent feature (though not part of the original ritual), became a gorgeous pageant in which sovereigns and princes took part, as well as magistrates and members of trade and craft guilds, and was followed by miracle plays and mysteries performed by members of the guilds.

The rejection of the doctrine of transubstantiation at the Reformation naturally involved the suppression of the festival, as a religious observance, in the Reformed churches. *See* also CHURCH YEAR.

CORRECTIONAL SCHOOL: *see* REFORMATORY.

CORREGGIO is the name universally given to ANTONIO ALLEGRI (*c.* 1494–1534), son of Pellegrino Allegri. He was born at Correggio probably not long before Aug. 30, 1494, and died there on March 5, 1534. He was one of the half-dozen greatest masters of painting of the High Renaissance in Italy, and, in his later works, a forerunner of the baroque style. In the 16th century he was already known as "the painter of the Graces," and although his works were concentrated at Parma and in a few neighbouring cities, he was early considered worthy of being named in the company of Raphael, Michelangelo and Titian. He was probably a pupil of Francesco Bianchi-Ferrari at Modena about 1503 and pursued further studies at Mantua during the period in which Andrea Mantegna, who died in 1506, was succeeded as court painter by Lorenzo Costa. Correggio's early works are pervaded with his knowledge of Mantegna, although they are all softness and light and shade where Mantegna uses line. An early tradition records that he completed the decoration in Mantegna's family chapel in the church of S. Andrea at Mantua after Mantegna's death.

A group of devotional pictures, which became increasingly luscious in colour, antedate his first securely documented work, the altarpiece in the Dresden collection called "The Madonna of St. Francis," which was commissioned for S. Francesco at Correggio in 1516. The most important of these are "The Marriage of St. Catherine" (Detroit), the "Nativity" and "Adoration of the Kings" (Brera gallery, Milan), and "Christ Leaving His Mother" (National gallery, London). His mature style, however, only emerged with his first commission for Parma, the ceiling of the abbess' parlour in the convent of S. Paolo, which was probably executed about 1518–19.

Although there are echoes in this work of Mantegna's frescoes in the Castello at Mantua, it was wholly original in conception. The ceiling was conceived as a trellis in 16 compartments, with an oval gap in each revealing pairs of children who form an allegory of human activities, and each trellis terminates in a lunette in *grisaille* with classical personifications often taken from antique coins. This learned humanist program, assimilated to art with extraordinary perfection, was one of the last of its kind planned for a sacred building prior to the reforms within the church which were urged by popes from Julius II onward.

Correggio's other great decorative works were all made for Parma. The decoration of the cupola of S. Giovanni Evangelista (1520–23) was followed by that of the apse of the same church, of which only the "Coronation of the Virgin" survives in the Parma gallery. In the cupola is St. John seeing the vision of the Ascension; this was still in the High Renaissance tradition and owed much to Michelangelo.

In the cupola of the cathedral (1526–30), with the "Assumption of the Virgin," Correggio anticipated the baroque and treated the whole field as a single pictorial unit of vast proportions, equating the dome of the church with the vault of heaven. It made a profound impression at the time, although criticism was not altogether favourable, but its influence was greatest a century later, in the Roman baroque movement, when its decorative implications were first carried further by Giovanni Lanfranco, himself a native of Parma.

The remainder of Correggio's most famous works, the dates of few known with certainty, fall into three groups: the great altarpieces (and a few other large religious compositions); exquisite small works of private devotion; and a handful of mythological subjects of a lyrically sensuous character. The altarpieces are among those landmarks of art which have acquired affectionate nicknames. The "St. Sebastian," the "Night" (finished about 1530) and the "St. George" (1530–32) are among those which are in the gallery at Dresden in Germany, but the "St. Jerome" (1527–28) and the "Madonna della Scodella" (1528–30) remained in the Parma gallery, as did the large "Deposition" and the "Martyrdom of St. Placidus and Others," which are among Correggio's most remarkable inventions. The "St. Jerome" in particular combines an intimate and domestic mood with astonishing softness and beauty of paint texture, and includes types of feminine beauty of ideal loveliness.

BY COURTESY OF GEMÄLDEGALERIE ABT. ALTE MEISTER

"THE MADONNA OF ST. FRANCIS," ALTARPIECE BY CORREGGIO; EARLY 16TH CENTURY. IN THE DRESDEN (GER.) GALLERY

This intimate and homely poetry was carried through into the small devotional works such as the "Madonna of the Basket" (National gallery, London), "La Zingarella" (Naples) and the "Virgin Adoring the Child" (Uffizi, Florence). The most famous of the devotional pictures which explored this vein of ideal feminine loveliness is the larger "Marriage of St. Catherine" (Louvre museum, Paris).

Correggio's technique, which was the reverse of linear and in which the paint seems to have been lightly breathed onto the forms, achieved its most remarkable results in the mythologies. The earliest were probably the "Antiope" (Louvre) and the "Education of Cupid" in the National gallery, London; the others all belong to his last years—the "Danaë" (Borghese gallery, Rome), the "Ganymede" and "Io" (both at Vienna), the battered "Leda" in Berlin, and the two allegories of Vice and Virtue painted for Isabella d'Este (in the Louvre). In these the sensuous character of the subject matter is enhanced by the quality of the paint and these pictures carry this kind of sensibility to the limits to which it can go without offense.

Correggio's drawings are spirited and audacious and always made with paintings in view. The intimate and most "precious" quality of his more widely distributed works has sometimes led him to be considered as an artist of less than the highest flight—a view which follows Giorgio Vasari who regretted that Correggio had never had the advantages of study in Rome. But this impression is redressed by the works which remain at Parma. Although his influence can be detected in later Parmese painting, and counts for something in the Mannerist style of Parmigianino, Correggio had no direct pupils who deserve mention. His decorative ideas were taken up by the baroque painters of the 17th century, he became almost a tutelary deity of the French rococo style, and his great altarpieces were among the works most abundantly copied by the traveling artists of the 18th century during their years of study in Italy.

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C. Ricci, *Correggio* (English trans., 1930); A. E. Popham, *Correggio Drawings* (1956). (E. K. We.)

CORREGGIO, DA, Italian feudal family who were lords of Correggio, near Reggio Emilia, from the 11th to the 17th century. During the 13th century, as leaders of the Guelfs, they came to dominate the politics of Parma, and in 1303 Ghiberto da Correggio was acclaimed lord of the city, which he ruled until 1316. In 1341 his son Azzo, a friend of Petrarch, who dedicated to him the *De remediis utriusque fortunae,* recovered control of Parma, only to sell it again three years later to the Este family of Ferrara. Correggio itself, however, remained independent, being raised to the rank of countship in 1452 and to that of principality in 1616. Shortly afterward, in 1630, Siro da Correggio was condemned by the Holy Roman emperor Ferdinand II to pay a heavy fine for minting bad coin; unable to raise the sum he was forced to cede Correggio to the Este of Modena in 1634. The family came to an end with the death of Camillo in 1711.

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CORREGIDOR, a rocky island at the entrance of Manila bay, Republic of the Philippines, famous for a historic defense by U.S. and Filipino forces against overwhelming numbers of Japanese during World War II. After the fall of Bataan in April 1942, Corregidor was the last outpost of organized resistance in the islands. For 27 days its forces, under Lieut. Gen. Jonathan M. Wainwright, repelled all efforts to dislodge them from the elaborate system of tunnels and emplacements built after the Spanish-American War, but were finally forced to capitulate on May 6, 1942. *See* also World War II: *The War in the Pacific.*

CORRELATIVE generally denotes the terms or partners of a relationship. A relationship requires at least two terms between which it holds, and they are said to be correlative terms. Thus "cause" and "effect" exemplify one kind of relationship; "teacher" and "pupil," another; "north" and "south," yet another relationship. The terms in each of these pairs are accordingly called, in logic, "correlative" terms. The expression has also been extended to propositions which express the same relationship from different points of view. Thus *S is north of P* implies *P is south of S.* They are simply correlative propositions.

CORRENS, KARL ERICH (1864–1933), German botanist, was one of several scientists who, near the end of the 19th century, independently and almost simultaneously rediscovered Mendel's laws (*see* Mendel, Gregor Johann). He was born at Munich on Sept. 19, 1864, and educated in the same city. After graduating from the university in 1891, he continued his studies, working under Karl von Naegeli, Gottlieb Haberlandt and Wilhelm Pfeffer. In 1892 he became *Privatdocent* of botany in the University of Tübingen and was promoted to a professorship in 1897. In 1902 he was transferred to Leipzig and in 1909 to Münster. He was appointed director of the Kaiser Wilhelm Research Institute for Biology and professor of the University of Berlin in 1914, and held that position until his death on Feb. 14, 1933.

Correns started his research work by investigation of the cell structure and the growth of the cell wall. Later he turned to the study of the reproduction of mosses. Mendel's law attracted his attention to the problems of genetics, and in this field he achieved so much that his eminence was recognized throughout the world. He was especially interested in hybridization and in the most difficult problems of inheritance in plants, including the so-called anomalous inheritance of variegation. The study of self-sterility in a number of plants culminated Correns' scientific activity.

CORRESPONDENCE, COMMITTEES OF. These were committees originally appointed by the legislatures in the American colonies to correspond with colonial agents in England. They assumed new functions on the eve of the American Revolution, providing colonial leadership and aiding intercolonial co-operation. Their emergence as agencies of colonial discontent was prompted by Samuel Adams who, at a Boston town meeting, Nov. 2, 1772, secured the appointment of a 21-man committee to communicate with other towns in Massachusetts. Similar groups had appeared in some 80 towns in the colony by Jan. 1773. These committees were all local in character. The emergence of intercolonial committees followed the suggestion of the Virginia house of burgesses which, on March 12, 1773, appointed 11 men, including Patrick Henry and Thomas Jefferson, as a committee for intercolonial communication. By the end of 1773, eight other American colonies had followed Virginia's example.

The committees played a major role in promoting unity against England and in calling together in Sept. 1774 the first continental congress (*q.v.*), a majority of whose delegates were committee members. With the breakdown of royal control these earlier committees were superseded by committees of safety, but the colonial experience subsequently was seen in the introduction of correspondence committees as a common system of early party organization in the United States. (N. E. Cu.)

CORRESPONDENCE INSTRUCTION, sometimes referred to in the U.S. as "home study," is a method of teaching by mail. In its fullest development it includes: (1) specially prepared materials, written in a self-explanatory fashion and arranged into a series of lessons; (2) supplementary printed and other materials; (3) a series of exercises to be worked out by the student; (4) the evaluation of these exercises by a competent instructor with the student being informed of this evaluation and, occasionally, being given the opportunity to correct his errors; and (5) a final examination over the whole course. Occasionally one or more of these five elements is omitted, as when a student is asked to grade his own exercises. Again, the elements may be combined in a programmed course or an instructional program designed for use in a teaching machine. At the extreme, so-called "correspondence instruction" is nothing more than a name used to sell specially prepared materials with the purchaser being given no individualized help or outside evaluation of his work.

Correspondence instruction has three great advantages: it makes possible the education of those who are isolated by geography or circumstance (such as people in rural areas, prisons or sanitariums); it is highly flexible, since the student may start at any time, study anywhere he wishes and proceed at his own desired rate of progress; and it may be used for highly specialized subjects in which the relatively few interested persons are scattered over a wide area. The disadvantages are in the lack of direct personal contact with the teacher and in the inability to profit from the stimulation of group learning processes. The correspondence student must rely heavily on his own initiative. Perhaps it is for this reason that course completion rates are usually low, despite many special efforts to raise them.

Teaching by mail has been a prominent feature of European and American life since the last quarter of the 19th century. In 1856 C. Toussaint and Gustav Langenscheidt founded a school in Berlin to teach languages by correspondence. Other early efforts were made in various European countries, but the first large-scale programs occurred in the U.S., particularly in the work of the Chautauqua institution and The University of Chicago (where a correspondence department was included as an integral part of the institution at the time of its founding in 1891).

The most prominent institutions using this method in both Europe and the U.S., however, have been the correspondence schools, independent institutions that are usually operated for profit. These schools range from large, well-established highly ethical institutions down to small, precariously financed and occasionally unscrupulous ventures. A very wide range of subjects is available, with a particularly heavy emphasis on academic and vocational subjects at all levels, but also with many courses designed to increase personal effectiveness in various fields. Students are secured chiefly by advertising, although some schools maintain sales representatives.

In the U.S., the typical student is a married man, about 26 years of age, with at least a high school education, taking a vocational course. In the United Kingdom the emphasis is upon professional or other vocational qualifications. Some professional bodies provide their own correspondence courses, but most correspondence instruction is conducted by private institutions. Several reputable

private correspondence colleges were established during the late 19th century. Courses are offered leading toward external degrees of London university and other educational qualifications such as the general certificate of education.

A number of efforts have been made in the U.S. to regulate correspondence schools and raise the quality of their instruction. The Federal Trade commission has been active in this respect, as have the various state departments of public instruction, often aided by special legislation. The larger and better established schools have attempted to improve the calibre of the work by creating in 1926 the National Home Study council, a voluntary inspecting and accrediting agency.

Correspondence instruction has also been extensively used by American universities as a part of their extension activities. The armed services also have provided a large number of correspondence courses for their reserve officers and men, and the United States Armed Forces institute operates an enormous program for persons on active duty in the various branches of military service. The British forces correspondence course scheme is available to all ranks in her majesty's armed forces. It provides courses leading to external degrees of London university, to professional and other vocational qualifications and courses for purely cultural study. Many adult education institutions, voluntary associations and government departments also maintain correspondence courses. Much of the work is individualized, but courses have also been developed on a group basis and made available to industrial, commercial and other types of users.

In addition, correspondence instruction has been used to supplement the work of elementary and high schools. In Australia all the state departments of education have since the early decades of the 20th century provided highly organized services of correspondence instruction for children of primary and secondary school age. The courses, which cover the entire curriculum, are supplemented by traveling libraries and exhibitions, correspondence school magazines, radio features and other means, including occasional regional and national meetings. For older students technical courses have been extensively developed, and some university courses are available. A similarly comprehensive governmental service operates in New Zealand. Several Canadian provincial governments offer correspondence instruction throughout grade school and some also provide correspondence courses for adults. In the U.S.S.R. extensive programs of correspondence instruction are conducted through the universities.

See also ADULT EDUCATION; UNIVERSITY EXTENSION.

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CORRÈZE, an inland *département* of central France, formed from the southern portion of the ancient province of Limousin (*q.v.*), is bounded north by Haute-Vienne and Creuse, east by Puy-de-Dôme, southeast by Cantal, south by Lot and west by Dordogne. Pop. (1954) 242,798. Area 5,887 sq.km. (2,273 sq.mi.). It is situated on the western margin of the Massif Central (*q.v.*) and is largely undulating plateau country composed of granite and other crystalline rocks that give an impermeable surface and infertile, acid soils. The highest ground, in the north, is part of the plateau of Millevaches, which separates the drainage basins of the Loire and Garonne. Most of the *départements* is drained southwest by the Dordogne and by the Vézère and its tributary the Corrèze. In its lower, western portion the softer sedimentary rocks that flank the Massif Central form a marginal depression, the basin of Brive, with rich if clayey soils. In this undulating, verdant lowland, mixed farming is practised on small holdings, with maize, a wealth of fruits, potatoes and other vegetables and the rearing of a variety of livestock. The vineyards that were formerly important were largely replaced by fruit trees after the Phylloxera infestation at the end of the 19th century. The crystalline uplands are tracts of much poorer farming where the traditional grain crop was rye, not wheat or maize. The higher parts provide only summer grazing and there is generally much heath remaining, but the lower tracts of undulating plateau form a *bocage* (*q.v.*) countryside of small, hedge-bounded fields, devoted to grass and other fodder crops. Intensive cattle rearing is the modern basis of the rural economy. There is no longer much cultivation of grain, and the chestnut woodlands that were once so important are neglected and ravaged by disease.

Apart from scattered brick- and tileworks, and leather and agricultural industries in the market towns, there is little manufacturing in the *département*. At Tulle (*q.v.*), which gives its name to a fine net, is a government firearms factory.

Corrèze is divided into the *arrondissements* of Tulle, Ussel and Brive. It lies in the archdiocese of Bourges and the educational division (*académie*) of Clermont-Ferrand and comes under the jurisdiction of the Limoges court of appeal. Tulle, the capital, in the centre of the *département* and Brive, or Brive-la-Gaillarde (*q.v.*), near its western border are the chief towns. There are Romanesque churches at Uzerche, Aubazine, Beaulieu-sur-Dordogne, Meymac and Vigeois. Uzerche and Treignac, with extensive remains of their medieval fortifications, and Turenne, dominated by the ruins of its castle, are picturesque towns.

(AR. E. S.)

CORRIB, LOUGH (LOUGH COIRB), a lake chiefly in County Galway, Republic of Ireland, is located on the western edge of the central Irish lowland. It is drained southward by the Corrib river through the city of Galway. Varying in width to a maximum of 10 mi. and with a total length of 29 mi., Corrib is the third largest lake in Ireland. On the west its shores form the fringe of Connemara (*q.v.*), and peat bogs of vast extent, in part due to the infilling of the lake, alternate with farmed ridges of glacial drifts. To the east there are also large bogs and limestone outcrops, of which some are bare rock with rough woodlands and others good pastures of farmed lands. The lake provides brown-trout fishing and facilities for pleasure boating. When Galway's Eglington canal was built (1848–57), steamboats went to a quay near Oughterard. The drainage was improved by schemes in 1846–50 and far more effectively in 1955–59. (T. W. FR.)

CORRIENTES, a province of the Mesopotamia region of northeastern Argentina, is bounded in the north and west by the Paraná river, which separates it from Paraguay, and in the east by the Uruguay river, which separates it from Brazil and Uruguay. Its area is 35,054 sq.mi. Pop. (1960) 543,226. The north of Corrientes consists mainly of a low-lying plain with swamps and lagoons, the largest lagoon being the Estero del Iberá. To the south there are fine natural pastures and woods in the rolling uplands and abundant streams. The climate is hot and humid in the north, subtropical in the southern hills, with hot, rainy summers and mild winters. The mean annual temperature is about 71° F. The principal activity is the raising of cattle and sheep. Among the chief crops are maize (Indian corn), rice, cotton, tobacco and flax. Yerba maté and tung are grown in the north, near the Misiones border. The province is especially noted for its citrus fruits. Provincial exports include cattle, hides, timber and firewood, oranges and quarried stone. Manufacturing industries are small, the most numerous being sawmills and tanneries.

The principal town and capital is Corrientes (*q.v.*), an important port on the Paraná for steamers plying between Buenos Aires, the upper reaches of the Paraná and the Paraguay river. Passengers traveling upstream usually change into vessels of smaller draft at Corrientes. This is the most densely populated district. Other ports on the Paraná are Goya (pop. [1956 est.] 25,208), which is on a side channel of the main river and is a flourishing commercial centre exporting pastoral and agricultural products; Empedrado; Bella Vista; and Esquina, which exports timber and firewood. Small ports on the Uruguay river are Monte Caseros, Paso de los Libres and Santo Tomé. For generations cattle were smuggled across this upper stretch of the Uruguay, when the difference between prices on the Argentine side of the river and the Brazilian side made it profitable. The rivers provide the main means of communication in northeastern Argentina, but the chief towns in the province are connected by railway and road. A railway from the town of Corrientes runs southeastward via the inland towns of

Mercedes and Curuzú Cuatiá to Buenos Aires, a distance of 660 mi., taking a day and a half. Another railway goes north from Monte Caseros, running close to the Uruguay river into Misiones on the way to Asunción, Parag. Branch lines connect with Goya and with the inland towns of General Paz and Mburucuyá, both of which lie in a particularly fertile northern district of the province.

(GE. P.)

CORRIENTES, a river port and capital city of Corrientes province in northeast Argentina. It lies on the left bank of the Paraná river, 20 mi. below the confluence of the upper Paraná and Paraguay rivers and 667 mi. N. of Buenos Aires by rail. Pop. (1960) 103,999. The city was founded in 1588 by Torres de Vera, who built a fort named San Juan de Vera de las Siete Corrientes ("seven currents") for the seven rapids in the river just upstream. It is a transshipment point for river traffic because vessels of shallower draft must be used for navigating the upper Paraná and the rivers of the Chaco. Its favourable situation in relation to the river basins has made Corrientes an important commercial and industrial centre. Meat-freezing works, tanneries, sawmills, textile plants and vegetable-oil factories in the city reflect the agricultural and pastoral wealth of its neighbourhood. Among the city's administrative buildings the government palace is noteworthy.

Corrientes is the seat of a bishop in the archdiocese of Paraná, and has a Renaissance-style cathedral (Las Mercedes). The church of La Cruz is a pilgrimage centre where the 16th-century cross of Torres de Vera is venerated.

Corrientes is the terminus of the railway from Entre Ríos province and branch lines serve the productive area of northern Corrientes province. Ferries link it with Barranqueras and the Chaco province on the opposite bank of the Paraná, and there are airline services to Buenos Aires, Rosario, Arg., and Asunción, Parag.

(G. J. B.)

CORROSION AND OXIDATION OF METALS. The term corrosion may be used to denote a chemical change in which metal passes from the elementary to the combined condition; examples include the formation of scale (oxide) on steel heated in air and of rust (hydrous oxide) on iron exposed to water or damp air.

To the pure scientist, corrosion reactions should form an essential division of chemical kinetics; they follow well-established laws, often simple and capable of rational interpretation, but differing somewhat from the laws which receive more prominent treatment in chemical textbooks.

In industry, corrosion processes are sometimes brought about intentionally, as in manufacturing the pigment white lead by the corrosion of metallic lead. More often, they are undesired changes involving damage and expense.

The damage caused by corrosion is enhanced whenever attack is concentrated upon small areas. Intense localized attack ("pitting") often occurs under conditions intermediate between those which produce general corrosion and those which confer complete immunity.

Thus, inadequate protective measures may actually accelerate penetration, leading to rapid perforation of some pipe or containing vessel. On certain materials, the boundaries of the grains are more susceptible than the interiors, and such substances, subjected to a static stress in a corrosive environment, may develop intergranular cracking, leading to failure; certain aircraft alloys, after incorrect heat treatment, are prone to this "stress corrosion cracking."

Where metal is subjected to alternating stresses in a corrosive environment, the most susceptible portions may be, not the intergranular boundaries, but disorganized matter produced along slip planes; thus, "corrosion fatigue" arises.

Structural members subjected to alternating stress may crack in a corrosive environment at stress ranges well within what would be the limits of safety in noncorrosive conditions.

Direct Oxidation.—An oxide-free surface of iron or copper exposed to dry air at ordinary temperatures soon becomes covered with an invisible oxide film, which isolates the metal from oxygen, so that its growth becomes continuously slower. The progress of oxidation—very rapid during the first few minutes, but steadily slackening—can be followed by gravimetric, optical or electrometric methods.

If the metal is gently heated in air, the film soon becomes thick enough to produce interference tints (*see* LIGHT: *Waves and Interference: The Colours of Thin Plates*). At high temperatures scale too thick to give interference colours is quickly formed on iron and copper. Even here the rate of oxidation declines as the film thickens, provided that the scale remains continuous; but thick scale is likely to flake off, particularly under conditions of bending, scraping or fluctuating temperature; to withstand oxidizing conditions at very high temperatures, a material must be chosen which produces a film that is protective while still thin.

At least three equations have been established for expressing mean film thickness, y, at time, t; namely,

parabolic equation, $dy/dt = k_1/y$ or $y^2 = K_1t + K_2$;
logarithmic equation, $dy/dt = k_2e^{-k_3y}$ or $y = K_3 \log (K_4t + K_5)$;
rectilinear equation, $dy/dt = k_4$ or $y = K_6t + K_7$.

($K_1 = 2k_1$; $K_3 = 1/k_3$; $K_4 = k_2k_3$; $K_6 = k_4$. All K's and k's represent constants independent of time but varying with temperature.)

Parabolic thickening occurs on copper heated in air at high temperatures (Norman Pilling and R. E. Bedworth, 1923); also on iron, nickel and tungsten, and on nickel-chromium alloys. It is generally attributed to the migration of metallic cations and electrons outward through the film to meet the oxygen, and the value of the constant k_1 is related to the electrical properties of the film substance by the equations of C. Wagner (1933, 1952). Enhanced resistance to oxidation is obtained by introducing into iron alloying constituents in which either the electronic conductivity or the cationic conductivity is low (*see* ELECTRICITY, CONDUCTION OF: *Conduction in Solids: Ionic Conduction*). Even small percentages of impurities may suffice to alter the nature or abundance of defects in the crystal lattice of the metal or of the oxide film in such a way as to affect the corrosion resistance markedly (E. Gulbransen, 1956). The improved oxidation resistance of iron-aluminum alloys is probably connected with the low electronic conductivity of an alumina film, while that of steels containing chromium has been attributed by some authorities to the low cationic conductivity of chromic oxide. (In practice, a layer of aluminum alloy is produced on fire bars and heat-treatment boxes by heating in a mixture containing aluminum powder, as in the calorizing process.)

The presence of sulfur compounds in the atmosphere accelerates attack by increasing the number of lattice defects in the scale; the products of combustion of coal rich in sulfur cause far more wastage than that of cleaner coal. Again, air containing hydrogen sulfide produces on copper at ordinary temperatures the same sequence of interference tints which, in pure air, occur only when the metal is heated.

At relatively low temperatures, where parabolic thickening is (in absence of sulfur compounds) unimportant except in the opening stages, film growth may occur on iron or copper according to the logarithmic law. A rectilinear growth was found on zinc exposed to London air at ordinary temperatures (W. H. J. Vernon, 1923) and logarithmic growth when it was exposed to relatively pure air over the temperature range 25°–400° C. (Vernon, E. I. Akeroyd and E. G. Stroud, 1939). Rectilinear thickening may be caused by the fact that the film substance is sometimes in its nature porous; *e.g.*, where it is an oxide which occupies a volume smaller than the metal destroyed in producing the oxide.

The cause of logarithmic growth is a matter still under discussion.

Corrosion by Liquids.—Wet corrosion may be divided into: (1) film-forming reactions; and (2) others. Where a solid film is formed over the metal, the rate of thickening usually dies away with time, sometimes according to the parabolic law given above. L. B. Parsons (1925) studied the behaviour of several metals toward iodine dissolved in various organic solvents. When the iodide of the metal under test was soluble in the organic liquid chosen, corrosion continued apace; when an insoluble solid iodide

appeared on the surface, the corrosion was unimportant.

Since most metallic oxides are sparingly soluble in water, the attack on heavy metals by pure water containing oxygen would be expected to be slow; this is found to be the case, although sometimes the attack is intensified through localization, and cannot then be neglected.

Where salts are present in the water, electrochemical corrosion becomes possible, often leading to soluble substances as anodic and cathodic products; in such cases no film is produced, and the corrosion continues unchecked. For instance, if rolled steel covered with broken oxide (mill scale) is placed in a salt solution with access of oxygen, an electric current flows between the oxide scale as cathode and the metal exposed at the breaks as anode.

The strength of the current flowing must be largely determined by the rate of arrival of oxygen at the cathode, but the corrosion is concentrated on the iron exposed at the breaks in the scale. If the discontinuities are small, the attack may be intense; this combination of large cathode and small anode is one likely to cause pitting or trenching.

The presence of a thick oxide scale on metal is not needed for electrochemical corrosion. A strip of iron or zinc sheet partly immersed in a salt solution will suffer electrochemical attack. The portion nearest to the water line, where the replenishment of oxygen is easiest, will then be the cathode, while the anode, where attack proceeds, is a zone a little way farther down. In such cases, it has been possible to measure the electric currents (U. R. Evans and T. P. Hoar, 1932); the strength of current flowing is sufficient to account for the rate of corrosion actually observed. Five different methods are now available for the measurement of these local corrosion currents, and it is no longer necessary to regard the electrochemical mechanism of corrosion as a theory.

The equations governing the corrosion of a divalent metal, M, in presence of oxygen can most simply be written,

$$\text{at the anode, } M = M2^{+} + 2e;$$
$$\text{at the cathode, } \tfrac{1}{2}O_2 + H_2O + 2e = 2OH^{-}$$

If iron is corroding in salt water containing oxygen, the anodic product can be regarded as ferrous chloride, and the cathodic product as sodium hydroxide. Where they meet they will form ferrous hydroxide [$FeO.H_2O$ or $Fe(OH)_2$], which will combine with further oxygen to give hydrated ferric oxide [$Fe_2O_3.H_2O$ or $FeO(OH)$], commonly known as yellow rust. If less oxygen is present, magnetite, in the black anhydrous form (Fe_3O_4) or a green hydrated form, is usually produced.

These bodies, being thrown out of solution some distance from the corroding surface at points where the anodic and cathodic products meet, will not stifle further attack, so that rusting, when once started, usually proceeds readily (except in hard water where rust is produced in a clinging, protective form as explained below).

If oxygen is absent, and even to some extent if it is present, an alternative cathodic change is possible; namely,

$$2H^{+} + 2e = H_2.$$

The two types of cathodic reaction (oxygen reduction and hydrogen liberation) involve either production of OH^{-} or destruction of H^{+} ions, and thus render the liquid more alkaline or less acid.

The hydrogen-evolution type of attack occurs most readily in acid solutions, although certain metals, like zinc or aluminum, the oxides of which are soluble in alkali (forming complex anions), can liberate hydrogen from solutions of caustic alkali.

When an oxidizing agent is present, other cathodic reactions are possible, sometimes permitting the electrochemical corrosion to attain high velocity; in the attack of nitric acid on copper, the cathodic reduction of nitric acid constitutes an autocatalytic cycle, and the attack may become violent, especially in crevices where the corrosion products escape dispersal.

Very careful measurements of the corrosion of fully immersed iron and zinc have been carried out by G. D. Bengough (1927 *et seq.*), with J. M. Stuart, then A. R. Lee and later F. Wormwell; some of their experiments lasted several years. On horizontal zinc or iron disks in stagnant potassium chloride solution, the corrosion rate was usually determined by the maximum rate at which oxygen could reach the specimen, which was itself influenced by the nature of the corrosion product; on iron the corrosion velocity often remained constant for long periods, suddenly changing when the physical character of the corrosion product underwent alteration.

Under conditions of shallow immersion, the corrosion velocity diminished when the depth of immersion was increased; in such cases, the oxygen was reaching the metal by diffusion. Beyond a certain depth of immersion, further increases in depth did not affect the velocity, since the oxygen was reaching the metal by convection.

Corrosion by the Atmosphere.—While the corrosion of fully immersed metal is frequently controlled by the rate of arrival of oxygen (water being everywhere in excess), the converse is true of atmospheric corrosion; here oxygen is everywhere in excess, and it is often the uptake of water which decides the velocity of corrosion. Vernon (1923 *et seq.*) and J. C. Hudson (1929 *et seq.*), who carried out much careful work on atmospheric attack, found that, in the case of metal exposed to indoor atmospheres, there is often a limiting humidity below which change is very slow. Thus, Vernon found that nickel exposed to air at a humidity below 70% undergoes little change; above this value, "fogging" takes place, unless the atmosphere is quite free from sulfur oxides. In the early stages, the deterioration is caused by a film made up of little droplets containing sulfuric acid (caused by the catalytic oxidation of adsorbed sulfur dioxide to give sulfuric acid, which then attracts more moisture); this is easily removed so that the brightness of the metal can be restored by simple wiping. On longer exposure, basic nickel sulfate is formed, and brightness can no longer be restored by wiping.

The corrosion of metals exposed out of doors increases with the sulfur oxides, largely derived from the combustion of coal, and is thus greater in towns or industrial regions than in the country. Near the sea, the presence of salt spray increases atmospheric corrosion. Careful measurements on numerous materials, ferrous and nonferrous, have been carried out by Hudson in various atmospheres. Iron and steel are corroded much more quickly than nonferrous materials. Among the materials included in Hudson's nonferrous tests, zinc, which corroded the fastest, usually suffered corrosion at four to five times the rate of 80/20 nickel-chromium alloy, which proved the most resistant among those studied.

Corrosion Caused by an External Electromotive Force.—While in natural corrosion there is usually a limit set to the rate of attack by the supply of some essential substance, no such limit exists where the metal undergoing corrosion is made the anode in an electrolytic cell supplied with current from an external source. In the absence of passivity (*see* below) or other complication, the rate of attack can be calculated, by Faraday's law, from the current forced through the cell.

Anodic action, however, does not always lead to attack. If a current be passed between two iron electrodes dipping into a liquid, two different changes may take place at the anode. The iron may pass into solution, giving a soluble ferrous salt, or, alternatively, hydroxyl ions may be discharged on the anode, leading to a protective oxide film; when once this film has been formed, the current flowing will be used in the evolution of oxygen gas. The decision between these two happenings depends largely on the pH value and the current density. At low values of pH and current density, the iron generally passes into solution as a soluble salt, whereas in weakly alkaline solution a protective film is formed, causing the metal to become "passive" so that corrosion ceases. In strongly alkaline solutions, some metals are attacked freely, forming complex anions. Thus, zinc can pass into solution as a zincate, while tungsten and molybdenum suffer anodic attack at high current efficiency, giving rise to tungstates and molybdates. With iron, dissolution in alkaline solutions occurs only at very high concentrations of alkali.

Even in acid solutions, an iron anode may become passive if the current density is sufficiently high, the establishment of passivity being favoured by stagnant conditions; under conditions

of rapid stirring, only very high current densities give rise to passivity. When iron is made an anode in dilute sulfuric acid, it first passes into solution as ferrous sulfate, and then suddenly becomes passive, almost ceasing to dissolve; the current is now devoted to evolution of oxygen. Extensive researches at Vienna by W. J. Müller (1927 *et seq.*) have shown that the first stage of passivity is the production of a supersaturated solution of ferrous sulfate over the anodic surface; if this is not dispersed by stirring, ferrous sulfate crystallizes out on the surface, raising the current density of the part not covered up by the microscopic crystals. At this stage the liquid next to the metal is probably no longer strongly acid, because of the migration of hydrogen ions toward the cathode, and conditions become favourable for the production of an oxide film.

The oxide film prevents further attack on the iron, and the current is now expended on the evolution of oxygen in bubbles, which disperse the ferrous sulfate, leaving the anodic surface bright and outwardly unchanged.

At one time scepticism was expressed as to whether the passivity set up in an acid solution could be due to an oxide film. It was contended that all known oxides of iron would dissolve in an acid. The invisible film on iron rendered passive by anodic treatment in sulfuric acid has, however, been isolated by undermining (Evans, 1930), and can be kept in acid for some hours without dissolving. This disposes of the objection. The rapid destruction of oxide films brought about by the action of acid on iron previously tinted by heating in air is due to the cell

ferric oxide | acid | iron

set up at discontinuities in the oxide film; the ferric oxide is the cathode of the cell, and, being reduced to the ferrous condition, rapidly passes into solution. If this reduction is prevented by making the electrode as a whole the anode, such interference-colour films are quite stable toward acid.

Prevention of Corrosion.—The protection of metal to be exposed to the atmosphere is usually obtained by applying suitable coats; sometimes these are paints consisting of a pigment embedded in an organic medium. It is best to include anticorrosive substances in the coat next to the metal, covering this with other paint coats chosen for their physical, mechanical or aesthetic characteristics. The inhibitive substances added to the lowest coat may be chromates; sodium chromate, mentioned as useful in water treatment, would clearly be too soluble, but zinc chromate is often employed, generally mixed with iron oxide. Another class of anticorrosive pigments are those containing lead; red lead, white lead, lead basic sulfate and even metallic lead have all been used as anticorrosive pigments. In oil paints they interact with the vehicle to give lead soaps; these are broken down by water, yielding strongly adsorbed compounds upon just those parts of the metal which would otherwise become the anodes of the corrosion process (J. E. O. Mayne, 1946).

Instead of paints, metallic coats can be used to protect iron and steel. At first sight it might seem best to use a relatively noble metal, which itself withstands corrosion, but if any discontinuity were to occur in such a coat, the dangerous combination of big cathode and small anode might make the corrosion of the exposed steel locally more intense than if no protection had been attempted. On the other hand, zinc or aluminum, which are anodic to iron, will prevent for a time corrosion of iron exposed at gaps. Zinc is applied to iron by dipping it into molten zinc, or by electrodeposition, or by sherardizing (beating in a mixture containing zinc dust); the last process gives a coating which is largely zinc-iron alloy, and there is frequently an alloy layer present in the base of the coatings obtained by the first-named procedure.

A useful method of applying coats is by metal spraying; a cloud of metallic globules from a "pistol" is directed upon the surface to be coated, and produces a layer of overlapping scales. One of the most promising plans for protecting steel consists in first shot-blasting the surface, then applying a sprayed coat of aluminum and finally adding an ordinary paint; the paint often keeps its colour far better than if applied directly to steel.

The advantage of metal spraying is that it can be applied to a structure after its erection. Another plan suited for application in the field depends upon the use of paints so richly pigmented with zinc dust as to constitute almost a continuous metallic coat; such paints confer protection on steel exposed at discontinuities under suitable conditions, and can be applied by brush without special equipment. The coat after drying may contain 95% of metallic zinc.

The persistence of the electrochemical corrosion set up when certain salt solutions containing oxygen act on metal is connected with the soluble nature of the anodic and cathodic products. If the salts present are such that either the cathodic or anodic product is sparingly soluble, the corrosion process may stifle itself. Various substances have the power of preventing attack by natural waters on iron or steel. One of these, calcium bicarbonate, is present in many hard natural waters, and on that account it is possible to run such waters through pipelines without the pipes becoming blocked or the waters emerging red with rust. The rise of pH value which always accompanies the cathodic reaction precipitates on the pipe a film of calcium carbonate, later converted, in part, to a clinging form of rust by interaction with the iron salts formed by the incipient anodic process. Acid waters from moorland regions, or soft waters from igneous rock districts, are often corrosive; they can be made less corrosive by passage through beds of limestone or calcined dolomite, during which they acquire calcium bicarbonate and lose their acid character. These cathodic inhibitors are not entirely efficient; they fail to stop corrosion if the water contains much chloride, and in any case they do not prevent attack upon freshly abraded iron; the attack becomes slow only after a film of clinging chalky rust has appeared on the surface.

Anodic inhibitors are chemicals which produce a sparingly soluble anodic product. Examples are sodium phosphate or sodium chromate; the latter seems to operate by producing an oxide film and by interacting with any ferrous ions formed at the weak places in it to give a mixture containing Fe^{3+}, or Cr^{3+} and OH^- (Hoar and Evans, 1932), so that discontinuities are repaired. The amount of inhibitor needed increases if the water contains chlorides. If the addition of inhibitor is insufficient, the corroded area is diminished more quickly than the total amount of corrosion, so that the corrosion per unit area of the part affected is actually increased. In other words, an insufficient addition of inhibitor may intensify attack. Consequently, anodic inhibitors are dangerous if used without judgment, although they can be more efficient than cathodic inhibitors; freshly abraded iron may be kept in a chromate solution indefinitely without rusting.

As indicated above, certain substances classified as anodic inhibitors for iron have been presumed to act by virtue of their ability to induce the formation of a protective insoluble film from ferrous ions that emerge through breaks in the film. There are other inhibitors the action of which is assumed to depend upon their being adsorbed on the surface so that, again, the active metal and corrosive environment are physically separated. It has also been suggested (H. H. Uhlig, 1951) that inhibitors of the type of chromates may owe their effectiveness to adsorption of the inhibitor anion. Use of an artificially prepared radioactive isotope of chromium (Cr^{51}) made possible a more detailed study of the action of the chromate ion as an inhibitor and gave support to the conclusion that adsorption is present (R. A. Powers and N. Hackerman, 1953). In addition, the discovery (G. H. Cartledge, 1955, 1956) of inhibiting properties in the pertechnetate ion, TcO_4^-, derived from the radioactive and long-lived artificial element, technetium, permitted experimental studies to be conducted over much longer times than are possible with the transitory chromium isotope.

These studies led to the suggestion that chemical reaction of the inhibitor itself may not be essential to the inhibitory process if oxygen is present. The hypothesis was suggested that adsorption of the inhibitor at the boundary between the solid surface and the surrounding solution gives rise to electrostatic forces that modify the energy relationships at the interface and permit the corrosion rate to be reduced, under favourable circumstances substantially to zero. Experiments in the latter 1950s led to the view that the film demonstrated by Evans (1930) is still present

but that its stability and effectiveness depend upon a labile adsorption of the inhibitor when other vigorous passivating conditions are absent. "Passivation" and "inhibition" are therefore not different fundamentally (G. H. Cartledge and R. F. Sympson, 1957).

Losses due to corrosion are often serious economically owing to some specific characteristic of the environment. Thus, pipelines or other metallic objects buried underground require protection against corrosion arising from stray electric currents entering and leaving the metal at different points, or from the acidity or some other chemical constituent in the soil. Plastic coatings are extensively used as a preventive measure in these instances.

Another very effective system of protection known as cathodic protection is widely used. In this treatment, the metal to be protected is connected electrically to a more easily corroded metal, such as magnesium. This sets up an electric circuit such that the magnesium corrodes as a "sacrificial anode," while the less active metal serves as the cathode and is not itself attacked.

Metals exposed to sea water are subject to corrosion not only because of the electrochemical action that can occur in any salt solution, but also because of the extensive deposition on the metal of marine organisms. The effect of these deposits is due to several factors, including the disturbance of protective paint coatings, the setting up of galvanic cells due to a differential supply of oxygen under the organism, or even the generation of substances, such as sulfides, which accelerate corrosion specifically. Protective measures in such cases depend chiefly on thorough coating of the metal surface with paints containing, in the final coats, toxic substances such as copper or a cuprous compound. An experiment in the latter 1950s demonstrated the effectiveness of cathodic protection as applied to ships' bottoms.

The problems of corrosion were greatly intensified in the 1950s by the developments in jet engines and the applications of nuclear energy. The extremely high temperatures encountered in jet engines and gas turbines necessitated the development of new alloys that have sufficient resistance to corrosion by the hot combustion gases as well as adequate mechanical properties at the high temperatures encountered.

In certain types of equipment associated with nuclear reactors, not only are metals exposed to corrosive chemicals and elevated temperatures, but the intense radiation associated with fission greatly modifies the environment and may enhance the corrosion. The details of the effect of radiation upon corrosion rates were still very imperfectly understood in the early 1960s. The experimental use of molten metals as mediums for heat transfer in nuclear reactors has introduced a type of corrosion known as mass transfer, whereby metal may be dissolved from the hottest parts of the system and deposited in cooler areas.

See also references under "Corrosion and Oxidation of Metals" in the Index volume.

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CORRUPT PRACTICES is a general term including bribery, undue influence, etc., but has specific reference to electoral systems. Beginning in the 19th century, many nations outlawed practices that interfered with the freedom of elections, such as cheating, intimidation, coercion and personation. Improvements in electoral administration, notably the secret ballot, were also designed to reduce corrupt election practices. Legislation gradually extended to the more general regulation of money in nomination and election campaigns, including the specification of purposes for which money might and might not legally be spent, the fixing of legal limits on the size of expenditures and contributions, prohibitions against contributions from certain sources, and the requirement that receipts and expenditures of designated kinds be publicly reported. In attempts to ensure freely competitive elections, later measures in some nations and in some U.S. states sought to provide major candidates with certain communications facilities and with other assistance in meeting campaign costs.

United States.—Corrupt practices in the United States are regulated by both state and federal legislation. Piecemeal action was taken during the 19th century, especially penal statutes against bribery and related abuses. Somewhat later, certain states and congress moved to limit the assessment of public officeholders. It was not until 1890, however, that New York adopted its publicity law, the first in a long series of enactments attempting to bring about disclosure of the sources and uses of campaign money, an effort that became a cornerstone of state regulation, and was followed by federal reporting requirements, the first of which was adopted in 1910. State legislatures addressed themselves repeatedly over the years to various types of controls. Three-fourths of the states amended their statutes in some way between 1951 and 1957, one-fourth of them making general revisions during that period. The principal federal regulations rested on the Corrupt Practices act of 1925, the Hatch acts of 1939 and 1940, and the Labor-Management Relations act of 1947 (the Taft-Hartley act).

Although corrupt-practices legislation in the United States attempted and accomplished more than in other nations, it was characterized in general by faulty conception, imperfect draftsmanship and casual enforcement.

State Regulation.—By 1961, 43 states had some kind of public reporting requirement. Illinois, Rhode Island, Delaware, Louisiana and Nevada were without one, the latter three states having repealed theirs within recent years. A survey in 1954 showed that in all states with reporting requirements, candidates had to make reports, and in 33 of them parties or campaign committees also had to file reports. In six states, information on disbursements only was called for, whereas elsewhere receipts were also covered. The requirements applied only to primaries for the nomination of candidates in six states, and to primaries and general elections in the others. In most states, reports were called for after the voting, but in 17 they had to be submitted both before as well as after.

The states have differed widely in their restrictions on sources of campaign contributions. In 1959 about one-third had prohibitions against the solicitation of significant groups of state employees or otherwise tried to limit the freedom with which such employees could make campaign gifts. About two-thirds of them limited the right of corporations to give money to candidates or their supporters. Four prohibited the gift of labour-union dues money on behalf of political candidates.

Four states also limited the size of individual contributions, the permissible maximum ranging from $1,000 to $5,000. Two-thirds of the states had ceilings on campaign expenditures. The ceilings applied generally, but not invariably, to both primaries and general elections, but usually only to expenditures by the candidate, or with his knowledge and consent. Even where they also applied to campaign committees, they generally failed to limit total expenditures. Between 1942 and 1956 seven states abandoned this type of attempted control.

Between 1908 and 1959 eight states authorized the issuance of official pamphlets to assist candidates in publicizing themselves. In the latter year only Oregon, North Dakota and Idaho did so. Minnesota in 1955 and California in 1957 authorized a state income-tax deduction for certain political contributions up to $100, and Minnesota did the same for limited campaign expenditures for certain party officials and candidates. The commonwealth of Puerto Rico in 1957 adopted a measure under which the government paid the bills of a political party up to a maximum of $75,000 in nonelection years and $150,000 in election years.

Act of 1925.—Because of constitutional uncertainties arising out of earlier federal legislation, the Corrupt Practices act of 1925,

which repealed previous legislation, made no effort to control nominating primaries or conventions. It required the treasurer of every political committee with activities in two or more states to file periodic reports with the clerk of the U.S. house of representatives, four reporting dates being specified for nonelection years and six for election years. The sworn statements were required to show the name and address of each contributor of $100 or more with the amount given, the total of other contributions, the names and addresses of all persons to whom expenditures of $10 or more were paid, with the amount, date and purpose of each such expenditure, and the total of other expenses. Individuals spending $50 or more in two or more states other than by a contribution were required to make a similar report of their expenditures. Each candidate for representative and for senator was required to file with the clerk and with the secretary of the senate, respectively, before and after each election, a sworn statement itemizing contributions and expenditures handled by him personally or by someone else with his knowledge and consent in support of his candidacy.

Under the act, as amended, any candidate for senator could spend up to $10,000 and any candidate for representative up to $2,500 unless state law prescribed a lower figure. Important categories of expenditures were excluded from the limits, and the limits themselves could be raised to a maximum of $25,000 and $5,000 respectively, under a formula that took account of the number of votes cast in the last election.

The act contained various other prohibitions, carrying forward one originally enacted in 1907 making it unlawful for any national bank or corporation organized under authority of congress to make a contribution in connection with any election, or for any corporation to contribute to federal campaigns.

Hatch Acts.—The Hatch act of 1939, amended in 1940, extended existing controls over federal civil-service employees by prohibiting all federal employees other than policy-making officers from taking active part in political campaigns. These limitations, as well as a ban on the solicitation of political contributions by one employee from another, applied to state and local officers employed in connection with activities financed in whole or in part by federal funds.

No political committee with activities in two or more states could legally receive or spend in excess of $3,000,000 during a calendar year. It was also made illegal to contribute directly or indirectly an aggregate in excess of $5,000 during a calendar year to or on behalf of any candidate for nomination or election to a federal office, or to a national political party or to an organization active on behalf of such a candidate, other than a state or local political committee. As the legislation was interpreted, individuals could give up to the limit to as many candidates or committees as they wished, and any number of different committees could spend up to the legal maximum.

The Hatch acts also contained prohibitions against buying goods, advertising or articles of any kind for the benefit of federal candidates, as well as provisions making it unlawful for anyone entering a contract with the United States government to make a contribution, measures that were largely unenforced.

Labor-Management Relations Act of 1947.—Trade unions, but not political committees formed under their auspices, were prohibited by this act from making contributions or expenditures in connection with the nomination or election of federal officials. The act also extended the prohibitions against corporate political action to include expenditures and nominations.

England.—Early measures in England culminated in the Corrupt and Illegal Practices Prevention act, 1883. This legislation, altered by several later enactments including the Representation of the People (Amendment) act, 1958, set the basic regulatory pattern. The expenses that might be incurred by a candidate for parliament during the campaign period were strictly limited according to the number of electors in each candidate's constituency (the authorized amounts averaging about £850 for each candidate in 1955, plus certain personal expenses up to £100 additional). The candidate himself, or a single election agent designated by him, was required personally to receive all money and to authorize all expenditures. Detailed reports were required, showing the sources of funds and to whom expenditures were paid and for what purposes. Summaries of the reports appeared in local papers and were printed in a document prepared by the home office. The use of money for some purposes was prohibited (*e.g.*, bribery, treating, precinct workers, music, banners, hired cars). Anonymously published campaign documents were forbidden.

Parliamentary candidates were permitted to mail one two-ounce letter free to each elector and to rent public buildings at maintenance cost. They could not buy radio or television time, though in fact each important party was provided limited amounts of free time during a campaign.

British efforts to regulate corrupt practices enjoyed general approval inside and outside the country, although the objectives sought were modest compared with those in some other places, especially the United States. No public accounting was required of money spent by central party organizations not directly allocable to an individual candidate, nor of money received and used on behalf of candidates outside the actual campaign period, usually about three weeks. No attempt was made to prevent campaign contributions and expenditures by corporations and labour unions.

The regulation of corrupt practices in local-government elections in England was similar to that of parliamentary elections; certain similar features were also adopted in other commonwealth nations.

See also ELECTORAL SYSTEMS; BRIBERY.

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CORSAIR, the name given by the Mediterranean peoples to the privateers of the Barbary coast who plundered the shipping of Christian nations. *See* BARBARY PIRATES.

CORSE, JOHN MURRAY (1835–1893), U.S. army officer and hero of the Civil War battle of Allatoona, was born in Pittsburgh, Pa., on April 27, 1835. He attended West Point and later studied law.

In 1861 he was appointed major in the 6th Iowa infantry. He distinguished himself in several campaigns, was wounded at the battle of Missionary Ridge (1863) and promoted to the rank of brigadier general. In command of a division during Sherman's Atlanta campaign, Corse played a leading role in one of the most dramatic events of the war. Hood in his campaign of harassment against Sherman's forces in Georgia in the fall of 1864, ordered an attack on a Union supply post at Allatoona, about 30 mi. N.W. of Atlanta. Corse, ordered to hold the post, moved in with a force of less than 2,000 and successfully repulsed an enemy numbering nearly 5,000. A third of the forces on each side were lost in the bloody battle and Corse was severely wounded. Philipp Bliss, the singing evangelist, wrote his popular hymn "Hold the Fort" in commemoration of the action.

Corse retired at the end of the war with the rank of major general. He became a collector of internal revenue and later a contractor. Active in Democratic politics, he was appointed postmaster of Boston in 1886. He died in Winchester, Mass., on April 27, 1893.

CORSICA (Fr. CORSE), the third largest island in the Mediterranean sea, forms the sixth *département* of France by size (3,367 sq.mi.) together with 43 offshore islets. Corsica lies about 105 mi. from southern France and 51 mi. from Italy and is separated from Sardinia by the 7-mi. strait of Bonifacio. It has a north-south length of 114 mi. between latitude 41° 20′ and 43° N. Ajaccio, the capital, is on the same latitude as Rome. Oval-shaped, the island has a maximum width of 52 mi.

Physical Features.—Corsica is the most mountainous island in the Mediterranean, with an average elevation of about 1,863 ft. Its highest summit, Mt. Cinto, reaches 8,891 ft. and there are about 40 other peaks rising above 6,500 ft.

Geologically Corsica represents two distinct mountain systems. The eastern and northeastern sector of the island consists of folded, alpine structures, most of them in metamorphosed *schistes lustrés*, and thought to be autochthonous nappes having their roots

in Tuscany, Italy. Heavily dissected, mountainous relief is characteristic, reaching 5,800 ft. in the district of Castagniccia (chestnut woods). North of the Golo river, the nappes are folded in wider, clearer amplitudes, the synclinal basins of Novella and St. Florent alternating with the two anticlinal ranges of the Agriates and Cap Corse. To the west and southwest of these alpine structures, the remaining two-thirds of Corsica comprise the rejuvenated remnant of an ancient land mass. This is granitic Corsica, with its rock types weathered into distinctive land forms. The hornblende granite weathers rapidly into softly rounded plateaus, while the hard granulites and rhyolites form the high ridges and rugged pinnacles notable in the Calanques de Piana on the west coast. Further variety is produced by gabbros, diorites, serpentines and eroded breccias of volcanic origin, while parallel and transverse dikes may run for several miles as scarped walls, especially in the southeast. Chemical weathering has been marked, especially in the curious hollowed-out *tufoni* of the northwest, and in the low limestone karst (*q.v.*) of Bonifacio. Quaternary glaciation has only modified the high relief of the summits. Much more significant has been the deep valley erosion, the major valleys flowing first in flat-floored waterfalls (*e.g.*, Scala de Santa Regina).

A major contrast is presented between the coasts of the east and the west. In eastern Corsica the extensive coastal plain of Aleria (about 40 mi. in length and up to 8 mi. wide), together with smaller plains farther north and south, reveal emergent features with lagoons, sandspits, etc. Facing west, the coast has submergent features, with deep rias and small isolated plains at their head, cut off from each other by rocky headlands. Such are the drowned gulfs of Valinco, Ajaccio, Sagone and Porto, with former coast lines detached as in the Îles Sanguinaires and with deep water inshore. The ancient Hercynian folds and later fractures running northeast-southwest are represented by 30–40 main valleys and interfluves on the western coast, making coastal communications difficult. In contrast the eastern mountain flanks are less broken and descend steeply and rapidly to the extensive coastal plain. This plain was infilled by the deposits of the two largest rivers, the Golo in the north and the Tavignano farther south, and by those of numerous secondary streams which flow down the eastern mountain sides. The upper courses of most of the rivers are flat-floored, high basins just below the mountain crests. From them the streams descend rapidly in their middle courses through gorges. The western rivers flow to the heads of the gulfs where they have formed small, isolated plains at the sea's edge, each one separated from that at the mouth of the next stream by cliffed promontories.

Climate.—The Corsican climate is typical of the western Mediterranean. By virtue of its insular position and moderate size, the temperature range is reduced and the precipitation is above the average. Mean monthly temperatures near the coast vary from about 50° F. in January to 75° F. in August. The annual precipitation ranges from about 24 in. at sea level to over 50 in. in the mountains. There is approximately the same amount on both sides of the island, thunderstorms having their maximum intensity on the eastward, leeward coast. On average there are 60–70 rain days in the year, the maximum occurring generally in the autumn, although the wet season is prolonged into the late spring. Summer drought is most pronounced in the extreme south. The snow line lies at about 4,500 ft. in April, but snow disappears from the peaks by late May. (J. M. Ho.)

Vegetation and Animal Life.—The flora belongs to the Sardo-Corsican province. The natural plant cover can be divided into four zones according to altitude. (1) The Mediterranean belt from sea level up to 1,300 ft., which includes halophytes (seacoast plants) with sandy habitat and rock creviced plant associations; *maquis,* with arbutus, tree heath, mastic, buckthorn, myrtle and rosemary; and *garigue* of cistus—the *maquis* and *garigue* alternating with olive tree cultivations and woods of cork oak or holm oak. (2) The submontane belt (1,300–3,000 ft.) consisting of woods of chestnut, pubescent oak (*Quercus pubescens*) or maritime pine (*Pinus pinaster*). (3) The montane belt (3,000–5,000 ft.) where are found pure or mixed communities of Corsican pine, beech and fir. (4) The alpine belt with Corsican alter shrub, stunted subshrub formations, grass communities and boulder vegetation in altitudinal sequence. This zone extends to the bare areas of the higher summits.

The mountainous interior holds wild boar, foxes, deer and hares and also game birds. There, too, is the mouflon, the only European wild sheep. (R. E. G. P.-S.; Ma. Bu.)

Archaeology.—After a Neolithic period having affinities with that of North Africa and the eastern Mediterranean, which can be traced in the rock shelters by arrowheads and obsidian blades and scrapers as well as a traditional microlithic industry, the Chalcolithic culture penetrated to Corsica at the beginning of the 3rd millennium B.C. It did not use hypogea, but employed natural caves (rarely) for burials. Some rock paintings of this period in red ochre of a schematic art and possibly of Iberian treatment were discovered in shelters to the west of Cap Corse.

In the Early Bronze Age (2500–1700 B.C.) the important Megalithic religion covered the island with dolmens, great cists, and numerous isolated and grouped menhirs. Palaggio, situated 4 km. (2.4 mi.) from the sea and 2 km. to the right of the road from Sartène to the little port of Tizzano, alone comprises more than 90 menhirs in two rows. The granite of all these monuments was carefully worked. At the end of the Early Bronze Age, after the zenith of the Megalithic culture, occurred an insular phase of artistic evolution. This was represented first by engravings on dolmens (circles and bossed bulls' horns) and later by engravings on the menhirs, which progressively advanced to the stage of a true culture—that of the statue menhir—at the beginning of the Middle Bronze Age. More than 40 statues, varying from the archaic to sculpture in the round and from 6 to 9 ft. high, have been examined in the island's two principal groups; the southern group is the most dense and the most characteristic. The main centre of this culture, where it also reached its peak, was at Filitosa, a site 40 km. (25 mi.) S. of Ajaccio. There, between 1948 and 1959, 16 statues were found, most of them armed with swords and daggers in low relief. These statue menhirs are unique and their art form, peculiar to the island, cannot usefully be compared with that of groups elsewhere. The anthropomorphic statues of Corsica were probably representations of dead personages, for they were connected with a funerary cult. They have been dated from the 15th to the 14th centuries B.C., immediately before the arrival of a new civilization—that of the builders of circular, dry-stone monuments, sometimes of cyclopean arrangement, with inner chambers and passages. In the walls of one of these, six earlier statue menhirs were found broken up and used as building material.

These circular monuments, called *torre,* reach a diameter of about 50 ft. and have been definitely attributed to the period between the Middle and Late Bronze Age—1700 to 1200 B.C. They form part of a Mediterranean Bronze Age current covering, among other regions, Apulia in southern Italy with its specchie (rude stone structures); and Gallura and the north of Sardinia (*q.v.*) with its galleried nuraghi (dry-stone towers) or pseudonuraghi. These basically related monuments served both a funerary (by cremation) and a religious purpose; their importance lies in the fact that they were anterior to, or at the very beginning of, the Nuraghic civilization of Sardinia. In Corsica the principal circular monuments, of which there are about 30, are near Filitosa and, higher up, in the Taravo valley, at Balestra, at Foce and at Torre on the east coast near Porto-Vecchio. Of the Iron Age (Hallstatt) there are several funeral sites yielding ornaments and bronze weapons, tanged, as at Cagnano near Luri. In the centre of the island there are rock engravings with stylized and geometrical signs. (R. A. Gr.)

History.—The recorded history of Corsica (Greek Cyrnos or Kyrnos) begins *c.* 560 B.C., when Greeks from Phocaea in Asia Minor founded the town of Alalia on the east coast. Twenty years later almost the whole population of Phocaea, fleeing the Persian armies, joined the colony; but in 535 the Greeks were defeated in battle by an allied Carthaginian-Etruscan fleet. Although Herodotus states that they abandoned Alalia, archaeology shows that Greek influence remained paramount there during the next 300 years, in spite of Carthaginian and Roman ambitions. Sicilian Greeks raided the coast in 453 and 384, but the island had fallen

under Carthaginian domination by the end of the 4th century. In 259 B.C. Lucius Cornelius Scipio won a great victory over the Carthaginians and captured Alalia, then known as Aleria.

The Romans.—The indigenous population put up a ferocious resistance to the Roman invaders. The conquest of the island was achieved in a sequence of hard-fought campaigns between 234 and 163 B.C. Corsica, with Sardinia, was formed into a single Roman province. In 93 B.C. Gaius Marius founded Mariana; 13 years later Lucius Cornelius Sulla rebuilt Aleria.

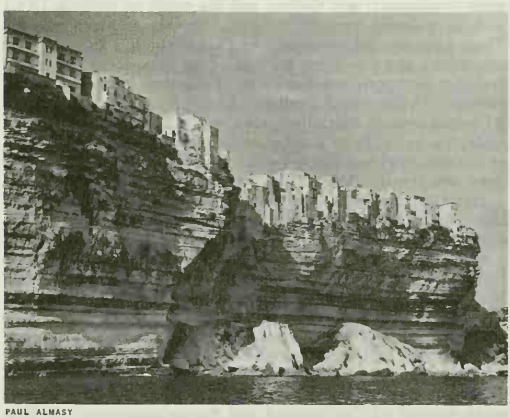
Though the philosopher Lucius Annaeus Seneca complained bitterly of his exile in Corsica (A.D. 43–49), under the Roman empire the island flourished. Ptolemy's map shows a string of ports round the coasts and numerous inland settlements. The Romans built roads, cultivated the fertile east coast and implanted their language—the basis of the subsisting Corsican dialect. Christianity had taken root by the 3rd century.

Barbarian Invasions and the Papacy.—With the collapse of the West Roman empire the Vandals invaded Corsica (*c.* 450), entirely destroying Aleria. They are remembered chiefly for deforesting large areas for shipbuilding timber. A brief Ostrogothic occupation intervened before the island was finally reconquered by the Byzantines and organized with Sardinia as a province (552). The Corsicans gained nothing by the change, for they were mercilessly overtaxed by corrupt officials.

In 725 Corsica was annexed to the Lombard kingdom of Italy, to be freed about 50 years later. Meanwhile the Frankish king, Pepin the Short, in 757, had promised the island, when liberated, to the papacy. The donation was confirmed by Charlemagne. The pope was thenceforth titular ruler of Corsica, but in practice delegated its administration.

Before the Corsicans could benefit by this arrangement they were subjected to about 300 years of Saracen invasions. Raids from north Africa had begun early in the 8th century; incursions from Spain followed. In spite of expeditions organized by Charlemagne and his son Pepin of Italy the attacks became increasingly frequent and destructive. The Tuscan count Boniface II founded Bonifacio, in the south, after a victorious crusade (*c.* 828); but by the mid-9th century conditions had become so desperate as to produce a mass exodus of Corsicans to Rome. Corsica, it seems, was finally freed from the Saracen menace early in the 11th century by the combined action of Pisan and Genoese fleets.

Pisa and Genoa.—In 1077 Gregory VII asserted papal authority by entrusting the administration of Corsica to the bishop of Pisa. The domination of the Pisans was an enlightened ecclesiastical protectorate; innumerable churches were built under their direction. Genoa, however, soon manifested hostility. In 1133 Pope Innocent II attempted to appease the conflict by dividing the jurisdiction of the six Corsican bishoprics between the republics of Pisa and Genoa, three to each. The compromise satisfied neither; war between them was constant off the coasts. Bonifacio, fiercely disputed, fell to the Genoese in 1187; peopled by their citizens it became their base for territorial expansion.



PAUL ALMASY

BONIFACIO, ON THE CLIFFS OF CORSICA; FOUNDED IN 828

The 13th century saw the rise to power of the ambitious feudal family of Cinarca. During the next 250 years its leaders, established in large fiefs in the west and south, sought to extend their domination over the whole island. Thus Sinucello della Rocca, known as the *giudice* (judge) of Cinarca, virtually ruled Corsica during the latter half of the 13th century, until, as a vassal of Pisa, he was captured and imprisoned by the Genoese. Meanwhile Genoa had defeated the Pisans in the naval battle of Meloria (1284), and the role of Pisa in Corsica was at an end.

Genoa and Aragon.—In 1296 Pope Boniface VIII invested James, king of Aragon, with the suzerainty of Corsica and Sardinia. This unfortunate step inaugurated a new period of rivalry and war. While Aragon sought to prepare the annexation of the island by alliances with the nobles of Cinarca, republican Genoa cultivated the allegiance of the common people, who had begun to resent the increasing pretensions of the minor feudal lords. An Aragonese attack on Bonifacio in 1346 drove the Genoese to action. In the following year they sent an expeditionary force to conquer the island, but the Black Death cut short the campaign. It was not until ten years later that they could again turn their attention to Corsica. The moment was favourable. Sambocuccio d'Alando, elected leader of the populations of central Corsica, led a successful revolt against the feudal lords of that region. Needing support, he appealed to Genoa to assume the government of the island. The Genoese seized the offer with alacrity. Their governors' authority, however, was only operative in the north and centre, where the feudal regime had been broken: this territory was known as the Terra di Comune. The Cinarchesi, favouring Aragon, remained in control of the south.

Arrigo della Rocca was the first who attempted to dominate Corsica with Aragonese aid (1376). Genoa, alarmed at the prospect of a costly war, assigned Corsica to a financial company known as the Maona. Its forces had to combat Arrigo on and off until his death in 1401. Bastia, founded by the Genoese about 1380, became their administrative capital. With the death of Arrigo, his nephew, Vincentello d'Istria, took up the Aragonese cause. By 1420 he had all but ousted the Genoese from Corsica. Aragonese troops, commanded by King Alfonso V, landed the same year. The town of Calvi submitted; but the Genoese inhabitants of Bonifacio successfully resisted the Spanish fleet in a heroic five months' siege. Alfonso V thereupon abandoned the island, leaving Vincentello as viceroy. Vincentello's rule was uncontested until he was captured and executed by the Genoese in 1434.

At this period a new class of Corsican leaders emerged: the *caporali*. Originally elected magistrates or chiefs of the districts freed from the feudal regime, they came to form an influential and greedy subaristocracy, obtaining pensions from the Genoese and other rulers in return for their co-operation.

Bank of San Giorgio.—After a period of anarchy the Genoese in 1453, at the request of a Corsican delegation, placed the island under the government of the Bank of San Giorgio. This was a powerful financial company already entrusted with the administration of Genoa's eastern colonies. The rule of the bank was opposed by a series of formidable revolts led by the war lords of Cinarca: Raffe da Leca (executed in 1456), Rinuccio da Leca (executed in 1489), Gian Paolo da Leca (exiled in 1500) and Rinuccio della Rocca (assassinated in 1511). The officers of the bank retaliated with the utmost ruthlessness: they burnt villages, crops and trees and forcibly exiled the population of the Niolo (a mountain region). With the death of Rinuccio della Rocca, who had kept them at war for ten years, the power of the Cinarchesi was finally broken.

The Genoese scorched earth policy was compensated by various efficient constructive works: the coastal towns were refortified, Ajaccio was founded (1492), and a chain of watchtowers built round the coasts as defense against Moorish raids. The administration was not, in its form, tyrannical. The governor was assisted by three lieutenants and a *vicario*, who judged criminal cases; local government and civil jurisdiction remained in the hands of

the Corsicans, the *pievi* (groups of parishes) being administered by a podesta (mayor) aided by *raxioneri* (accountants), all Corsicans and elected by the people. Nonetheless many of the more dynamic Corsicans preferred to emigrate rather than submit to the unpopular foreign regime. Constant raids on the coasts by Barbary pirates added to the general distress. As soldiers of fortune Corsicans made their names in all the Italian states; others built up fortunes in Spain and Marseilles.

Sampiero Corso and the First French Intervention.—It was a soldier of fortune of humble origin, Sampiero Corso, who once again offered the Corsicans an alternative to Genoese rule. Engaged first in the troops of Giovanni de' Medici and then in the French army with the rank of colonel, in 1553 Sampiero prevailed on Henry II of France (then at war with the Holy Roman emperor Charles V, ally of Genoa) to invade Corsica. The French army was supported by the Turkish fleet and a strong Corsican contingent commanded by Sampiero. By 1556, when the truce of Vaucelles put an end to hostilities, the French had occupied the whole island except Calvi and Bastia. They ruled judiciously until Corsica was returned to Genoa by the treaty of Cateau Cambrésis (1559), to the disappointment of most of the people. Having unsuccessfully solicited aid from Turkey, Sampiero returned to Corsica with a handful of followers and waged a desperate three years' war against the Genoese until he was killed in an ambush in 1567.

Genoese Rule.—The republic, having assumed direct control of the island, reorganized its administration. A revised legal code was promulgated. Justice was rendered by the governor, by various officials (some of whom were Corsicans) and by the podestai. The governor could condemn to death without trial. Eighteen Corsican delegates—12 for the northeast (the *nobili dodici*) and 6 for the southwest (the *nobili sei*)—were charged to formulate the grievances of the people. Every year they sent an *oratore* to Genoa to present their requests. If this regime was not really totalitarian, its execution left much to be desired. The Genoese officials were usually ruined gentlemen who sought to recuperate their fortunes by selling privileges and favours. The administration of justice was notoriously corrupt. In these circumstances the Corsicans preferred private vengeance; the vendetta (*q.v.*), a custom dating back to the early middle ages, increased, in spite of the harsh repressive measures of the Genoese. In 1676 Genoa ceded a tract of land to about 700 Mainote Greeks, refugees from Turkish oppression. They remained loyal to the republic.

Nationalist Rebellions.—In 1729 rebellion broke out in central Corsica following a dispute with a Genoese tax collector. Genoa solicited help from the Holy Roman emperor Charles VI, who sent troops and negotiated a peace in 1732. Its terms, however, were not respected, and in 1734 the Corsican nationalists again took to arms. The leaders, Luigi Giafferri and Giacinto Paoli, declared the island independent and proclaimed a democratic constitution.

In 1736 the German adventurer Theodor, baron von Neuhof (*q.v.*) landed with a shipload of arms and supplies. Promising important foreign help, he managed to persuade the Corsican leaders to crown him king (Theodore I) at Cervione. This fanciful but not incompetent charlatan distributed titles of nobility, coined money and won some military successes until, running out of funds, he left the island the same year. The rebellion nonetheless continued. Genoa sought assistance from France. The comte de Boissieux (Louis de Frétat) was defeated by the Corsican patriots in 1738; but the marquis de Maillebois (J. B. Desmarets), replacing him, overcame resistance in a rapid campaign which drove Giafferri and Paoli into exile. Peace was re-established when the French withdrew in 1741.

Two years later Theodore reappeared on a British ship, but left hurriedly, having been coldly received by his "subjects." The Corsicans obtained more serious aid from Charles Emmanuel III, duke of Savoy-Sardinia, then the ally of the Austrians and the British in the War of the Austrian Succession. British warships and Sardinian troops captured Bastia in 1745, but the town was retaken soon afterward by a combined Genoese-Franco-Spanish force.

Unable to master the situation, Genoa again obtained French help. The marquis de Cursay (Séraphin Rioult de Douilly) between 1748 and 1753 conciliated the patriots and made himself so well-respected on the island that the Genoese, jealous of his influence, contrived to have him removed. Thereupon the Corsican leader Giovan Pietro Gaffori put into execution a previously prepared democratic constitution. He was murdered in 1753.

Pasquale Paoli.—At this crucial moment in the national struggle Pasquale Paoli (*q.v.*), the 30-year-old son of the exiled Giacinto, landed in Corsica. In July 1755 he was elected general of the Corsicans at an assembly in the Franciscan monastery of San Antonio della Casabianca. Within the next six months he had overcome a rival Corsican faction. With the Genoese confined to their coastal towns, Paoli proceeded to organize Corsica as an independent democratic state from his mountain capital, Corte. The constitution that he gave to his countrymen was more liberal than any known in his day. The legislative power was exercised by *consulte* composed of representatives elected by all male Corsicans of 25 or more years of age; Paoli himself held the executive power assisted by an elected council. During the 14 years of his rule this man of genius was able to lead the Corsicans in a great regenerative effort: he repressed the vendetta, created a university and a printing press, coined money, founded a port (L'Île-Rousse) to replace Genoese Calvi and built a navy which took part in his conquest of the island of Capraia (1767).

The Genoese, powerless, once again turned to France. By the treaty of Compiègne (1764) Louis XV undertook to garrison their coastal towns in Corsica for four years. Paoli vainly sought an alliance with France in which Corsican independence would be recognized. In 1768 the Genoese sold their rights on Corsica to France, and French troops invaded the island in overwhelming numbers. The Corsicans were decisively defeated at Ponte Nuovo in May 1769. Paoli embarked for England in June. Two months later, on Aug. 15, Napoleon Bonaparte was born in Ajaccio.

The French Revolution and the Napoleonic Period.—For the next 20 years Corsica was administered as a *pays d'états* under the French monarchy, which recognized the Corsican nobility and accomplished various useful public works. But the French Revolution (1789) was welcomed by the Corsicans. In 1790 the constituent assembly declared Corsica a *département* of France. By virtue of the amnesty of political exiles Pasquale Paoli returned to the island the same year. Enthusiastically acclaimed by the people, he was appointed president of the administrative council and commander-in-chief of the national guard. Paoli, however, had little sympathy with the new regime. He was opposed to the extremes of revolutionary policy and resented the influence of the Jacobin clubs in the Corsican towns. Blamed for the failure of an expedition against Sardinia in 1792, he was arraigned by the Convention (April 2, 1793). His response was to convoke a national assembly at Corte in May 1793, an act tantamount to a declaration of rebellion. Napoleon Bonaparte, loyal to revolutionary France, was driven off the island by Paoli's partisans. Paoli appealed for British protection.

Admiral Samuel Hood reached Corsica in Feb. 1794; by August the British had reduced the three coastal towns held by revolutionary troops. In June the Corsican assembly formally accepted the constitution of the Anglo-Corsican kingdom. British rule lasted two years, with Sir Gilbert Elliot as viceroy. Paoli's presence being considered responsible for growing unrest, he was invited in 1795 to return to England, where he died in 1807.

In Aug. 1796 the British government ordered the evacuation of Corsica. An expeditionary force, dispatched by Napoleon from Italy, moved into the island in October while British troops were embarking. British forces again occupied Bastia for a short time in 1814, but in the settlement of 1815 Corsica was restored to the French crown.

19th and 20th Centuries.—During the 19th century the French accomplished the immense task of building roads in Corsica and providing public education. The island remained underdeveloped but the Corsicans found many opportunities for making successful careers in continental France and the French colonies. With the final suppression of banditry, in the 1930s, and the elimination of malaria at the end of World War II, Corsica—*l'Ile de Beauté*—

began to attract an important tourist traffic.

Napoleon secured the permanent loyalty of his countrymen to France. More than 20,000 Corsicans died in World War I. Mussolini's claim that Corsica formed a natural part of Italy met with no response from the Corsicans, as became obvious when in Nov. 1942, during World War II, 80,000 Italian troops under Gen. G. Magli occupied the island. Later they were joined by about 15,000 Germans. The Corsicans organized a redoubtable resistance (incorporated in the Front National) which, when Italy capitulated on Sept. 8, 1943, was able to liberate Ajaccio and inflict serious damage on the German forces, the Italians co-operating or remaining neutral. Free French units from Algiers joined the struggle on Sept. 20. Between Sept. 29 and Oct. 4 the Germans were driven from the island, retreating via Bastia. The Italians retired to Sardinia. As the first liberated *département* of metropolitan France Corsica served as a valuable base for the Allies.

The *coup d'état* of May 13, 1958, in Algiers (*see* FRANCE: *History*) was followed on May 24–25 by a similar movement in Corsica, where committees of public safety were set up in Ajaccio, Corte, Calvi and, subsequently, Bastia and Bonifacio. Corsica thus played a prominent part in the events which brought Gen. Charles de Gaulle to power as the first president of the 5th French republic. (D. CA.)

Population.—In 1954 the population of Corsica was 246,995. Nearly three-quarters lived in settlements of less than 2,000 inhabitants. The distribution of chestnut forests, formerly an important source of food, helps to explain the marked concentration of many villages and hamlets at 1,300 to 2,500 ft. above sea level (114 out of 204 settlements in northeast Corsica) and for the traditional high density of population in the district of Castagniccia. Favoured areas, such as the semiurban environs of Bastia, Ajaccio (*qq.v.*) and L'Île-Rousse, and the fertile districts of Cap Corse and the Balagne, have the highest densities, with more than 500 persons per square mile. Nearly one-half of the country has an average density of from 50 to 150 per square mile, and almost as large an area is very sparsely settled. The uplands of Agriates and the central mountain chain are almost deserted. The scourge of malaria along the coasts below 1,000 ft. (*i.e.*, the upper limit of the mosquito *Anopheles maculipennis*), especially in the eastern plains, explains their low densities. After a number of half-hearted efforts a vigorous campaign in 1948–49 made the plains healthy for the first time in centuries. Despite a high birth rate the population only grew from 163,896 in 1801 to 322,854 in 1936. Since then it has fallen rapidly and by 1961 was estimated at around 140,000. Emigration, the result of rural poverty and the lack of industrial employment, has long been a feature, accelerated further during World War II by refugee movements from the island. There were many Corsican casualties in the war.

In 1954, 84% of the urban and 29% of the total population lived in the two principal towns, Bastia (42,729), the chief port, and Ajaccio (28,732), the administrative capital. Apart from the cities, six other centres have today between 2,000 and 5,000 inhabitants, all on the coast except Corte (*q.v.*), the third town (4,369) and for a short time in the 18th century the capital. Bastia owes its importance to its favourable position as the nearest port to southern France, its control of much of the trade of the east coast, the terminus of the railway system and its being the outlet for the most densely populated hinterland. Ajaccio is well placed to dominate the commercial activities and tourism of the west coast.

The physical characteristics of the people are strikingly uniform and perhaps of ancient ethnic identity. In the past the strict system of marriage within a group of related families may have aided this; certainly the vendetta between opposing families was a negative control. The Corsicans are Roman Catholics, apart from a small minority of Greek Orthodox at Cargèse, descended from Greek settlers in the 18th century. The Corsican dialect is more akin to Italian than French, and is widely spoken. A northern variety, Cismontan, is of Tuscan origin, and in the south Oltremontan has more affinities with the dialect spoken in northern Sardinia.

J. M. HOUSTON

PRINCIPAL TOWNS AND CITIES, RAILWAYS AND LAND USE IN CORSICA

The Economy.—Hampered by lack of capital and primitive methods of agriculture, the cultivated land has never been of much importance. Cereal lands declined seriously after the mid-19th century; early vegetables now occupy a more extensive area and have a more promising future. Olive groves, especially in the Balagne, and vineyards in Cap Corse and the main valleys have been traditionally the chief crops. Fruit trees, especially citrus almonds and peaches are cultivated in the low, sheltered areas of Nebbio, Balagne, Porto-Vecchio and Ajaccio. Chestnuts, once a dominant source of food supply, have greatly declined except in the Castagniccia. Most cultivators are proprietors of holdings averaging about 44 ac. The land is much fragmented and terracing on the mountain slopes is extensive. A typical holding may have a small vineyard and olive grove, valley land periodically reclaimed from waste or under intensive cultivation, and a share in the communal chestnut woods and pastures.

Rough pasture, still utilized seasonally by transhumant flocks of sheep and goats, occupies more than a quarter of the total area. A large number of dairies produce *broccio* from the goats' milk which is sent to Roquefort, France, for final processing as cheese. Two-thirds of the ewes' milk is also made into cheese.

Fishing has never been important and is still largely a subsistence economy. The industries of Corsica are of small scale and diverse, being chiefly dependent upon the agricultural and forest products. They include the preparation of tannic acid from chestnut bark; the manufacture of edible pastes, cheese, tobacco and citron preserves; making semifinished pipes from the roots of heath; canning fish; sawmilling; and charcoal making. There is also the bottling of mineral waters from local spas (notably Orezza), the mining of anthracite and several nonferrous metals and the quarrying of granite, marble and amianthus, a kind of

asbestos which is found and processed at Canari. After 1937 some hydroelectric plants were installed, but there has been little capital available to exploit fully the potential power of the rivers.

Corsica is well served by regular shipping services from the ports of Marseilles, Toulon, Nice, Genoa and Leghorn, and also by air transport; but internal communications are rather poor. A survey of 1949 showed that about half the main roads were too narrow, and there are still villages inaccessible by road. A motor road of varying quality encircles the island to link the coastal towns. A narrow-gauge railway connects Bastia and Ajaccio with a branch line to L'Île-Rousse and Calvi. The eastern branch line to Porto-Vecchio was left unrepaired after destruction during World War II.

See also references under "Corsica" in the Index volume.

(J. M. Ho.)

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CORSICANA, a city of central Texas, U.S., seat of Navarro county, is about 55 mi. S.S.E. of Dallas. Named by Jose Antonio Navarro after Corsica, where his father was born, it was settled in 1848, incorporated in 1850 and chartered in 1871. (For comparative population figures *see* table in TEXAS: *Population.*)

Site of an early oil discovery (1894; first production 1895), the area's petroleum output is valued at $10,000,000 annually. Navarro county is a large cotton producer and is noted for its fine Hereford cattle. (N. McG.)

CORSINI, a Florentine princely family, whose first recorded ancestors rose to wealth as wool merchants in the 13th century. As typical members of the *popolo grasso* (rich merchants) which ruled Florence during the later middle ages, they regularly served as priors and ambassadors of the commune. Filippo Corsini (1334–1421) was created count palatine by the emperor Charles IV in 1371. Two Corsinis were bishops of Fiesole, Andrea (1349) and Neri (1374); and two bishops of Florence, Piero (1363) and Amerigo (1411). Though some of the Corsini opposed the Medici, the family as a whole continued to flourish in business and politics under Medici rule, acquiring titles, lands and offices. Thus another Filippo (1578–1636), who managed affairs in Rome, was created by Pope Urban VIII marquis of Sismano, Casigliano and Civitella, of which his father Bartolomeo (1545–1613) had earlier purchased the lordships; and Bartolomeo di Filippo (1622–85) was in turn made marquis of Laiatico and Orciatico by grand duke Ferdinand II, and marquis of Giovagallo and Tresana by the king of Spain. Further titles followed the election of Lorenzo Corsini as pope Clement XII in 1730; his nephew Bartolomeo (1683–1752) was made prince of Sismano and a grandee of Spain (1732). Lorenzo began the Biblioteca Corsiniana, now in the Accademia dei Lincei at Rome. Throughout the Napoleonic period and down to the unification of Italy the Corsini remained active and influential in Tuscan affairs. The family continues.

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(P. J. J.)

CORTE, the largest inland town in the island of Corsica, France, is situated on the Tavignano river 84 km. (52 mi.) N.E. of Ajaccio by railway. Pop. (1954) 4,369. At the upper (west) end of the town stands the citadel built in 1420 by H. Vincetello d'Istria, the Aragonese viceroy, and to the southwest are the crags of Monte Rotondo. Corte was the island's capital under the provisional government formed by Pasquale Paoli (*q.v.*) during his dictatorship of 1755–69, and during the English occupation under Sir Gilbert Elliot (1794–96). The only buildings of interest are in the upper town and include, opposite the church, the Maison Gaffori, the scene in 1750 of the heroic resistance to the Genoese made by Mme. Gaffori, who held the house until relieved by her husband, Gen. Giampietro Gaffori. Both the general and Paoli are commemorated by statues. There are marble quarries in the neighbourhood and the town has a trade in wine, olive oil, chestnuts and cheeses.

CÔRTE-REAL, JERÓNIMO (1533–1588), Portuguese epic poet who endeavoured, with little success, to follow in the path opened by Camões' *Lusíadas,* was of the same noble family as the famous explorer Gaspar Côrte-Real. He took part in military actions on land and at sea. He had some gift for painting as well as being a poet and soldier; one of his pictures is preserved in the church of S. Antão in Évora. He produced three epic poems: *Sucesso do segundo cêrco de Dio* (1574), on the historic siege of that Indian island-fortress; the *Austriada* (1578), in Spanish, on the victory of Don John of Austria at Lepanto; *O Naufrágio de Sepúlveda* (1594). All are long, discursive and prosaic and are of only slight literary value.

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CORTÉS, HERNÁN or HERNANDO (1485–1547), Spanish conqueror of Mexico, born at Medellín, Estremadura, in 1485. He studied law at the University of Salamanca but returned home in 1501, probably without a degree. In 1504 he sailed to Santo Domingo (Hispaniola), where he settled as a farmer and public notary in Azúa, a small town on the island, while friends and neighbours sailed for dangerous if glorious conquests. In 1511 he accompanied Diego Velázquez in his expedition to Cuba, where he became alcalde of Santiago (then the capital). Velázquez sent Cortés to Yucatán to rescue two unsuccessful expeditions and to explore the country. On Feb. 19, 1519, Cortés set out with 11 vessels, 508 soldiers and captains, 100 seamen including pilots and masters, 16 horses, 10 bronze guns, 4 falconets and 13 shotguns. In March 1519, he landed at Tabasco where he stayed for a time in order to gain knowledge from the natives, who, though somewhat awed by the strangeness of the men, the weapons and the animals, fought and defended their land. He won them over however and received presents from them, as well as 20 women, one of whom, Doña Marina (Malintzin), became his mistress and interpreter and bore him a son, Martín. He sailed to another spot on the coast and founded Veracruz, mainly to have himself elected captain general and chief justice by his soldiers as citizens, thus shaking off the authority of Velázquez. He then had his ships run aground and dismantled, a fact which gave rise to the legend that he burned them. He set out for the interior, relying sometimes on force, sometimes on amity toward the local chiefs but always careful to reduce disturbance and duress to a strict minimum. The nation of Tlaxcala, in a state of chronic war with Montezuma, ruler of the Aztec empire of Mexico, resisted Cortés at first but when defeated became his most faithful ally. Rejecting all of Montezuma's threats and blandishments to keep him away from Tenochtitlán or Mexico, the capital (rebuilt as Mexico City after 1521), Cortés entered the city on Nov. 8, 1519, with his small force and only 1,000 Tlaxcatecs. Montezuma, believing him to incarnate the Aztec god Quetzalcoatl, received him with great honour. Bernal Díaz, a soldier in the army, gives a vivid picture of the wealth of the city, the horrors of its human sacrifices and the magnificence of the emperor. Cortés decided to seize Montezuma in order to hold the country through its monarch, and achieve not only its political conquest but its religious conversion. He found a convenient pretext as the news reached the city that the garrison he had left in Veracruz had been attacked by the Indians and his chief killed. He went with his officers to the palace and seized Montezuma whom he put in irons. He obtained the surrender of the leader of the Veracruz attack and burned him at the stake using for faggots the wooden weapons he discovered Montezuma had amassed. This done, with his own hands he unlocked the irons on the emperor's feet. He was by that time master of Mexico. But then Montezuma first, and Cortés later, heard of the arrival of a Spanish force under Pánfilo de Narváez sent by Velázquez to deprive him of his command. Leaving a garrison in Tenochtitlán of 80 Spaniards and a few hundred Tlaxcatecs, he marched against Narváez, defeated him and enlisted his army in his own forces. On his return, he found the Spanish garrison after an irresponsible aggression besieged by Indians. Montezuma was killed as he was trying to induce the Indians to cease their

attacks. Hard pressed and lacking food, Cortés decided to leave the city by night. The operation was performed, but with heavy loss in blood and booty. After six days of retreat he won the battle of Otumba over the Indians sent in pursuit (July 7, 1520). Well received by his allies of Tlaxcala, he reorganized his forces, subdued the neighbouring territories and after a stubborn siege captured the city (Aug. 13, 1521). This victory marked the fall of the Aztec empire.

Several embassies he had sent to Spain convinced the emperor Charles V of the immense value of the conquest. Cortés returned to Spain (1528), was appointed captain general and made marqués del Valle de Oaxaca. He lived like a prince and worked like a statesman. He revealed himself as the greatest of the conquerors, intent on organizing the land, studying its resources and pushing forward the work of exploration within and outside the country he had conquered. His enemies in Madrid and in Mexico did their best to thwart his efforts. His goods were seized by order of the council of the Indies and his retainers imprisoned. He went to Spain to appeal to the emperor, who received him with marks of honour and friendship; but he returned to Mexico with a diminished authority, for Charles V appointed Antonio de Mendoza as viceroy. Frustrated in his ambition as governor of the country he had conquered, Cortés explored the peninsula of Lower California (1535) and surveyed part of the gulf between it and Mexico. Earlier, his exploration of Las Hibueras (Honduras) was a feat of leadership and endurance perhaps even greater than his conquest of Mexico.

Discouraged by his struggle with unworthy adversaries, Cortés sailed to Spain again. This time he was received coldly. He attended the emperor assiduously and served as volunteer in the disastrous expedition against the pirates of Algiers in 1541. Kept at arm's length by the noblemen who surrounded Charles V, he was unable to take a military part worthy of his talents in that enterprise which under his command would in all likelihood have been a brilliant success. The emperor was unable to find employment for the ablest leader in the country. He retired from court and died in his estate of Castilleja de la Cuesta near Seville on Dec. 2, 1547. (*See* also MEXICO CITY; AZTEC.)

The only writings of Cortés are the five letters addressed to Charles V. The best edition is that of Francisco Antonio Lorenzana, archbishop of Mexico, entitled *Historia de Nueva España escrita por su esclarecido conquistador, Hernán Cortés, aumentada con otros documentos y notas* (1770). An English translation, edited by Francis A. MacNutt, was published in 1908.

See also references under "Cortés, Hernán" in the Index volume.

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(S. DE M.)

CORTÉS, a small department of Honduras facing the Caribbean sea. Pop. (1961) 199,215; area 1,527 sq.mi. The department consists mostly of coastal plains and river lowlands, has fertile soils and an annual precipitation of 60 to 80 in. It has good transport facilities. Main products are bananas for export with nearly 40% of the national total. It also produces rice, sugar, sweet potatoes, poultry and cattle. Puerto Cortés (pop. 12,228) at the mouth of the Ulúa river is the largest port in Honduras and is connected by Inter-Ocean highway with Tegucigalpa. The departmental capital, San Pedro Sula (*q.v.*), is an important banana and sugar centre. (C. F. J.)

CORTES, the plural form of a Spanish word meaning court, is used in particular to designate the parliaments of the medieval Spanish kingdoms and, in modern times, the national legislative or deliberative assembly. The *Cortes* developed in the middle ages when elected representatives of the free municipalities began, as of right, to take part in the deliberations of the *curia regis* on certain subjects. Their admission was due to the crown's need for financial aid beyond that provided by its customary dues and its inability, in law, to impose extra taxation without the consent of the municipalities. In both León and Castile the *Cortes* were in existence by the early 13th century. Their functions and procedures were similar and, after the union of the two crowns (1230), they often held joint meetings—a procedure which was normal after 1301. Parliaments also functioned in Catalonia from 1218, Valencia (1283), Aragon (1274) and Navarre (1300).

The *Cortes* of León and Castile was composed of three estates: nobles, clergy and the *procuradores* of the free municipalities (*concejos*), who bore written instructions (*poderes*) from their electors. Redress followed supply. The king convoked meetings when and where he pleased. The crown's proposals were discussed and voted on by the whole *Cortes*. The three estates also had the right to present petitions to which the king must reply. If he accepted a petition it became law. During the 14th century the *procuradores* dominated the *Cortes* because they, and only they, could authorize the special taxation needed by the crown. The nobles, largely exempt from such taxation, and the clergy virtually withdrew from the *Cortes* and an alliance of king and *procuradores* was used to weaken the political power of the magnates. The influence ot the third estate in the Castilian *Cortes* reached its peak in the last decades of the 14th century, because of the continuous needs of the early Trastámara kings to finance their wars. Under John I, the *procuradores* not only intervened in foreign affairs and administrative matters outside their earlier competence, but insisted on supervising the royal accounts and on the formation of a royal council on which they were represented. Decline, thereafter, was swift. Alienation of crown lands reduced drastically the number of free municipalities entitled to be represented. Roman and canon lawyers, dependent on the king and partisans of royal supremacy, secured a foothold in the *Cortes*. The crown then contrived, by various devices, to lessen its financial dependence on the *procuradores* and their capacity to resist its demands. Nevertheless, and despite its part in the rising of the *comuneros* against the emperor Charles V (1520–21), the *Cortes* of Castile was more prominent in 16th-century affairs than has often been thought.

The Catalan *Cort general* had three estates, which, in theory, the sovereign was obliged to summon at regular intervals. Barcelona sent five representatives (*sindichs*), the other municipalities only one. Redress preceded supply, and the *Cort* had legislative power. Royal proposals were studied separately, in committee, by each estate and these informed each other of their conclusions before meeting in plenary session under the presidency of the crown. From the mid-14th century a permanent parliamentary commission (*diputació del general*), resident in Barcelona, was set up to act when the *Cort* was not in session. In practice the Catalan parliament was strongly oligarchical. The parliament of Valencia was modeled on that of Catalonia, and the Aragonese *Cortes* borrowed from the Catalans the idea of a permanent commission, the form of municipal representation, and other features. In Aragon, however, the magnates and lesser nobility were separately represented, and the nobles were always very powerful. A special feature there was the office of *justicia mayor*, a hereditary and immovable official who heard complaints, in parliament, against the king and his officials or of violations of charters and rights. At one period the Aragonese *Cortes* claimed the right to depose the king if it so wished, but the latter, in practice, had more power than in theory, for only he could initiate legislation. Unlike any other peninsular parliament, the *Cortes* of Navarre voted the customary taxes as well as extraordinary subsidies.

All these assemblies survived until the 18th century, but long before then they were dead politically. In 1700, for example, the *Cortes* of Castile had not been summoned since 1665, while the assemblies of Catalonia and Valencia had last met in 1640 and 1645 respectively. The situation was unaltered by the change of dynasty; indeed, the *Cortes* of Aragon and Valencia in 1709, and that of Catalonia in 1724 were merged with the *Cortes* of Castile. The Bourbon kings viewed the *Cortes* merely as a rubber stamp and this attitude fairly characterized its position until the 19th

century. For the development of the *Cortes* in the constitutional era, *see* SPAIN: *History*. (P. E. R.)

CORTEX, the outer portion of various structures in the biologic world. It is sometimes used figuratively. In botany it means the rind, bark or outer portion of the stalks of a variety of growths. Medicinally it is employed to describe the origin of certain drugs such as quinine from cinchona bark. In the medical sciences it is used to designate the outer portion of various organs such as the brain, kidney, adrenal glands, etc., as distinguished from the inner substance. The cortex usually lies just beneath or within the covering layer or membrane or capsule if one is present. (F. L. A.)

CORTI, LUIGI, CONTE (1823–1888), Italian diplomatist, foreign minister at the time of the congress of Berlin, was born at Gambarana (Pavia) on Oct. 28, 1823. Early involved with Benedetto Cairoli in anti-Austrian conspiracies, he was exiled to Turin, where he entered the Piedmontese foreign office in 1846. After serving in the campaign of 1848, he was in 1850 appointed secretary of legation in London, after which he was minister in Stockholm (1864), Madrid (1867), The Hague (1869), Washington (1870), and Istanbul (1875). Called by Cairoli to the direction of foreign affairs in 1878, he took part in the congress of Berlin, but declined Lord Derby's offer for an Anglo-Italian agreement in defense of common interests. At Berlin he sustained the cause of Greek irredentism, but otherwise remained isolated and incurred the wrath of his countrymen by returning to Italy with "clean hands." In Oct. 1878 he resigned. In 1881 he was sent to Istanbul by Cairoli, where he presided over the futile conference on the Egyptian question. In 1886 he was transferred to London as ambassador, but he was brusquely recalled by Francesco Crispi in the following year through a misunderstanding. The shock may have led to his death in Rome on April 9, 1888.

CORTINA D'AMPEZZO, a mountain resort of the Dolomites, province of Belluno, Veneto region, northern Italy, is situated in a beautiful hollow among fir-covered mountains on the left bank of the Boite river, 74 km. (46 mi.) N. of Belluno by road. Pop. (1957 est.) 6,640 (commune). Its altitude is 4,016 ft. The town is dominated by its modern Gothic church whose tall bell tower plays chimes identical with those of Westminster abbey, London. The huge Olympic ice stadium and the two artificial ice tracks were built for the seventh winter Olympic games, held here in 1956, and at nearby Zuel is the Olympic ski-jumping chute. Cortina is on the railway from Pieve di Cadore to Dobbiaco. There is much local work in wrought iron, filigree and inlaid wood, especially cuckoo clocks. Cortina is one of the towns which make up the Great Community of Ampezzo and the people still retain their national costumes and Raetic or Ladin language. (M. T. A. N.)

CORTISONE, one of several hormones secreted by the cortex (outer layer) of adrenal glands. Cortisone is useful in treating adrenal cortical insufficiency (Addison's disease) in man. Beginning in 1948, it was found clinically useful in suppressing the symptoms of rheumatoid arthritis and related diseases, certain allergies, acute leukemia, and certain inflammatory conditions of the eye and skin. Large doses are required. It does not cure these diseases. Sometimes the therapeutic use of cortisone causes gastric ulcers, edema, diabetes, hypertension, hirsutism, psychic disorders, etc., making it necessary to stop this type of therapy. Hydrocortisone, a somewhat more potent adrenocortical hormone, has similar therapeutic effects and the same limitations. Similar clinical effects can be obtained by administration of adrenocorticotropin (ACTH), secreted by the anterior pituitary, which stimulates the adrenal cortex to secrete cortisone and hydrocortisone. The clinical use of these natural hormones has been largely superseded by synthetic derivatives of hydrocortisone that are more potent and suppress the symptoms of disease with fewer side effects. *See* STEROIDS; *see* also references under "Cortisone" in the Index volume. (D. J. I.)

CORTLAND, a city of central New York, U.S., on the Tioughnioga river midway between Syracuse and Binghamton; the largest community in, and seat of Cortland county. Originally part of the Phelps and Gorham purchase (1788), Cortland was first settled in 1791. It was incorporated as a village in 1853 and as a city in 1900.

Cortland's diverse manufactures include industrial wire cloth and netting, wire, nails, forgings and stampings, motor trucks, women's foundation garments and various precision mechanisms. Dairying is the predominant agricultural activity of the area, and sales of cattle, poultry, eggs and maple sirup are significant.

A State University College of Education, founded in 1863 and offering elementary and secondary school training, is located there. Winter sports and proximity to the Finger lakes are among the area's attractions. Three miles north is the village of Homer, the "Homeville" of the novel, motion picture and radio series *David Harum*.

For comparative population figures *see* table in NEW YORK: *Population*. (R. C. HE.)

CORTONA, PIETRO DA (PIETRO BERRETTINI) (1596–1669), Italian painter and architect, one of the leading exponents of baroque art, was born at Cortona on Nov. 1, 1596. He created great illusionistic ceiling decorations at Rome in the Palazzo Barberini and the Chiesa Nuova, and in the Palazzo Pitti at Florence. Cortona built at Rome the church of SS. Martina e Luca and the façade of Sta. Maria della Pace and submitted in 1664 an unsuccessful design for the Louvre at Paris. With G. D. Ottonelli he wrote a treatise on the iconography of religious art, *Trattato della pittura e scultura, uso et abuso loro* (1652). He died at Rome on May 16, 1669. (D. R. CN.)

CORTONA, a city of central Italy, region of Tuscany, province of Arezzo, is situated at the end of the Val di Chiana on the south slope of the Colle di San Egidio and on the right bank of the Esse river, 120 km. (75 mi.) S.E. of Florence by road. Pop. (1957 est.) 29,527 (commune). The chief streets are wide and flat but the smaller ones are steep. There are several fine squares, and from the Piazza del Duomo there is an excellent view of the Chiana valley and Lake Trasimeno. The medieval walls survive, built on top of Etruscan walls. The cathedral has a partly Romanesque west front, a Renaissance-type bell tower and a fine portal by Giuliano da Sangallo (15th century). It contains paintings by Luca Signorelli, who was born in Cortona, and a magnificent Greco-Roman sarcophagus of an unknown warrior. In front of the cathedral is the church of Gesù (15th century), now a museum. It consists of one church superimposed on another. The upper church has a fine carved wooden ceiling by Michelangelo Leggi (1536). Notable among the exhibits is a painting of the Annunciation by Fra Angelico. The churches of S. Domenico, S. Antonio and S. Francesco are fine Gothic. The Romanesque Gothic church of Sta. Margherita and the church of the Madonna del Calcinaio are also noteworthy. The railway station is at Camucia, 4.5 km. ($2\frac{3}{4}$ mi.) away on the main line from Florence to Rome. Agriculture and stock raising are the main occupations. Once a malarial marsh, the Val di Chiana was drained and produces some of the best cattle in Italy.

The Roman Corito, the town was probably of Umbrian origin but was later an important Etruscan magisterial centre. In Roman days Hannibal passed by it to his victory at nearby Lake Trasimeno (217 B.C.), and in A.D. 405 it was taken by the Goths. It emerged from a long period of obscurity in 1202, when it was a free commune. It was sacked by Arezzo in 1258. Cortona recovered and had its own mint as well as becoming an episcopal see in 1325. After a long period of peace it was besieged in 1529 by the armies of Clement VII and Charles V, and thereafter joined the grand duchy of Tuscany. In World War II it was captured by Allied forces in July 1944. (M. T. A. N.)

CORTOT, ALFRED DENIS (1877–1962), French pianist, conductor and teacher known for his poetic interpretations of the later romantic composers, was born at Nyon, Switz., on Sept. 25, 1877. He studied the piano at the Paris Conservatoire under Louis Diémer and, after gaining experience as assistant conductor at Bayreuth, conducted the first French performance of Wagner's *Götterdämmerung* (1902). He founded the Société des Concerts and the Paris Orchestre Philharmonique. In 1905 he formed a trio with Jacques Thibaud and Pablo Casals, and in 1918 founded

the École Normale de Musique in Paris where his piano classes had a wide influence. Cortot published works on piano technique, a historical survey of French piano music, and edited the works of Chopin and Schumann. He also made one of the finest private collections of musical autographs. About 1950 he retired to Lausanne, Switz., where he died on June 15, 1962.

CORT VAN DER LINDEN, PIETER WILHELM ADRIAAN (1846–1935), Dutch Liberal statesman, prime minister during World War I, was born at The Hague on May 14, 1846. Up to 1881 a solicitor at The Hague, from then to 1897 professor of economics at Groningen and Amsterdam, he started reuniting the Liberals on a program of social reform in 1886. He was minister of justice in the cabinet that succeeded in enacting much of this program (1897–1901). In 1902 he was made a member of the state council. In 1913 Cort van der Linden formed an extraparliamentary cabinet, which during World War I succeeded in bringing about a revision of the constitution. In 1917, this settled both the franchise and the school issues, which for half a century had dominated Dutch politics. Proportional representation, with universal male suffrage, was introduced; and private denominational schools were put on the same financial footing as public secular ones. After his resignation in 1918 Cort van der Linden was again appointed a member of the state council. He died at The Hague on July 15, 1935. (F. DE J.)

CORUM, the chief town of the *il* (province) of Corum, Turk., altitude 2,300 ft., is situated on the edge of a plain, almost equidistant from Amasya and Yozgat on the main road to the Black sea coast at Samsun, 130 mi. N.N.E. of Ankara. Pop. (1960) 34,629. The country around is fertile and extensively cultivated; cereals, fruits, tobacco and opium poppies are the chief crops. Corum is an important hand-spinning and weaving centre. Manufacturing of copper utensils and leather is also carried on. The ancient Euchaita, 15 mi. E., was attacked by the Huns in 508 and became a bishopric at an early period. It contained the tomb of St. Theodore, who was reputed to have slain a dragon in the vicinity and became one of the great warrior saints of the Greek church. The *il* of CORUM has a population of 446,389 (1960). The chief *ilceler,* or *kazas,* are Alaca, Iskilip, Mecitozu, Osmancik and Sungurlu. (N. TU.; S. ER.; E. TU.)

CORUMBÁ, a city and river port (1960 pop. 36,744) in the state of Mato Grosso, Brazil. Situated on the Paraguay river at 360-ft. elevation, and fronting on Bolivia, the town was founded as a military outpost and colony in Sept. 1778 by Luis de Albuquerque. Corumbá's position was enhanced by the opening of the Paraguay to international commerce following the Paraguayan War (1865–1870) when it became terminus of river craft from Buenos Aires and Asunción. The buttes of Morro do Urucum to the south contain vast deposits of manganese and iron, mined since the 1940s. Corumbá produces animal products such as hides and dried beef, and is the leading entrepôt centre in southern Mato Grosso. It is a junction of air routes and has railroad connections with São Paulo and Santa Cruz, Bolivia. (J. L. TR.)

CORUÑA, LA (often in English CORUNNA; French LA COROGNE; English formerly THE GROYNE), capital of the province of the same name occupying the northwest corner of Spain, lies on Ría de la Coruña (Corunna bay), an inlet of the Atlantic ocean. Pop. (1960) 177,502 (mun.). A peninsula jutting northward separates Orzán bay on the west from the harbour on the east. The old town (Ciudad Vieja) occupies an eastern spur of the peninsula; the modern city (Ciudad Nueva or Pescadería "fishing quarter") stands on the low isthmus joining the peninsula to the mainland and on the mainland itself. A feature of the houses is their *miradores,* or window balconies glazed for protection against the wind. In the old town are the early 12th-century church of Santiago and the church of Santa María del Campo (13th century but badly restored). The church of Santo Domingo is in 18th-century Galician baroque; south of it in the Jardín de San Carlos overlooking the harbour is the granite tomb of Sir John Moore. About 2½ km. (1½ mi.) northwest of the old town, near the end of the peninsula, is the "tower of Hercules." It is supposed to have been built by the Phoenicians but was probably a Roman lighthouse dating from Trajan's reign. It commands a fine view and still serves as a lighthouse.

Separating the old and new towns is the wide Plaza de María Pita, named after a heroine who displayed great bravery during the English attack of 1589. Near the Alameda gardens with their palms and orange trees is Canton Grande; a tablet on No. 13 marks the house where Sir John Moore died. Corunna is a popular summer resort and has excellent bathing beaches on Orzán bay and at Santa Cristina, 5 km. (3 mi.) S. The town has streetcar and bus services and is linked by rail with Madrid and with Oporto in Portugal. It has schools of navigation and agriculture, an arsenal and barracks.

Because of its position near a great sea route between northwest Europe and South and Central America, Corunna is one of the chief ports of northern Spain. The sheltered harbour can accommodate ocean-going vessels; it is a regular port of call for several shipping lines and is the chief Spanish passenger port for Cuba and South America. Corunna is an important fishing centre for sardines, herrings, haddocks and conger eels, and has a salting and canning industry. It also exports farm produce (especially onions and potatoes), and its imports include coal, salt and manufactured goods. There is a state tobacco factory in the southern suburb of Santa Lucia and shipyards for building fishing vessels.

History.—Under the Roman empire, Corunna was the port of Brigantium, but its present name is probably derived from that of Coronium by which it was known in the middle ages. In 1370 it was for a short time occupied by the Portuguese. In 1386 John of Gaunt landed there to conquer Galicia in pursuit of his claim to the kingdom of Castile. Philip II of Spain sailed from Corunna in 1554 to marry Mary Tudor of England, and in June 1588 most of the ships of the "invincible armada" despatched by him against England were forced by heavy squalls to take refuge in the port. In the following year an expedition sent in reprisal under Sir Francis Drake and Sir John Norris burnt the shipping at Corunna and sacked the lower part of the town. In 1815 and 1820 it was the scene of antimonarchist risings; in 1823 following a siege it was taken by French troops engaged in restoring the reactionary rule of Ferdinand VII. In 1836 it was captured by the Carlists (adherents to Don Carlos: *see* SPAIN: *History*). Corunna suffered heavily when Spain was deprived of Cuba and Puerto Rico by the Spanish-American War of 1898, for it had hitherto had a thriving trade with those colonies. Nationalist troops captured it early in the Civil War of 1936–39.

To many English-speaking people Corunna is familiar chiefly through *The Burial of Sir John Moore after Corunna,* a famous funeral elegy written in 1816 by the Irish poet Charles Wolfe (*q.v.*). Moore, commanding the British forces in Spain, was toward the end of 1808 advancing to relieve the pressure on the Spaniards by attacking Marshal Nicolas Jean de Dieu Soult on the Carrion river when he learned that the French had cut off his retreat into Portugal. (*See* PENINSULAR WAR.) He therefore withdrew on Corunna—a march of more than 200 mi. across the Cantabrian mountains in midwinter. The supply and transport services were inadequate and British losses through straggling and sickness were heavy, but on Jan. 11, 1809, Moore reached Corunna to find that the British fleet had not yet arrived. He chose as his main position the Monte Mero ridge straddling the road by which Soult must approach, about 3 km. (2 mi.) S. of the harbour. Soult, with about 16,000 troops opposed to Moore's force of about 15,000, attacked on Jan. 16. The initial advantage lay with the British but unfortunately a round shot struck Moore from his horse, carrying away his left arm; knowing his wound to be mortal he handed over command to Sir John Hope and was carried from the field. At evening he died. The battle flickered out; neither side could claim a victory (each had lost about 900 men) and the British were able to embark next day unmolested in the fleet which had by then arrived. At dawn Moore, "his martial cloak around him," was buried in the ramparts of the citadel; the place was later laid out as a garden. (*See* also MOORE, SIR JOHN.)

Corunna Province.—The province, until 1833 part of the captaincy-general and former kingdom of Galicia (*q.v.*), has a population (1960) of 991,729, and an area of 7,876 sq.km. (3,041 sq.mi.). It has a rocky coast with deep indentations

formed by drowned valleys. These (Santa Marta, Ferrol, Corunna, Corcubión, Arosa bays) afford sites for sheltered ports but the coast is dangerous because of frequent winter gales and fogs in winter and spring. Cape Finisterre (the Promontorium Nerium of the Romans), a huge granitic mass 100 km. (62 mi.) S.W. of Corunna by road, is one of the chief European headlands.

The interior of the province is mountainous but seldom exceeds 1,500 ft. elevation and is drained by many short rivers. The climate is mild and equable but the rainfall is the heaviest of any Spanish province (Santiago de Compostela, 66 in. annually). The slopes are covered with woods (oak, chestnut) and pastures and in the valleys beans, onions, potatoes and fruit are grown for export. The broken nature of the country discourages cereal growing but in limited areas heavy crops of maize (corn), wheat and rye are obtained. The local wines are heady, rough and of inferior flavour. The breeding of pigs and cattle is important, though the export of livestock, once considerable, declined because of foreign competition. A little tin, tungsten, copper and lignite are mined and Vimianzo near the west coast was once famous for its gold mines. Along the coast there are valuable fisheries of sardines, lobsters, hake and other fish. The chief exports are farm produce and fish; the imports coal, petroleum fuels, salt fish, timber, hides, salt and manufactured goods.

The principal ports are Corunna and El Ferrol (*q.v.*). The chief inland town is Santiago de Compostela (*q.v.*). Air services link Santiago with Barcelona, Bilbao and Madrid but other communications are sparse. Except for a main railway line from Corunna through Lugo to Madrid, with a branch northward to El Ferrol and a southward line through Santiago to Vigo and Oporto, the inhabitants are dependent on somewhat indifferent roads.

See O. Pedrayo, *Guia de Galicia* (1954); Martínez-Barbeito, *Galicia* (1957). (M. B. F.)

CORUNDUM is a mineral composed of aluminum oxide, Al_2O_3, and in its finer varieties forms valuable gems such as ruby and sapphire (*qq.v.*). The massive form in combination with iron oxides and spinel is called emery (*q.v.*). The name corundum is believed to be derived from Hindi (*Karund*), the mineral first being identified from India.

Next to diamond, corundum is the hardest known mineral (9 on Mohs' scale), this being sufficient to separate it from all other minerals. The pure mineral is colourless, small amounts of impurities explaining the wide range of colours in nature. Ruby contains chromium, sapphire presumably iron or titanium; most corundum contains nearly 1% iron oxide. Zoisite, sillimanite, kyanite, margarite, damourite and hydrated alumina minerals are common alteration products. Corundum is used for bearings in fine machinery such as watches and motors and, as emery, for polishing. It is a prominent constituent of many refractories, in many instances being formed on firing. Artificial corundum (*q.v.*) has similar properties and has become the source of most pure alumina (*q.v.*) abrasives. Synthetic rubies and sapphires that defy detection by all but the expert are manufactured. Gem corundum has come principally from Ceylon, Burma, Thailand, Montana, and Queensland, the stones being recovered from metamorphic rocks and placer deposits. Corundum has also been mined in Ontario, South Africa, the Ural mountains, South Carolina and other places.

Corundum crystallizes in the hexagonal system (rhombohedral class) showing considerable variety of habit, the commonest being acute hexagonal bipyramids, sometimes in barrel-shaped forms, or tabular owing to predominance of the basal form. Corundum has no true cleavage but a parting parallel to the base and the rhombohedron, the latter a plane of lamellar twinning, sometimes secondarily produced through pressure. Density is 3.95 to 4.0, refringence (refraction) as high as 1.7686 (sodium light), melting point 2,040° C., dielectric (nonconductive) constant about 10. Corundum resists attack by acids and alkalies. Alumina-rich melts have great power of crystallization, making it difficult to preserve glasses of such composition. Single crystal alumina rodies can be formed into rods and bent at high temperature, yet retain monocrystallinity. No other natural Al_2O_3 mineral is known but essentially anhydrous oxides are encountered in laboratory studies, differing distinctly from the α-Al_2O_3 or corundum phase into which they transform on heating to about 1,200° C. So-called β-Al_2O_3 is actually $Na_2O.11Al_2O_3$, and is not a dimorph of corundum as was long thought.

B. M. SHAUB

CORUNDUM CRYSTALS FROM TRANSVAAL, SOUTH AFRICA, IN BARREL AND TABULAR FORMS

Corundum is widespread in nature, occurring in igneous, sedimentary and metamorphic rocks. Certain rocks of the syenite clan commonly carry appreciable corundum. The occurrence of corundum in quartz-bearing igneous rocks is rare and is considered anomalous from thermodynamic considerations. *See* also GEM.

(W. K. GR.)

CORUNDUM, ARTIFICIAL, has the same properties as natural corundum (*q.v.*) or α-alumina. Probably the most important advance in the abrasive field was the development of techniques around 1900 for the large-scale production of artificial corundum. In addition to being very hard (9 on Mohs' scale) artificial corundum is exceedingly strong. It fractures in such a way that new, sharp cutting points are continually formed. It has low specific heat and thermal expansion. These properties adapt it particularly to the working of materials of high tensile strength, such as the various steels, which is the most important use for abrasives. The grains are used extensively in all kinds of grinding and polishing wheels, coated paper, cloth and disks, and to a lesser extent as loose grains. Specific applications are exemplified by the following: automatic and hand-grinding operations of all types, for snagging steel castings, surface and internal grinding, honing, tool and cutter grinding, polishing articles such as cutlery and hardware; cut-off saws; loose grain polishing of plate glass and metallurgical specimens; in dental and other air-drills. Fused alumina is employed as grog, in special refractory concrete. Fine bearings, record-player needles, and other uses employ artificial corundum crystals.

Artificial corundum sometimes is known as fused bauxite, or fused alumina, and by trade names such as Alundum, Borolon, Aloxite, Lionite, and Oxaluma. Fused bauxite is made by melting calcined bauxite (composition approximately 86% Al_2O_3, $<7\%$ SiO_2, 3% Fe_2O_3, 3% TiO_2 and $<1\%$ water) with coke and metallic iron in electric arc furnaces of several tons capacity, at a temperature of about 2,200° C. Hanging graphite electrodes carry alternating current to the melt. Furnaces are of two types: (1) batch, a removable conical shell on a flat, carbon-lined, wheeled base, (2) continuous, tilting furnaces from which small pigs can be poured. Furnace shells are water-cooled. Large continuous furnaces may operate at several thousand kilowatts.

In batch furnacing the coke reduces oxide impurities to elements, which unite with the added iron to form magnetic ferrosilicon; this settles to the bottom, leaving the alumina in a much purified state. Carbon is eliminated as carbon monoxide (CO) which burns to the dioxide (CO_2) on leaving the furnace. When the furnace is fully charged the electrodes are withdrawn, and before long the shell can be lifted off to allow the several ton ingot to cool. As it solidifies, the alumina crystallizes into a solid mass of large irregular crystals. Both batch and continuous procedures can be controlled to yield a product containing roughly 95% alumina, 1.5% silica, 0.5% ferric oxide, and 3% titania.

The lump abrasive is crushed and ground in jaw crushers, rolls, and ball mills, followed by removal of residual magnetic material by magnetic separators. Grading into a great variety of size fractions, from 6 mesh per inch to micron sizes, is carried out by vibrating screens, hydroclassifiers, and air separators. Fused bauxite is commonly deep reddish-brown and translucent.

The production of white abrasive from Bayer process calcined alumina (which itself is largely artificial corundum) has continuously expanded. This employs essentially the same process as for calcined bauxite (*q.v.*), but the starting purity of the alumina (99%) obviates the need of separation of silicon and iron. Bayer alumina contains some soda, part of which combines with

alumina to form so-called β-alumina, actually $Na_2O.11Al_2O_3$, which is brittle and objectionable in the final product. It may be removed from the cooled batch pig by cobbing the central and upper zones where it tends to segregate during crystallization. Other impurities imparting colour to the product are also objectionable. White fused alumina is crushed and sized as is fused bauxite. A special process involving fusion and crystallization in a water-decomposable matrix allows the development of small, sharp, separate crystals that can be recovered as such, avoiding the need of heavy crushing and sizing. Artificial corundum is also produced as a specialty product by slow accretion and controlled growth on a boule in an oxyhydrogen flame. *See* GEM: *Synthetic Gems.*

See A. W. Wilkinson, "The Production of Synthetic Abrasives," *Canadian Chemical Processing*, vol. 38 (Sept. 1954); A. L. Ball and A. A. Kline, "Applications of Abrasives," *A. S. T. M. Stand.*, Bull. 191 (July 1953). (W. K. GR.)

CORVALLIS, a city in western Oregon, U.S., at the head of navigation of the Willamette river, 85 mi. S.W. of Portland; seat of Benton county. Founded as Marysville in 1850, the name was changed to Corvallis ("heart of the valley") in 1853. It was incorporated in 1857. Essentially nonindustrial, the community centres its cultural, social and athletic activities around Oregon State college, founded in 1858, oldest and largest of the state's institutions of higher education. The unique Horner Museum of the Oregon Country is located there. Camp Adair of World War II, a short distance from Corvallis, is the site of an air force installation of the North American Air Defense command (NORAD). For comparative population figures *see* table in OREGON: *Population.* (J. W. E.)

CORVÉE, a term used in feudal law to designate the regular work that vassals owed their lord. It came to mean a contribution and in medieval Latin it meant labour exacted by the authorities. From this was derived the Old French *corvée,* adopted without change by the English.

In France the distinction was made between the *corvées réelles* (genuine), those days of work due in return for the property right, and *corvées personnelles* (personal), due by reason of residence and usually confined to road work. The term has retained its meaning as a payment in kind or in work levied on the inhabitants of a parish for the upkeep of local roads. It has also come to be used figuratively as a military term to describe fatigue duty, and thence extended to describe any drudgery or any work done reluctantly.

The use of the *corvée* as a system of obtaining labour dates from ancient times. Under the Roman empire, personal services were due from certain classes of the population to the state and also to private proprietors. Obligations were imposed on freedmen as a condition of their enfranchisement and in the country usually took the form of unpaid work on the landlord's domain. The semiservile *coloni* were bound, besides paying rent in money or kind, to do a certain number of days' unremunerated labour on that part of the estate reserved by the landed proprietor. The state also exacted personal labour from certain classes in lieu of taxes for such purposes as the upkeep of roads, bridges and dikes. The inhabitants of the various regions were responsible for the maintenance of the posting system, for which horses, carts or labour would be requisitioned. Under the Frankish kings, who followed the Roman tradition, this system was preserved. Between the 6th and 10th centuries the Gallo-Roman estates were converted to the feudal model, and the officials of the Frankish empire developed into hereditary feudal nobles. They evolved the system of the *corvée* as it existed throughout the middle ages in Europe.

Similar labour obligations existed in other parts of the world. In Japan the *yo* system of imposing compulsory labour on the farmers was incorporated in the tax system in the 7th century A.D. This system included *yo* (labour tax) of 10 days per year; *cho* (tax on materials produced) of 10 days per year; and *so* (land tax) of 20 days per year. Certain articles such as silk cloth might be paid in lieu of the forced labour. In Egypt it is said that 100,000 men were made to work 3 months per year for 18 years to build the Great Pyramid. The *corvée* was used for centuries to obtain labour to remove the mud left at the bottom of the canals by the rise of the Nile. The *corvée* system was enforced with the *kurbash,* a strip of hippopotamus hide used for flogging. When the use of the *kurbash* was outlawed in 1883 by British authorities, enforcement of the *corvée* became difficult. It was partially abolished in 1886 and by 1892 was completely eliminated for dredging purposes. However, there still remained an emergency obligation to guard the banks of the Nile river to prevent inundation.

Although the *corvée* applied originally to feudal dues, it later became synonymous with statute labour, a specified amount of labour on public projects required by law. The *corvée* was revived when money payment did not provide sufficient labour for public projects. This might occur when public revenues were low, when there was a shortage of labour, or when the available labour did not customarily seek outside employment. It was revived in France in 1726 for road work and was finally abolished during the French Revolution. In England and Scotland statute labour on roads was used from the 16th through the 19th centuries, by which time the turnpike system had begun to take over the main roads. Compulsory labour was also enforced in the American colonies, able-bodied male inhabitants being required to contribute days of labour on public works. In the northern colonies all male inhabitants were liable but in the southern colonies the obligation was generally limited to labourers, servants and slaves. The obligation to work on the roads was carried down to the 20th century in many localities, although a money payment was accepted in lieu of labour. This requirement was held in 1916 not to violate the U.S. constitutional prohibition against involuntary servitude and was considered in the same category as training in the militia.

The basic distinction between the *corvée* and forced labour is that the *corvée* is a general and periodic short-term obligation; forced labour is usually prescribed for a long or indefinite period as a method of discipline or discrimination on a highly selective basis. The Forced Labour convention adopted by the International Labour organization (ILO) in 1930 defined forced labour as "all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily." Forced labour for private employers was outlawed. Forced labour for public purposes was allowed during a transitional period for the purpose of work in the public interest; as a form of tax or as a personal service exacted by chiefs who are duly recognized; for porterage; and in agriculture to protect against famine. The ILO definition of forced labour specifically excluded military service, normal civic obligations of a citizen, work or service imposed by court decision after due process of law and work required during emergency conditions such as flood or earthquake.

The 1930 convention applied primarily to colonial territories, and it became outmoded as a result of the social evolution that took place in these territories. In 1957 the ILO adopted the Abolition of Forced Labour convention which reflected a fundamental change in the purpose of forced labour. The later convention was directed chiefly at such countries as Albania, Bulgaria, the People's Republic of China, Czechoslovakia, Hungary, Poland, Rumania, the U.S.S.R. and Yugoslavia, which after World War II had instituted a national policy for the utilization of involuntary labour. In the 1957 convention the ILO outlawed any form of forced labour "(a) as a means of political coercion or education or as a punishment for holding or expressing political views ideologically opposed to the established political, social or economic system; (b) as a method of mobilizing and using labour for purposes of economic development; (c) as a means of labour discipline; (d) as a punishment for having participated in strikes; (e) as a means of racial, social, national or religious discrimination."

In the People's Republic of China there are both types of compulsory labour. Civilians may be drafted to spend ten days a year on road work, repairing dikes, etc. Permanent forced labour is recruited from both ordinary convicts and "counterrevolutionaries," and is used for water conservation projects, railway construction and agriculture.

Compulsory labour in Africa is generally limited to the condi-

tions allowed by the ILO convention. It was instituted by Europeans to counteract the African's resistance to leaving the village to work for wages. In French West Africa the *corvée* was applied until 1946; all able-bodied African males were obliged to work about 15 days a year on public works. In Belgian territories, compulsory agricultural work up to 45 days per year, 15 days of public works and liability for porterage existed in the 1950s, although an individual might substitute a money payment. Forced labour is forbidden in all British territories in Africa, although porterage service to native chiefs and compulsory agricultural work may still be found. Road repairs and porterage are allowed in Liberia. In South Africa, the hiring of prisoners to private individuals for agricultural labour is common. Unpaid labour could be requisitioned in Portuguese Africa for public works, and contract labour for private employers could be recruited among Africans who could not prove financial responsibility.

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CORVETTE, a type of ship-rigged sloop of war in the days of sail. Corvettes usually carried only one tier of guns and in size ranked below frigates. The last of the true corvettes in the British navy were scrapped in 1903, but the name was revived during World War II to denote lightly armed and highly maneuverable vessels designed for antisubmarine escort duty. These new corvettes possessed many of the capabilities of destroyers but were smaller and were less expensive to build and operate. More than 150 were built or begun in Britain and Canada, and some were transferred to the United States under reverse Lend-Lease. Some of the "Castle" class of corvettes were in the British fleet in 1959, but had been redesignated antisubmarine frigates, 2nd rate. Typical characteristics were as follows: displacement, 1,580 tons, fully loaded; length, 252 ft.; beam, 37 ft.; draft, 15½ ft.; speed, 24 knots. Their complement was 100 officers and men. (J. B. HN.)

CORVIDAE, the family of birds that includes jays, magpies, ravens and crows, said to be the cleverest of the perching birds. *See* CROW; JAY; MAGPIE; RAVEN.

CORVUS, MARCUS VALERIUS (*c.* 370–270 B.C.), Roman general. According to legend a raven (*corvus*) settled on his helmet during his combat with a gigantic Gaul and distracted the enemy's attention by flying in his face (349). He was twice dictator and six times consul, and occupied the curule chair 21 times. In successive campaigns he defeated the Volsci, the Samnites, the Etruscans and the Marsi. Not all the victories attributed to him by tradition can be accepted.

See Livy, bk. 7–10 *passim.* (H. H. SD.)

CORWIN, THOMAS (1794–1865), U.S. congressman, cabinet member and diplomat, was born in Bourbon county, Ky., on July 29, 1794. In 1798 his father, Matthias Corwin (1761–1829), moved to what later became Lebanon, O., where the son worked on the farm, read widely and in 1817 was admitted to the bar. With his remarkable wit and intelligence Corwin became an immediate success as a lawyer. During the 1820s he served three terms in the Ohio general assembly, but after 1831 he turned to national politics, identifying himself with the Whig party. He was a member of the national house of representatives, 1831–40; governor of Ohio, 1840–42; U.S. senator, 1845–50. His most memorable speech in the senate was his attack on the Mexican War delivered on Feb. 11, 1847. He was secretary of the treasury (1850–53) in the cabinet of President Fillmore. Because of his innate conservatism, he entered the Republican party reluctantly, and as a member of that party returned to the national house of representatives in 1859. During the crisis of 1861 he served as chairman of the congressional committee of thirty-three, which sought a compromise between North and South. Corwin was U.S. minister to Mexico in 1861–64 and was instrumental in preventing Southern agents from gaining support from the Mexican government. He died at Washington, D.C., Dec. 18, 1865. (N. A. G.)

CORYATE, THOMAS (1577?–1617), English traveler and writer of early books of travels, was born at Odcombe, Somerset, *c.* 1577, where his father was rector. Educated at Winchester college and at Gloucester hall, Oxford, he became a kind of court fool, eventually entering the household of Prince Henry, the eldest son of James I. In 1611 he published *Coryats Crudities,* an account of the travels in France, Italy and other countries, covering nearly 2,000 mi. on foot, which he had undertaken in 1608.

Verses written by Ben Jonson, John Donne, George Chapman, Michael Drayton and other poets in mock praise of the author were added to the volume at the command of Prince Henry, and afterward reprinted as the *Odcombian Banquet* (1611). In the same year Coryate published a second work of the same nature as his first, *Coryats Crambe.* In 1612 he set out on another journey, again mostly on foot, to Greece, the Holy Land, Persia and India. He sent home from Agra and Ajmere an account of his adventures. Some of his letters were published in 1616 under the title *Thomas Coriate Traveller for the English Wits: Greeting,* and some fragments of his writings were included in *Purchas His Pilgrimes* (1625). Coryate's writings are not without humour and show a genuine, if uncritical, interest in antiquities. He died at Surat, India, in Dec. 1617. (P. Dw.)

CORYBANT, one of the Corybantes, daimones with much the same relation to the Asiatic Great Mother of the Gods (*q.v.*) as the Curetes (*q.v.*) bear to Zeus. From their first appearance in literature, they are often identified or confused with the Curetes, and are distinguished only by their Asiatic origin and by the more pronouncedly orgiastic nature of their rites. Various accounts of their origin are given: they were earthborn sons of Cronus, of Zeus and Calliope, of Rhea, of the Great Mother and a mystic father, of Apollo and Thalia, of Athena and Helios. Their names and number are vague and vary from one authority to another. It is known that they had a mystic cult and that a prominent feature of their ritual was a wild dance, which was claimed to have powers of healing mental disorder. It seems possible that originally they were priests or medicine men of ancient times, later thought of as superhuman.

In art the Corybantes appear, usually not more than two or three in number, fully armed and executing their orgiastic dance.

CORYDON, a town of southern Indiana, U.S., seat of Harrison county, located 20 mi. W. of Louisville, Ky. Corydon was settled about 1805 and was the capital of Indiana territory (1813–16) and of the state from 1816 until the capital was moved to Indianapolis in 1825. The convention which drafted the first constitution for Indiana met there in June 1816. Indiana's first statehouse stands in the public square. The Civil War battle of Corydon, in which Confederate raiders captured and held the town for a few hours, was fought between the forces of Gen. John H. Morgan and the Corydon home guards on July 9, 1863. The oldest continuous county fair in Indiana is held in Corydon yearly in September. Wyandotte cave is located 12 mi. west.

Corydon is the centre of an active agricultural area; its principal crops are poultry, eggs, beef and dairy cattle and burley tobacco. Industries include a furniture factory, a poultry processing plant and glassworks. The population is about 2,700.

COS (STANKO; Gr. Kos; Ital. Coo; Turk. ISTANKOY; Lat. Cos), an island of Greece not far from the southwestern corner of Asia Minor, is the second largest of the Dodecanese (*q.v.*). Pop. (1951) 19,076, nearly all Greek. Area 282 sq.km. (109 sq.mi.). The island consists of three regions: an abrupt limestone ridge (anc. Prion, "the saw," from its jagged profile) along the eastern half of the south coast; a rugged peninsula (Kephala) at the west end; and a central lowland of fertile marls prolonged along the north coast to the ancient capital facing the mainland. Along the north slope of the Prion ridge copious deep-seated springs provide water for the town and for extensive irrigation. Cos lettuce is well known. The principal resources of Cos are its vineyards, figs and olives; wheat, barley and maize are grown,

though a considerable proportion of the arable land is left untouched. Melons, grapes and other summer fruits are exported in large quantities to Egypt, mostly in local sailing boats. Cotton, tobacco, sesame and silk are grown in small quantities. The capital, Cos (pop. [1951] 8,390), is on the northeast coast.

The medieval harbour is fit only for quite small vessels, but the roadstead is safe in most weathers and steamers call there. The ancient and medieval town round the harbour has a well-preserved fortress, founded by the Knights of Rhodes; in its walls are interesting architectural fragments. The famous plane tree in the market square has a circumference of about 30 ft. and its huge branches have to be supported by pillars. Of its age there is no certain knowledge; the popular tradition connects it with Hippocrates. The town is supplied by an aqueduct, about 4 mi. in length, from the fine ancient well house of Borinna high on Mt. Prion. The village of Pili has the fine Greek tomb of Charmylos, and at Kephala, site of the ancient town of Isthmos, is an outlying castle of the Knights of St. John. The prosperous village of Andimakhia is the corn market of the central lowland. The precinct of Aesculapius (excavated in 1900–04 and later extensively restored), about 2 mi. from the town of Cos, consists of three terraces, containing temples, an altar, porticoes and other buildings and a medicinal spring; below is a large enclosure with porticoes. The earliest buildings on the middle terrace date from the 6th century B.C. The temple on the upper terrace, with an imposing flight of steps, is of the 2nd century B.C. After a destructive earthquake the whole site was remodeled by Xenophon, the physician who poisoned the emperor Claudius. The sanctuary was desolated by the earthquake of A.D. 554.

History.—Cos was settled by Dorian colonists from Epidaurus who worshipped Aesculapius, whose sanctuary became a health resort and the first school of scientific medicine. In the 5th century B.C. it joined the Delian league. Usually its government was aristocratic, but in 366 a democracy was instituted. In 357–355 it resisted Athenian aggression, then fell for a few years into the power of Mausolus, prince of Halicarnassus. In the Hellenistic age Cos owed its prosperity to the friendship of the Greek dynasty of Egypt, who valued it as a naval outpost. As a seat of learning it was adopted for the education of Ptolemaic princes; among its most famous men were the physician Hippocrates, the painter Apelles and the poets Philetas and Theocritus (*qq.v.*). Like its neighbour Rhodes, Cos generally supported the Romans. In A.D. 53 it was made a free city. In 1315 it was occupied by the Knights of St. John, its castle, with that at Halicarnassus (Budrum), serving as outer guard to Rhodes. In 1523 it passed under Ottoman sway and, having been occupied by Italy during the Tripoli war in 1912, it was formally ceded to Italy by Turkey in the treaty of Lausanne, 1924, and then to Greece in 1947.

See also RHODES.

See A. Philippson, *Die gr. Landschaften,* iv, pp. 288 ff. (1959). (X.; W. G. F.)

COSA, an ancient Etruscan city on the west coast of Italy near modern Orbetello, Grosseto province. The site immediately adjoins the southern neck of sand that joins Monte Argentario to the mainland. Probably not important in Etruscan times, in Roman times it was a dependency of Vulci, about 20 mi. distant.

In 273 B.C. a Roman colony was founded at Cosa. In 209 it was one of the Latin colonies that furnished supplies for the Second Punic War. Its inhabitants petitioned for new colonists in 199 B.C. In the 1st century B.C. its port, Portus Cosanus, which had already been used in the Punic and Social Wars, served as a station for the Roman fleet, and is probably to be identified with Portus Herculis (mod. Porto d'Ercole) on the opposite side of the bay and not with modern Porto Cosano. After this, although it remained populated until the 3rd century A.D., Cosa played no part in history. In the 5th century it is spoken of by Rutilius Claudius Namatianus as deserted and was perhaps devastated by the Visigoths. The name of Ansedonia was given to the ruins in the 11th century but it is not certain whether this indicates a new settlement.

The walls and 14 defensive towers of ancient Cosa can still be traced to the south and west of the town, and large sections are well preserved. They are built of polygonal masonry of an archaic style. High antiquity has been claimed for these walls, but it is more probable that they were constructed during the first phases of Roman occupation in the 3rd century B.C.

See G. Dennis, *Cities and Cemeteries of Etruria,* vol. ii, pp. 245–262 (1878); D. Levi in *Studi Etruschi,* vol. i, p. 477 (1927). (WM. C.)

COSELEY, an urban district (1895) in the Bilston parliamentary division of Staffordshire, Eng., lies in the Black Country (*q.v.*) between Birmingham and Wolverhampton. Pop. (1961) 39,557. The district includes Hurst Hill, Turls Hill, Woodsetton, Foxyards, Princes End, Upper Ettingshall, Lanesfield, Parkfield and a part of Bradley. Ettingshall was settled before the Norman Conquest and Coseley itself was a coal and iron mining centre from at least the 17th century, while it is known that nails were made there in the 16th. But Coseley's modern industrial expansion dates from 1927 when the Wolverhampton-Birmingham road was cut, offering improved communications for manufacturers. Among the few old buildings in the area is High Arcal farm (early 17th century). The Beacon tower (mid-19th century) is a well-known landmark and Mons hill is a nature reserve. There is no more coal mining in the district; the main industries are metal founding, steel making, the making of electrical products, agricultural, textile and other machinery, and prefabricated buildings.

COSENZA, a town and archiepiscopal see of southern Italy, capital of the region of Calabria and the province of Cosenza, is situated in mountainous country on the Crati, 343 km. (213 mi.) S.E. of Naples by road. Pop. (1957 commune est.) 68,231. The oldest part of the town lies at the confluence of the Crati and Bussento and consists of a tightly packed concentration of houses and palaces climbing to the hilltop by typically narrow stair-step streets. This area is dominated by a partly Swabian and partly Angevin castle. North of the Bussento is the new part of the town. The chief buildings are the Romanesque and Norman cathedral (1185) and the churches of S. Domenico (13th century), S. Francesco di Paola, Cappuccinelle, Sta. Maria in Constantinopoli and Sta. Catarina, which have fine interiors and many art treasures. One of the exhibits in the museum is the flag of the unsuccessful expedition of the Bandiera brothers in 1844. The Accademia Cosentina was founded early in the 16th century by Aulo Parrasio. Railways run to Paola, Sibari, Crotone and Catanzaro. Agriculture (especially the production of cereals, wine, oil and fruit), furniture making and the production of wool and tannic acid are carried on.

During the Punic Wars the town (ancient Consentia) supported Hannibal. Alaric, king of the Goths, died there and is said to have been buried in the bed of the Bussento. The town passed in turn to the Byzantines, Saracens and Spanish until it was proclaimed a republic in 1799. Under the Bourbon kingdom of Naples it was the scene of uprisings culminating in the Bandiera brothers' abortive attempt. In World War II it was captured by the Allies on Sept. 8, 1943. (M. T. A. N.)

COSGRAVE, WILLIAM THOMAS (1880–), Irish statesman, who was president of the Irish Free State in the troubled years 1922–32, was born in Dublin on June 6, 1880, the son of Thomas Cosgrave, who was at one time a town councilor and poor-law guardian. William Cosgrave was attracted at an early age by the Sinn Féin movement. He became a member of the Dublin corporation in 1909, and was subsequently re-elected in the Sinn Féin interest. He joined the Irish Volunteers in 1913 and when that body divided in Aug. 1914, he was with the minority who refused to follow John Edward Redmond (*q.v.*). He took part in the Easter rising in 1916, and was afterward interned at Frongoch in Wales. In 1917, shortly after his return to Ireland, Cosgrave fought a by-election in Kilkenny city as the Sinn Féin candidate, and was elected by a large majority. Re-elected in Dec. 1918, this time for north Kilkenny, he was a member of the first *dail eireann* (assembly of Ireland) and became minister for local government in the first republican ministry. It was his task to organize a policy of non-cooperation with the British authorities and to build up an alternative system of local government. Like all other members of the republican ministry he was more than once imprisoned.

Cosgrave was a supporter of the 1921 treaty settlement with Great Britain and his speech in the debate on the treaty attracted attention. Later he became minister of local government in the newly formed provisional government. When, on Aug. 12, 1922, Arthur Griffith suddenly died and Michael Collins was chosen president in his place, Cosgrave became acting chairman of the provisional government. Ten days later Collins was shot and Cosgrave found himself at the head of a state fighting for existence. Until then he was little known in the country.

As soon as the newly elected *dail* could be summoned—and it could meet only behind closed doors and under a strong guard—Cosgrave made clear his view that the day of individual leadership was over and team work must take its place. In that anxious period he left much of the work, especially the carrying of the draft constitution through the assembly, to younger and more able subordinates. But he was always ready to shoulder responsibility and when tempers were roused he introduced a conciliatory spirit. He showed both breadth of view and a sense of humour, and endeavoured to reconcile the Protestant minority to the new Irish Free State. As president of the executive council of the Irish Free State, Cosgrave represented Ireland at the Imperial Conference in Oct. 1923; and a month earlier he was welcomed as Ireland's first spokesman at the assembly of the League of Nations. He restored settled government. The ministry for finance, which he took over at the outset, was transferred in 1923 to E. Blythe; the ministry for defense, which he took over in March 1924, in face of a threatened mutiny in the army, was handed over easily and without comment a few months later to a new minister. In his political career Cosgrave was not ambitious. He never sought to thrust his personality into the forefront, but he won a reputation for good sense and moral courage.

Under Cosgrave's guidance the country moved steadily to settled order; some industrial enterprises were launched with state aid, notably the Shannon electricity scheme. In the *dail* there was no serious opposition, since the party headed by Eamon de Valera which refused to take the oath prescribed in the treaty abstained from attendance. But neither Cosgrave nor his ministry enjoyed much popularity. Order is not enforced after a revolution without drastic measures, and taxation was heavy and sharply collected. Cosgrave seemed sure of a long tenure only because there was no alternative in sight. In July 1927, shortly after the general election, the assassination of Kevin O'Higgins, the vice president, produced a crisis. Very severe legislation against political associations of an unconstitutional character was introduced and a bill declaring that no candidature for the *dail* should be accepted unless the candidate declared himself willing to sit and to take the oath of allegiance. The result of this measure was that De Valera and his party decided to come in and, since this revolutionized the parliamentary situation, Cosgrave obtained leave to dissolve. The new election in Sept. 1927 left his party numerically the largest in the *dail* but without an over-all majority. He continued in office till De Valera's decisive victory at the general election of 1932. During these years Cosgrave's government made a significant contribution to the reshaping of British Commonwealth relations. In 1944 he resigned from the leadership of the Fine Gael party and withdrew from active politics. *See* also IRELAND, REPUBLIC OF: *History*. (S. G.; P. N. S. M.)

COSIN, JOHN (1594–1672), English bishop, born in Norwich on Nov. 30, 1594, was educated at Norwich grammar school and Caius college, Cambridge. In 1624 he became prebendary of Durham and in the following year archdeacon of the East Riding of Yorkshire. His *Collection of Private Devotions* (1627), which he is said to have prepared by command of Charles I, and his known friendship for Laud brought him under suspicion with the Puritans.

Cosin was appointed master of Peterhouse, Cambridge (1634), vice-chancellor of the university (1640) and dean of Peterborough (Oct. 1640). The Long parliament, however, deprived him of his benefices in 1641, and in 1642 he lost also the mastership of Peterhouse. He then joined the royal family in France, where he remained until the Restoration. Cosin was raised to the see of Durham in Dec. 1660, and was one of the revisers of the Prayer Book (1661). He died in London on Jan. 16, 1672.

A collected edition of Cosin's works, forming five volumes of the *Library of Anglo-Catholic Theology*, was published between 1843 and 1855; and his *Correspondence* was edited by George Ornsby for the Surtees society (1868–70).

See P. H. Osmond, *Life of John Cosin* (1913).

COSMAS OF ALEXANDRIA, surnamed INDICOPLEUSTES ("the Indian navigator"), was an explorer, a theologian, a geographer and the author of a treatise on the universe based on biblical revelation. He flourished in the 6th century A.D., was probably a Nestorian Christian, and sailed around the shores of the Indian ocean. He later became a monk and wrote a description of his travels. Controversies about this work led to the composition of his *Topographia Christiana*, which, except for a few fragments of his commentaries on the Psalms and the Gospels, is the only part of his writings which has survived. The *Topographia Christiana* appears to have been written between A.D. 535 and 547 and was a controversial work, designed to prove from arguments of common sense the literal accuracy of the biblical picture of the universe. According to Cosmas, the universe is best illustrated by the Tabernacle of Moses, which is its replica in every detail. The earth is a rectangular plane, covered by the firmament, above which lies heaven. In the centre of the plane is the inhabited earth, surrounded by ocean, and beyond this the paradise of Adam. The sun, much smaller than the earth, revolves around a conical mountain to the north, and is thereby obscured each night. Cosmas is particularly scornful of those who believe in a spherical earth or in the existence of an Antipodean population. His idiosyncratic work is not representative of the general state of cosmographic theory among Christian philosophers in his day, and it had small influence on later writers. It is of interest as a curiosity of literature and for certain observations, made particularly in Abyssinia, which are incorporated incidentally to the main argument.

The *Topographia* will be found in J. P. Migne, *Patrologia Graeca*, lxxxviii (1865); ed. with geographical notes by E. O. Winstedt (1909), English translation, with introduction and notes, by J. W. McCrindle (1897). (WM. C. B.)

COSMAS OF PRAGUE (1045?–1125), dean of Prague cathedral and the earliest Bohemian chronicler. His *Chronicae Bohemorum libri iii*, which contains the history and traditions of Bohemia up to nearly the time of his death, is the most important source of knowledge of the origin and development of the Bohemian state. The best edition is by B. Bretholz in *Monumenta Germaniae historica: Scriptores*, new series, vol. ii (1923).

See J. Loserth, *Studien zu Cosmas von Prag* (1880).

COSMAS AND DAMIAN, SAINTS, brothers, perhaps twins, the patron saints of physicians, of whose lives and martyrdom little is known with certainty. According to Christian tradition they were born and lived in Aegea in Cilicia in Asia Minor, and became distinguished physicians known not merely for their skill in medicine but also for their Christian charity in refusing payment for their services (for this reason they were given the surname *anargyroi*, the "silverless ones"). Their charity converted many to Christianity. Imprisoned during the persecution of Diocletian, they were tortured and finally beheaded (*c.* 303). By the middle of the 5th century their cult had become so widespread that churches were erected in their honour in various cities of the east, including Constantinople; and by A.D. 530 Pope Felix IV had erected a church in their honour in Rome. A variety of early accounts of their lives and martyrdom gave rise to many legends about them. Their feast day in the Eastern Church is Oct. 27; in the Roman Catholic Church it is Sept. 27. (R. P. N.)

COSMATI, the name bestowed on a Roman family of architects, sculptors and mosaicists, one of whose members bore the Christian name Cosmatus. The activity of this family can be traced through four generations, and opens with the work of Lorenzo, active through the last quarter of the 12th century. His name, with that of his son Jacopo, appears on the portals of the cathedral at Cività Castellana, Sta. Maria di Falleri and the Sacro Speco at Subiaco. The name of Jacopo appears alone on the portals of S. Saba, Rome (1205) and elsewhere, and in association with that of his son Cosmas on the triumphal arch on the façade of

the cathedral at Cività Castellana (1210). The Cosmas of these inscriptions appears to be identical with a "magister Cosmas," who signed a pavement in the Duomo at Anagni (1231). The names of two sons of Cosmas, Luca and Jacopo, appear in association with that of their father on pavements at Anagni and in the cloister of Sta. Scolastica at Subiaco; and that of Giovanni, a son of Cosmato, is found in Rome on tombs of Sta. Maria sopra Minerva (1296), Sta. Balbina (1303) and Sta. Maria Maggiore. The name of another son of Cosmato, Deodatus, occurs on a pavement in S. Giacomo alla Lungara, Rome, as well as at Teramo (1332) and on a ciborium in Sta. Maria in Cosmedin.

The architectural and decorative style, with its free use of marble inlay and glass mosaic, to which the term Cosmati work has been applied, was not practised solely by this family. Its earliest known exponent was a certain Paulus, who was responsible under Pope Paschal II (d. 1118) for the screen of the Duomo at Ferentino. Other families of Cosmati craftsmen were headed in the mid-12th century by Ranieri and Vassalletto.

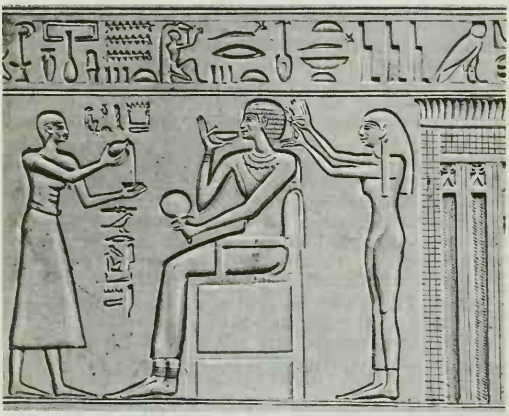
Among the most notable of the vast number of works in Rome in the style of the Cosmati are the pavements of S. Clemente and Sta. Maria in Cosmedin, the ambones in S. Lorenzo and Sta. Maria in Aracoeli, and the choir screen in S. Cesareo. The finest of the surviving Cosmati tombs is that of Pope Clement IV (d. 1268) in S. Francesco at Viterbo. This is the work of Pietro di Oderisio, who may in turn have been identical with a "Petrus Romanus" responsible for the shrine of St. Edward the Confessor (1269) and the tomb of King Henry III in Westminster abbey, London.

See E. Hutton, *The Cosmati* (1950). (J. W. P.-H.)

COSMETICS AND COSMETOLOGY. Cosmetics are substances especially prepared to improve, beautify and generally increase the attractiveness of the person. Cosmetic preparations are therefore intended to promote the health and beauty of the complexion, hair, hands and nails. It is the recognition of the dual role of health and beauty that has built cosmetics into a major industry in the U.S. and Britain.

HISTORICAL DEVELOPMENT

It is quite probable that cosmetics had their origin in China, but it is necessary to turn to Egypt for the source of the earliest records of cosmetic substances and their application. During the 1st (Thinite) dynasty (*c.* 3000 B.C.) it was customary to bury comforts and luxuries with the dead kings. Toilet articles and unguents have been found, and in the British museum there are many beautifully carved unguent vases that authorities have dated about 3500 B.C. Other interesting specimens are: *kohl* vases in glass and stibium pencils used in the 18th dynasty 1500 B.C.; papyrus showing men and women having lumps of nard fixed on top of the head (1500 B.C.). The opening by Howard Carter of the tomb of Tutankhamen, who ruled about 1350 B.C., has brought to light many excellent specimens. According to eyewitnesses, the unguent vases contained quantities of aromatics that were still elusively fragrant.



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

PANEL FROM THE SARCOPHAGUS OF PRINCESS KAWIT SHOWING MAID DRESSING HER HAIR AND SERVANT POURING MILK; EGYPTIAN, 11TH DYNASTY, ABOUT 2000 B.C. IN THE METROPOLITAN MUSEUM OF ART, NEW YORK CITY

Other monuments and tombs in Egypt still provide ample evidence of the value the ancient Egyptians placed upon cosmetics. For instance, on the large granite tablet inserted in the breast of the Sphinx, King Thutmose IV (*c.* 1420 B.C.) is portrayed making an offering of incense and of fragrant oil or unguent. At this period it is probable that the priests made most of these compounds, and their manufacture was considered a mysterious and much honoured art. The containers were beautifully executed, principally in ivory and alabaster, while frequently carved wood, onyx and porphyry were fashioned into pots and vases. The ingredients were naturally comparatively simple, limited in both numbers and variety. Among the ingredients grown in Egypt were thyme and origanum, together with a substance called *balanos* that appears to have been extracted from the shells of some unidentified fruit. But the greater proportion of the basic ingredients, such as myrrh, frankincense and spikenard came from Arabia. Sesame oil appears to have been one of the most favoured vehicles for the aromatics, although both almond and olive oils were undoubtedly used.

BY COURTESY OF (TOP) THE MUSEUM OF ART, RHODE ISLAND SCHOOL OF DESIGN; (CENTRE) SMITHSONIAN INSTITUTION, FREER GALLERY OF ART, WASHINGTON, D.C.; (BOTTOM) LANCÔME

(TOP) ETRUSCAN COSMETIC JAR, PAINTED IN THE BLACK-FIGURE STYLE; 6TH CENTURY B.C. IN THE MUSEUM OF ART, RHODE ISLAND SCHOOL OF DESIGN; (CENTRE) CHINESE BRONZE MIRROR; LATE HAN DYNASTY. IN THE FREER GALLERY OF ART, WASHINGTON, D.C.; (BOTTOM) FRENCH UNGUENT JAR; 19TH CENTURY. IN THE LANCÔME COLLECTION, PARIS

The ancient Egyptians were probably the first to introduce the bathtub and in later years the bath was treated on a more elaborate scale by the Greeks and Romans. This form of ablution was followed by the liberal application of perfumed oils and unguents that were found to be soothing and gave the skin a smooth, even colour. Cosmetics were used by Egyptian ladies who enhanced their personal beauty by using somewhat crude paints. Such painting reached its zenith in the time of Cleopatra. As judged from the discoveries in Egyptian tombs and from paintings, the make-up of eyes received the greatest attention. The effects achieved were not unlike some fashions in eye make-up in the 1960s. They were produced by painting the under side of the eye green and the lid, lashes and eyebrows black by the application of *kohl*—the product made from antimony (sulfide) and applied with an ivory or wooden stick. Henna was much favoured for dyeing the fingernails, palms of the hands and soles of the feet. Well-preserved specimens can be seen in the British museum of combs and polished metal mirrors used by Egyptian women. The Bible mentions cosmetics used by Jewish women in II Kings ix, 30, where it is written that "when Jehu was come to Jezreel, Jezebel

heard of it; and *she painted her face,* and tired her head, and looked out at a window." This is explained more clearly in the following passage: "Thou didst wash thyself, paintedst thine eyes [probably with *kohl*] and deckedst thyself with ornaments" (Ezek. xxiii. 40, and *see* also Jer. iv. 30). In the Koran aromatics play an important part. The use of eye paint is suggested by *Sura* lvi, "And theirs shall be the Houris with *large dark eyes* like pearls hidden in their shells."

The Romans, during their early history, showed very little interest in their personal appearance, and it was only after their incursion into southern Italy, then occupied by the Greeks, that they acquired a more intimate knowledge of the aesthetic side of life. By the time Nero became emperor, in A.D. 54, both cosmetics and perfumes had assumed an important role at court. He personally used cosmetics liberally, and his wife, Poppaea, made no secret of using artificial beauty aids. White lead and chalk were used to whiten the skin, Egyptian *kohl* for the eyelids and lashes; *fucus,* a sort of rouge, for the cheeks and lips; *psilotrum,* a species of depilatory; barley-flour and butter as a cure for pimples and skin eruptions; and pumice-stone for whitening the teeth. The ultra-fashionable ladies of the Roman court devised a method for bleaching their hair by means of a soap that came from Gaul. The Romans made many attractive containers for their perfumes and cosmetics. The three principal kinds were: (1) solid unguents or *ledysmata;* (2) liquid unguents or *stymmata;* and (3) powder perfumes or *diapasmata.* The solid unguents were generally of one specific perfume such as almond, rose or quince. The liquid unguents were most frequently compounds of flowers, spices and gums digested in either olive, ben or sesame oil. (Frangipani was invented by a Roman patrician.)

Though the use of cosmetics had long been known in Britain, importation of toilet articles from the east dates from the time of the crusades when returning crusaders brought back many of the cosmetics prized by ladies of the harem. By the reign of Queen Elizabeth I these substances had become more and more popular. The ladies of the court kept their toilet preparations in strongly perfumed boxes called "sweet coffers" that were considered a necessary part of the bedroom furniture. A recipe for making a beautiful complexion at the time of Elizabeth was first to take a very hot bath to induce excessive perspiration and to follow this up by washing the face with plenty of wine, to make it fair and ruddy. This latter treatment was even in those days fairly expensive though Mary Queen of Scots is alleged to have bathed in wine. This luxurious habit was not uncommon with the elder ladies of the court, but the younger ones had to be content with milk. Both sexes used powder and patches and other cosmetics at court. With the advent of the Commonwealth all these luxuries were discarded, but when Charles II was restored to the throne they became popular again. Milk baths were considered an indispensable aid to beauty and in later years the ladies of the court adopted a new practice, probably introduced from France, of powdering their hair, but this soon fell into disuse. By the 18th century cosmetics were used to such an extent by nearly all classes that in 1770, according to G. V. Septimus Piesse in his *Art of Perfumery* (1879), a bill introduced into the English parliament contained the following drastic provision: "That all women of whatever age, rank, profession, or degree, whether virgins, maids, or widows, that shall, from and after such Act, impose upon, seduce, and betray into matrimony, any of His Majesty's subjects, by the scents, paints, cosmetic washes, artificial teeth, false hair, Spanish wool, iron stays, hoops, high heeled shoes, bolstered hips, shall incur the penalty of the law in force against witchcraft and like misdemeanors and that the marriage, upon conviction, shall stand null and void." This same law was adopted by the state of Pennsylvania in the U.S. and the open use of cosmetics was generally looked upon with disfavour in most of the American colonies.

Cosmetics were much favoured in Italy and at the court of Louis XIII in France. One of the greatest users was Louis' queen, the beautiful Anne of Austria. From Spain creams of vanilla and cacao and almond paste were imported and used liberally to whiten the skin of the ladies of the court. Louis XIV disapproved of artificial enhancement and consequently cosmetics fell into disuse. They were again revived under the Regency when the "*poudre à la Maréchale*" was in vogue. The emperor Napoleon I was susceptible to the artistic refinements of his time and the empress Josephine brought from Martinique cosmetics that she always continued to use. The French at this period made a definite move to place the manufacture of perfume and beauty aids upon a scientific basis.

The history of cosmetics in the U.S. stems from Europe and closely parallels its development in Europe. Although the aboriginal Indians used a highly formalized technique of body painting and had knowledge of dyes and pigments, fats and oils, this use of cosmetics never influenced the settlers. During colonial times in the U.S., the use of cosmetics varied enormously in different parts of the country. Puritan New England, for instance, banned it on moral grounds, reflecting the puritanism of the mother country; in the south, especially in colonies of French origin, cosmetics flourished. The conservatism of the Victorian era that frowned upon artificial beauty aids also influenced the cosmetic habits in America. France pioneered in the development and manufacture of cosmetics and French women used make-up long before it was accepted in polite society in England or America. It was not until after World War I that barriers were lowered and prejudices were gradually discarded; even then the use of cosmetics was sporadic and limited as compared with that of the 1960s.

(W. A. Po.; G. R. F.)

COSMETOLOGY

Cosmetology is a term used in the United States to designate the practice of beauty culture in beauty shops and hairdressing establishments. In the U.S. this industry is limited by law to external treatments for the improvement of the complexion, facial contours, hair, hands and feet. Chiropody and body massage require special licences both in the U.S. and the U.K.

In Britain there are few government regulations affecting the beauty and hairdressing industry. Licences are not required but beauty shops are subject to inspection by local health service authorities. Also, the industry itself lays down certain rules, especially applied to the training of hairdressers through a system of apprentices.

The growth of the modern beauty-shop industry stems from the introduction of the Marcel wave, originated in the 1870s by a French hairdresser, Marcel Grateau. The Marcel waving iron (1897), which was an elaboration of the curling iron women used at home, produced the most natural undulating waves then known and it proved an instant success. As the beauty shop offered more up-to-date and better services its popularity increased, and the practice of hairdressers and manicurists who visited their clients in their homes was gradually replaced by the clients visiting the beauty shop.

An even greater impetus to cosmetology was the introduction in 1906 of the so-called permanent wave, first developed by Charles Nessler, a German coiffeur living in London. The machine was an elaborate contraption that required 10 or 12 hr. for an expensive, tedious and often painful process. Introduced in the United States in 1908, it did not gain a firm foothold until the 1920s when the technique had been improved and hairdressers had become more expert. Although at first resisted by the majority of hairdressers, the vogue for short hair gave permanent waving a tremendous boost. From then on it was left to the manufacturers who supplied the machines and chemicals to improve them and make the technique simpler for both the operator and their customers.

In the 1960s, the permanent wave was the greatest single source of income for the beauty shop, which in the U.S. and Britain includes the hairdresser, the coiffeur or hair stylist. The permanent wave accounted for about 30% of the business in the U.S. and England; cutting, shampooing, tinting and setting the hair brought in even greater revenue, while other aspects of beauty culture steadily dwindled in proportion. The beauty salons still gave "facials," the massage and contour treatments to help keep the face youthful-looking and to beautify the complexion. Beauty treatment for the hands consisted mainly of the manicure

(see *Manicure Preparations* below) and some salons gave pedicures, the beautifying treatment for feet, as well.

COSMETIC PREPARATIONS

Cosmetic preparations may be divided into three main categories: (1) creams, lotions and emulsions for the care of the skin and hair; (2) make-up preparations, such as powder, lipstick, rouge and nail lacquer, for beautifying; (3) hygienic or toilet preparations (sometimes called toiletries) for promoting good grooming and fastidiousness, such as deodorants, depilatories and preparations for the bath.

The use of cosmetics had never before been so universal as in the 1960s. In the past a wide gulf existed between the upper classes who were the chief users of cosmetics and the rest of the population. With the rise of the middle classes and an affluent society, this gulf has narrowed so that it no longer exists in Britain and the U.S. though it is still noticeable in countries that are poorer, have a large peasant population or have a lower standard of living. As the lifespan has increased, the need to keep the skin healthy and youthful-looking has grown in importance. Without care, the skin loses its resiliency, is depleted of its natural oils and moisture, and becomes dry, wrinkled and old-looking. Cosmetic creams and lotions are designed to prevent this and make-up is used to enhance the individual, often creating the illusion of beauty when skilfully applied.

The greatest problem of skin care is to keep the skin clean and functioning properly. Modern conditions, especially urban life with its atmospheric dirt, smoke and grime mixed with cosmetics, make thorough cleansing difficult. Although soap is a necessary and efficient cleansing agent, it has the tendency to dry out the skin. Cleansing creams dissolve the grime more gently; lubricating creams replace or supplement the natural oils that have been washed away; and foundation creams protect the skin.

Skin Care.—*Cold cream* is the basis for the oily and greasy types of creams to which both the cleansing and lubricating creams belong. A standard formula calls for spermaceti 125 gr., white wax 120 gr., expressed oil of almond 560 gr., sodium borate 5 gr., stronger rose water 190 gr. There are many variations of this formula in which other fats are substituted for spermaceti, and paraffin is used in place of white wax; mineral oil (liquid petrolatum) has mainly replaced almond oil as it is more stable, does not become rancid, and melts at a lower temperature. The variations in formulae change the creams only in detail. The standard cold creams are general purpose creams used for their soothing and softening effect.

Cleansing creams may be a simple form of cold cream or even a solidified mineral oil that melts almost at touch. As the name implies their purpose is to remove accumulated grime and make-up from the skin. They do this by penetrating the fine crevices of the skin and gently dissolving foreign particles. *Cleansing lotions* are usually emulsions made of lighter oils held in suspension with varying amounts of water.

Lubricating creams, night creams or massage creams are a type of cold cream with the addition of lanolin (wool fat) and its derivatives. Until labelling regulations came into force in the U.S. these creams were usually called "nourishing cream" or "skin food," as they are still called in England. Since the skin, like any other part of the body, can be fed only by assimilating food eaten in the usual way and carried through the blood stream to the tissues, these terms are misnomers and can result in a misunderstanding of the function of the creams. Because they contain lanolin, the best substitute for the natural oils secreted by the skin, these creams help to overcome dryness and with consistent use the skin becomes softer and more pliant. In the 1950s small quantities of vitamins and hormones were introduced in some of these lubricating creams in the hope of rejuvenating the skin. No conclusive scientific evidence had been found by the early 1960s to indicate that these ingredients can be absorbed by the tissues and that they do any good.

Vanishing or greaseless creams are used primarily as a protective film on the skin and are so called because they seem to disappear when rubbed into the skin. Originally these creams were made of stearic acid; ammonium, potassium or sodium stearate, a form of soap; glycerol (glycerin) to help retain water; and a substantial proportion of water. When this cream is applied, the water evaporates and a smooth, non-greasy, almost invisible film of stearic acid remains, making the skin appear smoother. Although all vanishing creams are variations of the soap base, some recent formulae include lanolin and its derivatives, cetyl alcohol and vegetable oils. Small quantities of mineral oil or petrolatum may be included for easier spreading and organic bases like triethanolamine may be added to help modify the soap. Sorbitol or propylene glycol sometimes replaces glycerol. These humectants, or moisturizers, also prevent the cream from caking, flaking or rolling when applied to the skin.

Foundation creams, also called powder base or make-up base, are a type of vanishing cream and are used primarily to create a smooth foundation for make-up. They protect the skin and conceal imperfections, while make-up becomes easier to apply and lasts longer. Foundation creams are usually tinted to blend with natural skin tones and some, more deeply coloured, are used to deepen the colour of the complexion. Foundation lotions are emulsified versions of the creams and are used for the same purpose.

Skin tonics or toning lotions are primarily perfumed alcohol and water. They are usually used after the removal of make-up with cleansing cream and act as a mild astringent, giving the skin a sensation of freshness.

Make-up.—This term, adopted from the theatre, refers to the use of beautifying cosmetics such as rouge, lipstick, powder and eye shadow. Until World War I make-up was considered improper and even immoral. Only face-powder, white, tinted pink (flesh) or cream (rachelle) and delicately perfumed, was considered permissible in polite society. Much of the face-powder and other make-up preparations were originally imported from France. But by the early 1920s a revolutionary change had taken place, particularly in the United States, first in the attitude toward make-up and secondly in the enterprising development of the cosmetic business. By 1925 rouge and lipstick were generally used and the influence of film stars gave make-up a tremendous boost. Gradually cosmetics developed into a social necessity as more and more women entered into the business world. At first powder, lipstick and rouge were available only in three shades, light, medium and dark, intended for the blonde, medium and brunette complexions. By the 1960s a vast range of shades was available. The popularity of eye make-up increased tremendously during the 1950s.

Face powder is used to give a smooth mat finish to the complexion. It should spread easily, evenly and cling well. The major ingredients are talc, a smooth unctuous mineral powder; kaolin, an absorbent processed china clay; zinc or magnesium stearate to increase bulk, improve adhesion and resist moisture; magnesium carbonate is also used as a bulking agent and perfume carrier. To these are added zinc oxide or titanium dioxide, the white opaque pigments that help hide imperfections, and the coloured pigments of iron oxide, earth pigments and insoluble forms of organic dyes that create the various powder shades. Small amounts of oil and other emollients are often added for adhesion and to stabilize colour. The fine texture of powder depends on the sifting process or "bolting." Some face powders are light and fluffy, giving a translucent effect; some are heavier and more opaque; others have a slightly lustrous sheen.

Compact or compressed powder is made by mixing powder with a weak gum solution as a binder and pressing it into cakes. The finished cake is somewhat denser than loose powder but soft enough to be readily picked up by a puff or pad.

Liquid powder is suspended in water or in oily and non-oily emulsions similar in composition to skin and hand lotions. It tends to dry the skin but when skilfully applied lasts well.

Cake make-up is a dense face powder treated with oil or wax to make it water-repellent, compounded with soap or a synthetic surface active agent and then pressed into cakes. It is applied with a moistened sponge or pad.

Cream make-up or suntan make-up (*see* below) is a densely pigmented foundation cream and powder combination used to darken the skin or to make it look like a suntanned complexion.

Lipsticks are made of waxes, fats, oils and pigments molded into smooth, creamy sticks. They should be firm enough to resist breaking when handled, and also not so soft that they will smear or melt in warm weather. The pigments used are a combination of skin-staining dyes called bromo acids that are among the non-toxic colours certified as safe for cosmetics. Castor oil is used partly as a solvent for the bromo acids and for its viscosity, which helps the colour to stay on the lips. Polyethylene glycols also help solubility and staining. Mineral oil gives lustre; cocoa butter and lanolin are soothing emollients. Other ingredients include a variety of waxes, such as beeswax and spermaceti, and oils for smooth consistency and hardening. Lipsticks are made by grinding the pigments and combining them with the melted waxes and oils. After being heated, the mixture is poured into molds for hardening.

Rouge is used to give colour to the cheeks or complexion. Compact rouge contains talc, kaolin, small amounts of white pigment, concentrated red pigment and a gum solution as a binder. Paste rouge pigments are ground with petrolatum, mineral oil, lanolin and waxes to form a smooth consistency. Rouge colours are made to match lipstick colours.

Mascara consists of carbon black, brown iron oxide or ultramarine blue pigment combined with a mild soap, triethanolamine stearate, and mixtures of carnauba wax, beeswax and spermaceti. It is applied to the eyelashes with a wet brush. *Cream tube mascaras* are of similar composition, with additional water to attain the required flowing consistency for use in special applicators. The mascara is a mixture of pigments, waxes and synthetic resin in a volatile solvent. After the solvent evaporates, the mascara on the lashes is highly resistant to water.

Eyebrow pencils and eyeliners are a mixture of pigments, petrolatum, lanolin and waxes made into pencil-like sticks or contained in plastic swivels. *Eyeshadow* is a creamy preparation of pigments mixed with petrolatum and lanolin. Special pearly effects are obtained by adding fish scale essence.

Suntan preparations are a form of make-up (see *Cream make-up* above) intended to make the complexion look as if it had been exposed to the sun. Some are stains consisting of a compound of dihydroxyacetone; others are a dense cream with ultra-violet ray-resistant properties. Other suntan preparations consisting mainly of light oils are used to prevent harmful sunburn when the skin is exposed to the direct rays of the sun for any length of time and to acquire an even suntan. Heavy pigmented preparations keep all active light away from the skin like a parasol and provide complete protection from both tanning and burning. Derivatives of salicylic, anthranilic and para-aminobenzoic acids in thin layers absorb the burning rays. The compounds are incorporated in oil, in alcoholic solution or an emulsified cream that may include a silicone to increase water resistance.

Hair Preparations.—The care of the hair has always been considered one of the greatest beauty problems. Hair is harder to keep clean than the face or any other part of the body, and dressing the hair in the prevailing fashion takes more time and dexterity than most women have. Like cosmetics, hair preparations may be divided into three groups: (1) the shampoos and tonics that keep hair and scalp clean and healthy; (2) lotions that make dressing the hair easier; (3) hair cosmetics that improve or change the appearance of hair.

Shampoos are based on soaps or synthetic (soapless) detergents; ideally they lather well and cleanse both hair and scalp. Soap shampoos, usually in liquid form, contain large proportions of coconut oil, which produces a heavy lather and is soluble enough to form concentrated solutions. Soaps have the advantage that they do not remove all the natural oil from the hair. Their disadvantage is that they react with the calcium and magnesium salts in hard water and form sticky curds that dull the hair. This deposit may be removed by rinsing with dilute acid solution, vinegar or lemon juice.

Synthetic detergent shampoos may be liquid, powder, paste or cream, all made with sulfonate salts that lather profusely in hard or soft water without leaving a lime compound deposit. These preparations are oil soluble and completely degrease the hair, leaving it dry and brittle. This disadvantage may be overcome by including a lanolin derivative in the detergent. Surfactants of the alkylolamide class may also be used.

Dry shampoos consist of infusorial (diatomaceous) earth or colloidal kaolin. When these powders are dusted into the hair and then brushed out, they carry along excess hair oil and dirt that they have absorbed.

Hair rinses and conditioners, which contain cationic surfactants that are attracted to and adhere to the hair, leave an extremely thin oily film; the film makes the hair easier to handle.

Hair bleaches consist of hydrogen peroxide solutions or creams usually activated before use by the addition of ammonia. Treatment of hair can be extended until virtually all colour has been removed. Extensive and continued bleaching will cause hair deterioration, which may be counteracted to a considerable extent by rinsing with diluted vinegar solution after each bleach treatment.

Permanent hair dyes are based upon paraphenylenediamine or paratolylenediamine. These compounds partially penetrate the hair shaft and form insoluble brown dyes when oxidized by air or with hydrogen peroxide. A wider range of shades is possible when these diamines are used in combination with organic dye intermediates. These intermediates interact during oxidation and can produce colours ranging from yellow through red and brown to black.

Hair tints, sometimes included in shampoos, contain water-soluble synthetic dyes and are produced in a wide range of colours. It depends on the type of dye and the method used in application as to the length of time the colour lasts.

Permanent waving solutions have evolved from the original ammonia preparations that required an elaborate mechanical arrangement for applying heat. The first process was followed by machineless heating pads that generated heat when moistened. Both of these techniques could be used only by the professional hairdresser. Not until the modern cold process was developed was it possible to do permanent waving in the home. The hair is wound on rods and moistened with a waving solution that first softens the hair. It is then saturated with the waving lotion and the waving action takes place either by a mild chemical oxidizing agent or by the action of air. A hardening agent consisting of thioglycolic acid made slightly alkaline with ammonia or similar mild bases is then applied.

Wave setting lotions are of two types. The dilute gum solutions make the hair easier to set and to keep in place. They consist of the natural gums karaya or tragacanth or synthetic resins in water with a certain proportion of alcohol to accelerate evaporation and of humectant to prevent flaking. The other form is the aerosol spray used after the hair is set. It is a modified shellac or a synthetic resin such as polyvinylpyrrolidone (PVP), which is sprayed uniformly on the hair and dries with extreme rapidity.

Hair lotions are used for grooming the hair and giving it sheen. They are often called brilliantine, a name long in use, and consist mainly of perfumed mineral oil or petrolatum. Some hair lotions are simple oily liquid emulsions or oily creams of castor oil, mineral oil or a synthetic oil in alcohol.

Hand Preparations.—Hand lotions of the classic glycerine and rose water type have been in use since the beginning of the 19th century. Sometimes witch hazel is added and, if a mild bleaching is desired, a small quantity of hydrogen peroxide or lemon juice is included.

Hand lotions and creams are based on the vanishing cream formulae. Glycerol is added as a humectant and skin softener, while quince seed mucilage stabilizes the mixture and gives the skin a silky feel. Glycerol monostearate or propylene glycol monostearate are also similar to vanishing cream but contain a higher proportion of water. Beginning in the 1950s, silicones were included in some preparations as an added protection; they are referred to as barrier creams.

Manicure Preparations.—Special care of the fingernails began in about 1900. Until nail lacquers were introduced, the manicure consisted of filing the ends of the nails into an oval shape, pushing back the cuticle, then buffing the nails to a high lustre with a

chamois-covered buffer and a polishing power of stannic oxide with chalk and a little jeweler's rouge. The changes in fashion include the use of bright colours on nails to match other make-up. A great deal more attention is paid in the United States to hands and fingernails than in any other country including Britain.

Nail lacquers in plain, transparent tints were first introduced as an easier way to give the nails a high polish. The chief ingredient is nitrocellulose, which is made flexible by the inclusion of plasticizers, more durable and lustrous by adding natural and synthetic resins, and more adherent by including gums. White titanium dioxide makes the lacquer opaque; pigments are added that harmonize with lipstick colours.

Polish remover consists of acetone or ethyl acetate and sometimes contains a small proportion of vegetable oil or lanolin.

Cuticle cream and oil consist of castor and mineral oils with glycerin. Sodium lauryl is sometimes added along with a mild antiseptic. These preparations are used to keep the cuticle soft and pliant. *Cuticle cream* is usually a combination of petrolatum, glycerin and gelatin.

Cuticle remover is usually a weak solution of potassium hydroxide that softens the cuticle and makes it easy to remove the dead skin that forms around the nail. This chemical actually dissolves dead tissue and should be rinsed off to avoid damage to live tissue.

Hygienic or Toilet Preparations.—*Bath preparations* other than soap include bath salts, bath oil, bubble bath, and talc or dusting powder. *Bath salts* are coloured and perfumed crystals that soften hard water, *i.e.*, they precipitate calcium salts and prevent the formation of curds of lime (calcium). These salts are based upon sodium carbonate decahydrate (sal soda) or sodium sesquicarbonate mixed with coloured and perfumed alcoholic solution. Rock salts are ineffective for water softening.

Bath oils are used mainly for their scent. The perfume is dissolved in a low-viscosity mineral oil or synthetic oil such as isopropyl myristate or palmitate. Another type, usually of a polyoxyethylene sorbitan monolaurate, produces a dispersion of extremely fine droplets that perfume the atmosphere.

Bubble baths are solid or liquid mixtures of perfumed high-foaming detergent. Among these foaming detergents are the alkylolamides, sulfated fatty alcohols, or sulfated fatty acid glycerides. The stable foam is usually almost immediately broken by the toilet soap used in the bath.

Bath powder and dusting powder usually consist of perfumed talc with a moderate proportion of absorbent kaolin.

Deodorants and Perspiration Checks.—Deodorants are used to neutralize perspiration odour. Colognes and toilet waters are mild forms; more effective are pastes and creams of antibacterial compounds, such as hexachlorophene and bithionol; antibiotics are sometimes added. Deodorant sticks are perfumed alcohol solidified to a translucent gel by a small proportion of sodium stearate. Perspiration checks and antiperspirants are also made in liquid or cream form. These consist of aluminum salt, a strong astringent that coagulates proteins, destroys bacteria and by constricting the pores reduces perspiration secretion.

Depilatories are used to remove unwanted hair, particularly from the arms and legs and from under the arms. Chemical depilatories loosen and soften the hair, which is then washed away. The depilatory creams made with strontium or related sulfides are effective but the strong odour of hydrogen sulfide (resembling rotten eggs) makes them objectionable. A more modern formula based on calcium thioglycolate has a milder odour than can be masked by certain perfumes. Depilatory or epilating waxes are based on rosin and wax mixtures. They are heated gently until melted and applied to the hairy area. The wax is allowed to cool and harden and then is pulled off; the hair comes off with it.

Preparations for Men.—*Shaving creams* are of the lathering or nonlathering types; they wet and soften the beard and keep individual hairs upright, making it easier to cut them with the razor.

Brushless shaving creams are based on the vanishing cream formula, often with a small amount of added synthetic wetting agent and additional humectant.

Lather shave cakes and sticks are good-quality toilet soaps with alkali at a minimum to reduce skin irritation. Lather creams are softer soaps, with some of the sodium soap replaced by soft potassium soap and more water left in the preparation. Fats and fatty acids used in the preparation of lather shave creams are quick-lathering soaps with dense, moist and lasting lather.

Aerosol shaves are correctly called pressure packs since gas under pressure expels foam, not a spray. They are formulated from soap solutions based upon mixtures of triethanolamine and fatty acids; the mixture may be expelled by a compressed gas or low-boiling liquid. Activation of the valve expels the soap and propellant mixture; expansion of the propellant at atmospheric pressure produces the lather.

After-shave lotions contain alcohol, water, perfume, astringent and, occasionally, an antiseptic. They feel refreshing and are mildly styptic.

Pre-shave lotions, for application before using an electric razor, are alcoholic solutions that leave a trace of oily film on the skin. Some are mildly astringent solutions that tend to tighten the skin and keep individual hairs erect in the path of the razor.

(X.; G. R. F.)

COSMICAL PHYSICS. In ancient astronomy, the word cosmical means "occurring at sunrise," and designates especially the rising or setting of the stars at that time. Cosmical physics is a term broadly applied to the totality of those branches of science which treat the phenomena of the cosmos (or universe) and their explanation by the laws of physics. It includes geomagnetism, seismology, the tides, meteorology as related to cosmical causes, the aurora, meteoric phenomena and the physical constitution of the heavenly bodies generally.

COSMIC RAYS. The term "cosmic rays" refers both to primary and to secondary cosmic rays. Primary cosmic rays are submicroscopic, electrically charged particles—largely protons—that travel in space at speeds nearly equal to that of light. Some of them happen to approach the earth where, high in the atmosphere, they collide with atoms in the air, giving part of their energy to electromagnetic radiation (photons) and to other particles, which proceed in nearly the same direction as the primaries. These new particles and photons are called secondary cosmic rays. Like the primaries, they too may interact with atoms in the air, or eventually with atoms in the earth, until ultimately the energy is converted into heat. The primary and secondary rays are not always distinguishable from each other. As will be explained in the final section of this article, scientists are convinced that there are in the primary rays an appreciable number of neutral (uncharged) particles, in addition to the charged particles.

Though much remains unknown, many things have been learned about cosmic radiation. It is possible to state what kinds of particles comprise the primary rays, to ascertain their density in the space around the earth and to specify their distribution in energy. Scientists can give a fairly complete description of what happens when the primary rays interact with the atmosphere: the kinds and numbers of secondary particles that are produced, and how these secondaries in turn behave until they are finally absorbed. From the radioactivity caused by the cosmic rays, it can even be calculated how intense they were in the distant past. Moreover, one of the sources of cosmic rays has been definitely identified; namely, the sun. But as to the detailed mechanism by which the sun generates cosmic rays, theories and experimental information are incomplete. Furthermore, it is clear that the primary particles of high energy—almost all of those producing detectable effects at sea level—come from beyond the solar system. The exact sources of these particles remain in doubt, although indirect evidence lends strong support to certain hypotheses that are explained in this article.

The presentation of topics in this article is as follows:

I. History
  1. Discovery of Cosmic Rays
  2. First Decade of Analysis
  3. Post-World War II Developments
II. Methods of Detection
  1. Counters
  2. Nuclear Emulsions
  3. Cloud Chambers

III. Nature and Origin of Primary Rays
1. Geomagnetic Effects
2. Composition of Primaries
Chemical Elements Present
Absence of Antimatter
3. Solar Flares
4. Other Time Variations Caused by the Sun
5. Crab Nebula; Synchrotron Radiation
6. Other Supernova Remnants
7. "Unusual" Stars
8. The Jet in Galaxy M87
9. Galactic Magnetic Fields
10. The Galactic Halo
11. Extragalactic Sources
12. Isotropy and Upper Energy Limit
IV. Particles Discovered in Secondary Rays
1. Positrons
2. μ Mesons
3. π^+ Mesons
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V. Transitions in the Atmosphere
1. Fate of Heavy Primaries
2. Interactions of Primary Protons
3. Absorption of Evaporation Products
4. Interactions of Secondary Nucleons
5. Fate of π^+ Mesons
6. Fate of μ Mesons
7. Fate of π^0 Mesons; Cascade Showers
8. Soft and Hard Components
9. Transition Curves
10. N-component
11. Extensive Air Showers
VI. Importance of Cosmic Rays
1. Exploring the Distant
2. Exploring the Tiny
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4. Cosmological Effects
VII. Undiscovered Primary Components
1. Evidence of Neutral Components
2. Predictions of Intensity
3. Problems of Detection

I. HISTORY

1. Discovery of Cosmic Rays.—Although cosmic rays are an ancient phenomenon, their effects went unrecognized until 1900–03, when ionization and electrical conduction in gases first came under close scrutiny. It was found that a sample of air in a closed vessel always exhibited a small electrical conductivity in spite of every precaution to eliminate radiation and to prevent leakage along the insulators. The conductivity was observed to increase in proportion to the pressure of the enclosed air, and to be diminished by surrounding the vessel with thick shields; therefore it seemed to be due to some kind of radiation continually entering the vessel through the walls. If so, this was a more penetrating radiation than had ever been known before.

The observation that ionization occurred not only over the land but over the sea, where radioactivity is negligible, suggested that natural radioactivity could not account for the whole effect; but it required daring balloon flights to demonstrate positively the existence of radiation coming from high in the atmosphere or outside it. In 1911–12, V. F. Hess made balloon ascensions as high as 5,000 m. He discovered that below about 700 m. the ionization decreased with altitude, indicating sources on the earth, but that above 700 m. the ionization increased steadily with elevation, being several times greater at 5,000 m. than at sea level. Hess also demonstrated that the ionization was the same night and day, and was therefore not due to rays coming directly from the sun. He concluded that the radiation observed at high elevations was of cosmic origin, and inferred by extrapolating to lower elevations an accurate value of the cosmic-ray ionization at sea level. In 1913 his results were confirmed by W. Kolhörster and extended to an elevation of 9,000 m., where the ionization rate was 12 times greater than at sea level.

The possibility that the radiation originated in the atmosphere was not fully eliminated, however, until R. A. Millikan and collaborators in 1922–26 showed that the air acted only as an absorber and not as a producer of the radiation. They demonstrated this by proving that the rates of ionization at different depths in high-altitude lakes were the same as at lower elevations under equivalent weights of air instead of water.

Until then, cosmic rays were considered to be exclusively gamma rays (*i.e.*, electromagnetic radiation of exceptionally short wave length) because of their penetrating power, which greatly exceeded that of the known charged rays emitted by radioactive substances. However, in 1927 D. Skobeltzyn observed in a cloud chamber some vertically directed tracks of charged particles so energetic that they were not noticeably deflected by his applied magnetic field, and he pointed out that the frequency of such particles was sufficient to account for the cosmic-ray ionization. Furthermore, in the same year J. Clay discovered the latitude effect; *i.e.*, that cosmic rays are less frequent near the equator than at high latitudes.

In 1929 W. Bothe and W. Kolhörster introduced the technique of employing Geiger-Müller counters in coincidence and proved, by the efficiency with which coincident discharges in the counters were obtained, that many of the observed cosmic rays were indeed charged particles. Climaxing this observation, they interpreted the latitude effect to be a consequence of the primary cosmic rays also being charged particles, and therefore being deflected by the lines of force of the earth's magnetic field as they approached the earth from outer space.

With the explanation of the latitude effect, the existence of charged particles of great energy approaching the earth from distances beyond the sun had become irrefutable. The discovery of the phenomenon of cosmic rays may be said to have been completed at that time, and the era of analysis of the phenomenon had begun.

2. First Decade of Analysis.—In the 1930s a world-wide survey of cosmic rays was carried out, both at ground level and with instruments transported in balloons. The intensities found at different latitudes and longitudes were compared with an analysis of the effects of the earth's magnetic field on incoming charged particles, and it was concluded that the primary radiation is composed in the main of positively charged particles, having an average energy of about 10 Bev (billion electron volts). (An electron volt, or ev, is the energy an electron or proton would be given by acceleration through a potential difference of one volt: 1.6×10^{-12} ergs, 1.6×10^{-19} joules or 1.18×10^{-19} foot-pounds. The units kev, Mev and Bev represent 10^3, 10^6 and 10^9 ev, respectively.)

The natural occurrence of such particles stimulated both theoretical and experimental investigations into the behaviour of elementary particles at very high energies. In the 1930s cascade showers were discovered, in which a single photon or electron of high energy generates a large progeny of secondary photons, electrons and positrons, the latter being elementary particles equal in mass to the electron but bearing a positive charge. P. Auger discovered extensive showers of particles in the air, indicating the arrival on the top of the atmosphere of single cosmic rays with energies of millions of Bev.

It was found that the secondary cosmic rays near sea level were divided into at least two components: a "soft" component, almost entirely absorbed in 10 cm. of lead, and a "hard" component that could penetrate far underground. The former was identified with electrons, and the latter was found to be comprised mainly of a new kind of particle, now called the mu (μ) meson (see *Particles Discovered in Secondary Rays*, below).

3. Post-World War II Developments.—During World War II, as in World War I, cosmic-ray research remained at a standstill. The first decade following the war was marked by rapid development of new experimental techniques and instrumentation: new types of counters, improved electronic devices, sensitive photographic emulsions, more refined cloud chambers and balloons capable of carrying heavier apparatus to higher altitudes. Both the importance and the qualitative nature of nuclear interactions in cosmic radiation were revealed. It was found that in addition to the electromagnetic cascade process, there is a more fundamental nuclear cascade, in the course of which the particles that start the electronic cascades (or electromagnetic cascade showers) are born. The particles that constitute the primary radiation falling on the top of the atmosphere were identified as protons and other atomic nuclei. And many new unstable particles were dis-

covered among the secondary rays.

Methods of radiochemical analysis were also developed, by which minute amounts of radioactivity created by the cosmic rays on the earth, in the ocean, in the air and in meteorites can be used to trace the course of both recent and ancient history.

The extension of radio techniques in this decade led to the discovery of cosmic radio signals coming from both interstellar gases and localized astronomical sources. The new field of radio astronomy (*q.v.*) grew rapidly, and the strong sources of radio noise were correlated with unusual galaxies and supernovae observed in optical telescopes. In 1953–55 it was established that the process responsible for most of the radio waves and much of the light from these objects is synchrotron radiation (*i.e.*, radiation emitted by high-velocity electrons in a magnetic field), indicating an intense flux of particles of cosmic-ray energy in those sources. Thus, a connection was established between optical astronomy, radio astronomy and the source of cosmic rays.

A new era was opened up in Oct. 1957 with the launching of the first artificial earth satellite, sputnik I: the era of direct exploration of space. With the aid of data recorded in rockets, satellites and space probes, relations between many diverse phenomena began to be apparent: comet tails, geomagnetic disturbances, the aurora borealis, the Van Allen radiation belts (*q.v.*), changes in radio-wave transmission and in the reception of cosmic radio noise, and variations in the intensity of primary cosmic rays. *See* International Geophysical Year; Space Exploration.

II. METHODS OF DETECTION

Until 1928 cosmic rays were detected almost exclusively with electrometers or ionization chambers, which measured only the average ionization current in a gas between an insulated electrode and the wall of a vessel. Since the currents were extremely small (on the order of 10^{-14} amp.) these instruments had to be very sensitive; but they were incapable of detecting and counting individual cosmic rays, or of distinguishing between the types of particles or radiation that might be causing the ionization.

1. Counters.—The invention of the Geiger-Müller or G-M counter made great advances possible, since this device can generate detectable electrical signals from single cosmic rays, permitting the times of arrival of individual particles to be measured, and the number of cosmic rays arriving in a fixed time and area to be counted.

G-M counters are limited in two ways: the time resolution cannot be better than about 10^{-7} sec., and the pulse does not indicate the amount of ionization made in the counter by the particle initiating the discharge. Removal of these limitations would help in identifying the particles and measuring their energies. Two kinds of detectors that satisfy these needs were developed by the mid-1950s. Both use a photosensitive electron tube called a photomultiplier (or multiplier phototube) to detect small amounts of visible light caused by the passage of charged cosmic rays through matter. In one kind, the light is produced in special materials that scintillate (*i.e.*, emit characteristic radiation in all directions when their atoms are excited by the passing particle). In the other, the light detected is "Cerenkov radiation" (*q.v.*), which is emitted in a fixed direction and is analogous to the bow wave of a boat moving through water. It is less intense than scintillations, but can be produced in any transparent substance. Both kinds of light are very weak, making sensitive amplifiers necessary; but the amounts of light caused by the cosmic rays depend in a known way on their velocities and charge, permitting these to be measured. The achievable time resolution is about 10^{-9} sec., 100 times better than can be obtained with G-M counters. (*See* Electron Tube: *Photoelectric Devices;* Nuclear Instruments.)

2. Nuclear Emulsions.—The most fruitful information about cosmic rays came, however, not from the above instruments that can resolve small time intervals, but from two other techniques which display the tracks of cosmic rays graphically, showing in detail what occurs in small regions of space. One method is the use of supersensitive photographic emulsions called nuclear emulsions; the older device is the cloud chamber.

Charged cosmic rays passing through emulsions cause ionization in some of the grains and make them developable. If an emulsion is sufficiently sensitive, a single cosmic ray makes enough developed grains so that under microscopic examination they form a well-defined track. Sometimes a cosmic ray undergoes a violent interaction with a nucleus in the emulsion, in which case several tracks are seen radiating from a common point. Such patterns are called "nuclear stars." On other occasions a track may come to an end as a cosmic-ray particle is slowed down in the emulsion, and then the particle may decay, giving rise to a new, lighter and faster particle.

The tracks found in a nuclear emulsion differ from each other systematically in regard to certain features which depend in known ways on the charge, mass and energy of the cosmic rays that produced the tracks. One of these features is the range or residual length of a track, which is observable if the particle stops in the emulsion. For particles having a given charge and velocity, the range is proportional to their mass. Another feature is the grain density g, or number of developed grains per unit length along the track. This is approximately proportional to Z^2/v^2, where Z is the charge of the particle and v its velocity. When g is too high the grains merge and cannot be counted; but if this merging is caused by a large value of the charge Z, numerous "delta rays" (characterized by knobs and short curly tracks) will be seen emanating from the main track. These delta rays consist of electrons with unusually high speeds that have been knocked out of atoms. The number of delta rays, like g, is approximately proportional to Z^2/v^2. Finally, the scattering, or erratic changes of direction of the track, can also be measured. The average deviation per unit length is proportional to Z/pv, p being the momentum of the particle.

It follows that two tracks made by particles of different charge or mass can be alike in any one of the measurable properties just described, provided the velocities of the particles are in the proper ratio; but in such cases the tracks will differ in regard to some other property. Thus, identification or mass determination requires measuring two or more of the distinctive features of a track.

With this method, and also by observations of the decay schemes (*i.e.*, characteristic particle transformations and release of energy) of cosmic rays that suffer radioactive decay in the emulsions, several kinds of elementary particles were discovered (see *Particles Discovered in Secondary Rays,* below). Furthermore, analysis of the tracks produced in emulsions carried by balloons near the top of the atmosphere permitted a direct determination of the composition of primary cosmic rays.

3. Cloud Chambers.—Cloud chambers (*q.v.*) differ from emulsions in that the tracks are produced in a gas and are visible to the naked eye. The function of the apparatus is to generate a controlled supersaturation of vapour in a closed container. General condensation is prevented because surface tension makes the microscopic droplets evaporate as fast as they are formed. The charged ions produced along the track of a cosmic ray, however, form centres about which drops can grow to a size sufficiently large to scatter enough light to be seen or photographed.

About as many new types of elementary particles have been discovered with cloud chambers as with nuclear emulsions. An equally important accomplishment of both tools of research, however, has been the clear demonstration of electromagnetic and nuclear interactions of the cosmic rays with matter: cascade showers, nuclear disintegrations and the multiple production of mesons. Interesting photographs of these phenomena and further clarification of the methods of identifying the tracks are contained in the books by G. D. Rochester and J. G. Wilson and by C. F. Powell, P. H. Fowler and D. H. Perkins listed in the bibliography.

III. NATURE AND ORIGIN OF PRIMARY RAYS

1. Geomagnetic Effects.—The first information about the nature of primary cosmic rays was derived from the effect of the earth's magnetism on the cosmic-ray intensity. Lines of force of the earth's magnetic field extend many thousands of miles into space around the earth, and charged particles are deflected in crossing these lines of force. Although the intensity of the field

is weak, its great extension accounts for a considerable effect on most of the cosmic rays. Particles with low kinetic energy are turned back and cannot reach the earth at all, while particles with sufficiently high kinetic energy are admitted in changed directions, but with as much intensity as if the field were not there. Particles of extremely low kinetic energy, except those of solar origin, are apparently excluded from the neighbourhood of the earth by interplanetary magnetic fields and by the solar wind, the latter being a stream of gas of solar origin that is caused by eruptions on the sun's surface.

The kinetic energy spectrum of arriving particles extends from about 10^8 ev to beyond 10^{19} ev, the number per steradian of solid angle having total energy per nucleon (including rest energy) exceeding E Bev being fairly well represented in quiet solar periods by

$$0.5\ E^{-(1.2\ +\ 0.064\ \log\ E)}$$ per square centimetre per second

The number of lines of force which must be crossed varies with the latitude. Even auroral particles can spiral in along the lines of force near the geomagnetic poles; but with decreasing latitude more and more lines of force must be crossed, and hence more energy is required. For protons in the vertical direction, the minimum kinetic energy is 0.4 Bev at geomagnetic lat. 60°, 4 Bev at 41° and 14 Bev at the equator. Measurements near the top of the atmosphere at these latitudes yield counting rates in the ratio 10 to 3 to 1, the rate at geomagnetic lat. 41° (including all directions) being 1 per square centimetre every four seconds.

At high latitudes, the total number of particles crossing unit area at the top of the atmosphere is about 1 per square centimetre every second in quiet periods of the sun. At the equator the number is about three per square centimetre per minute. The number of primary particles decreases rapidly with energy, and particles above 10^{19} ev in energy arrive at the very low rate of about 2 per square kilometre per year.

The cosmic rays of primary energy above 4 Bev are the ones that produce secondaries capable of reaching sea level. The number of secondary charged cosmic rays at sea level is about 1 per square centimetre per minute.

The latitude effect was originally discovered at sea level, but it is much smaller there than at high altitudes; at sea level there is only 8% increase between the equator and geomagnetic lat. 40°, with no further change beyond 40°. This absence of change is due to the fact that the particles with low enough momentum to be admitted only at high latitudes cannot produce secondaries energetic enough to penetrate through the atmosphere to sea level.

There is also an east-west effect. Positively charged primaries must cross more lines of force to arrive from an easterly direction than from the west, while the reverse applies to negatively charged primaries. Measurements show that more particles arrive from the west than from the east, and therefore that most if not all of the primary cosmic rays are positively charged. (*See* GEOMAGNETISM.)

2. Composition of Primaries.—Direct experiments have been performed to determine whether the primaries include electrons and positrons, and whether or not energetic photons comprise a small portion of the primary radiation. In one of these experiments, a cloud chamber was carried by a balloon near to the top of the atmosphere, with lead plates in the chamber so that electrons, positrons and photons could be recognized by cascade shower production. It was found that these components, if present at all, comprise less than 0.5% of the primaries of more than 1 Bev energy. (Ultimately, in 1961 a primary electron component of weak intensity was discovered, amounting to about 3% of the primary particles with energy above 10^8 ev, but including very few electrons above one Bev. Also in 1961, a satellite experiment detected a very small flux of primary gamma rays, on the order of .03% of the number of charged primaries.)

With neutral particles, photons, positrons and electrons ruled out as major components, and with the fact that the primaries were known to be both stable and positively charged, the most likely conclusion was that they were protons (the nuclei of hydrogen atoms) and possibly nuclei of heavier atoms. This was indeed the case. The most conclusive evidence came from the tracks seen in nuclear emulsions exposed near the top of the atmosphere. Most of the tracks showed by their grain density that the particles were singly charged; range and scattering measurements identified the mass as that of protons. About one-eighth of the primaries produced denser tracks indicative of alpha particles (helium nuclei, with nuclear charge, Z, of 2), and 1.6% were indicated to be nuclei of heavier atoms, ranging from lithium ($Z = 3$) to iron ($Z = 26$). No elements heavier than iron had been detected by 1961.

Chemical Elements Present.—Studies of meteorites, stellar spectra and the constitution of the earth have led to estimates of the relative abundance of the various elements in the universe. Although there is an approximate similarity with the composition of cosmic rays, if the elements in cosmic rays are compared at equal magnetic rigidity (equal ratio of momentum to nuclear charge), there are a number of highly significant differences. First, the elements lithium ($Z = 3$), beryllium ($Z = 4$) and boron ($Z = 5$) are much more abundant in cosmic rays than in the stars. To account for this, it must be assumed that the heavier nuclei have traveled long enough in interstellar space for some of them to suffer nuclear collisions, with consequent fragmentation into the light nuclei. Second, carbon is more abundant than oxygen in cosmic rays, but six times less abundant in the universe. This suggests that the major cosmic-ray production occurs in stars having conditions of temperature and pressure that lead to exceptional production of carbon. Third, all the heavy elements are more abundant relative to hydrogen in cosmic rays than in the universe, the discrepancy increasing from a factor of 2 to 50 with increasing Z from helium to iron. Since the cosmic rays have undergone some fragmentation in space, the discrepancy must be even greater at the source.

Therefore, the sources of high-energy cosmic rays must be exceptionally rich in heavy nuclei such as iron. Such composition is characteristic of supernovae. The presence of the lithium, beryllium and boron in the cosmic rays prescribes a lower limit to the average amount of matter traversed after the cosmic rays were produced, and the residue of iron and chromium prescribes an upper limit. These limits are about 1 and 8 g. per square centimetre for the product of density and distance. The corresponding time in transit is 600,000 to 5,000,000 yr. divided by the number of hydrogen atoms per cubic centimetre in the interstellar space.

Absence of Antimatter.—A search has been made among primary cosmic rays for nuclei of antimatter. Antimatter behaves chemically like ordinary matter, but is composed of atoms in which positrons, rather than electrons, revolve about nuclei consisting of antiprotons and antineutrons, rather than protons and neutrons. If ordinary matter and antimatter are brought together they annihilate each other, converting all their mass into energy. From the rarity of such processes in interstellar space, it is known that less than 10^{-8} of the atoms in our galaxy are composed of antiparticles; but the idea of symmetry in creation has encouraged the thought that distant galaxies may be of the opposite type, so that the amounts of matter and antimatter in the universe are equal. This idea has more than an aesthetic basis: the constituents of ordinary atoms can be created and destroyed in the laboratory, but only by processes in which equal numbers of antiparticles are also created and destroyed simultaneously.

It has been found that less than 1 in 1,000, if any, of the primary cosmic rays are antiparticles. Therefore, either the universe is not symmetric or else very few of the cosmic rays have come from distant galaxies.

3. Solar Flares.—Since 1933 increasingly numerous stations distributed over the earth have kept continuous records of the cosmic rays. Ordinarily the rates at sea level are quite steady, but on five occasions in the period 1942–60 sharp increases were noted. In ten minutes to one hour, the intensity rose by amounts varying from 15% to 5,000% (the latter enormous increase being recorded on Feb. 23, 1956). During the following day on each occasion the intensity gradually returned to normal.

Each of these events was coincident with an unusually strong solar flare (*see* SUN). Astronomers noted a sudden increase in

brilliance of a small area on the visible side of the sun where a sunspot group had been developing, and radio telescopes detected an outburst of solar radio noise. Photographs of the edge of the sun showed violent turbulent processes occurring, in which giant streams of matter shot far out into the corona. Radio stations suffered abrupt fade-out of high-frequency transmission, owing to increased ionization of the upper atmosphere produced by abnormal amounts of ultraviolet rays and X-rays from the sun; and low-frequency radio propagation was affected by enhanced ionization farther down in the stratosphere, which was caused by low-energy cosmic rays. About a day later, geophysicists observed sudden changes in the earth's magnetic field due to currents of charged particles near the earth that were caused by arrival of the solar streams.

On these few occasions the creation of high-energy cosmic rays at the sun certainly took place. One of the additional indications that the particles came from the sun was the location of the points of impact. The greatest and most abrupt increases of cosmic-ray intensity occurred in areas that coincided with the calculated regions where cosmic rays coming from the direction of the sun should strike after deflection by the earth's magnetic field.

In 1958 and subsequently, by use of high-altitude balloons, rockets and artificial satellites, and also by study of the reception of cosmic radio noise, it was learned that solar flares which produce fast protons are by no means as rare as the above-mentioned five giant flares detected at sea level. At an average frequency of about one a month, but varying widely in the 11-year sunspot cycle, flares on the visible side of the sun are followed within an hour by intense streams of protons striking the atmosphere at high latitudes; sometimes these protons arrive at hundreds of times the normal cosmic-ray rate, but they are too low in energy per particle to produce secondaries that penetrate to sea level. The solar particles are detectable with counters near the top of the atmosphere, and they can be observed indirectly at sea level in the auroral zone by means of the sudden absorption of cosmic radio noise caused by enhanced ionization in the upper atmosphere.

These events are initiated by explosions below the surface of the sun which cause turbulent hydrodynamic motions that grow into shock waves in the ionized gas of the corona. The rapid changes of magnetic field in these shock waves can accelerate some of the particles in the outer corona to cosmic-ray energies, mainly by electromagnetic induction (*i.e.*, by the fact that a changing magnetic field generates an electric force). A cloud of plasma shoots out from the solar surface, typically at a speed of 1,000 km. per second, with the cosmic rays embedded in it, trapped by the magnetic fields. On some occasions the cosmic-ray particles are energetic enough to escape from the plasma and travel ahead of it toward the earth, but they may still be dissipated by interplanetary magnetic fields. In cases when intense beams of solar cosmic rays succeeded in reaching the earth, the flares had been preceded within a few days by one or more other outbursts of solar plasma, which apparently swept out the normal interplanetary field and left in their wake a field-free region, in which the subsequent flare particles could travel comparatively unimpeded from the sun to the earth. The slower-moving plasma emitted with the flare particles arrived at the earth about a day later, producing a geomagnetic disturbance at that time.

Magnetometers in space vehicles have determined that the quiescent interplanetary magnetic field along the earth's orbit is constant at about 2.7 gammas (1 gamma = 10^{-5} gauss), upon which increases as large as 50 γ are superimposed by solar disturbances. In a field as strong as 2.7 γ, even the more energetic solar protons (0.1 to 10 Bev) would ordinarily be trapped and would diffuse very slowly to the earth if the field had not been rearranged or removed by a prior solar stream.

Although the sun is the only positively identified source of cosmic rays, it is definitely known that the sun is not the source of all of them. In the first place, the observed flare increases are much too rare. Second, the average energy of the cosmic rays received during the flares is much less than the normal value. Third, the chemical composition is abnormal, helium being virtually absent in the solar-flare particles. Fourth, even cosmic rays of extremely high energy are ordinarily found to be almost perfectly isotropic; *i.e.*, they arrive equally from all directions in space. If these high-energy particles came from the sun, they could be made isotropic only by being deflected back and forth thousands of times by magnetic fields in the solar system; but for this the existing fields are much too small. The sun may be the source of a significant part of the least energetic cosmic rays, but not of those of high energy. (*See* MAGNETOHYDRODYNAMICS.)

4. Other Time Variations Caused by the Sun.—A periodic 11-year cycle has been found in cosmic-ray intensity. The variation observed near sea level at moderate latitudes is only about 5%, but at high latitudes and altitudes, where particles of lower energy can enter, the change between the maximum in 1954 and the minimum in 1958 exceeded a factor of five. The cosmic-ray cycle is related to the 11-year cycle in sunspots, solar coronal activity and geomagnetic disturbance, the intensity being least when the solar activity is greatest. During years of high solar activity there often occurs a cosmic-ray variation that repeats with a 27-day period. This is approximately the period of rotation of the sun, and the cosmic-ray effect proved to be associated with the passage of regions of solar activity through the meridian. The variation is typically several per cent. There is also a very small diurnal variation, much less than 1%, that changes with time in amplitude and phase.

In addition to these periodic variations, a decrease in cosmic-ray intensity called a "Forbush effect" occasionally occurs one or two days after a disturbance on the sun. The effect persists for several days, and is correlated with a geomagnetic storm; *i.e.*, a small change in the earth's field caused by particle emission from the sun. On rare occasions the decrease has been as large as 20%. In 1960 instruments on the space probe Pioneer V detected such a Forbush effect in space, 3,000,000 mi. from earth, while at the same time an equal decrease in cosmic radiation was recorded on earth.

The periodic variations and Forbush decreases are caused by the streams of magnetized plasma referred to above, which are emitted sporadically by the sun in connection with solar flares and travel outward at speeds of about 1,000 km. per second. The density of the magnetic streams in the solar system is greatest in years of high sunspot activity. The streams deflect cosmic rays approaching from interstellar space and prevent some of them, especially those of low energy, from reaching the earth. The fact that the average cosmic-ray intensity is low in disturbed solar periods shows that the sun is ordinarily more effective in keeping cosmic rays away from the earth than in producing them.

In 1960 this explanation was confirmed by direct measurement of the cosmic-ray intensity between the orbits of Earth and Venus. As Pioneer V went closer to the sun, the cosmic-ray intensity went down slightly, as expected in consequence of solar modulation of galactic cosmic rays, instead of going up, as would have occurred if the sun were mainly a producer of the cosmic rays.

5. Crab Nebula; Synchrotron Radiation.—In the constellation of Taurus, within the earth's galaxy, there is a nebular object (the Crab nebula) which is apparently the expanding debris of a supernoval explosion recorded by the Chinese in A.D. 1054. Its present brightness is that of 1,000 suns. In the 1950s a remarkable discovery was made concerning this nebula: in addition to unpolarized light of characteristic wave lengths, such as ordinary stars produce, it emits visible light with a continuous spectrum, and this light is strongly polarized. Only one process is known whereby such light can be generated with appreciable efficiency: the acceleration of highly relativistic electrons (*i.e.*, electrons with velocities near that of light) moving in a magnetic field. Such light is seen, for instance, in high-energy electron accelerators called synchrotrons, and has become known as synchrotron radiation.

The Crab nebula is also one of the strongest sources of radio noise in the sky. The strength and spectral distribution of this radiation are consistent with the amount of continuous visible light, if both are attributed to synchrotron radiation from the same source. The hypothesis was substantiated in 1957 by the discovery that the radio waves, like the light waves, are strongly

olarized, and that the directions of polarization of the light nd radio waves are consistent with each other.

Synchrotron radiation has a short wave-length limit proportional o m^3/BE^2, and dissipates energy at a rate proportional to B^2E^2/m^4; where m is the mass of the particles, E their energy and B the nagnetic field strength. Since the light extends at least into the lue colour, BE^2 must extend to at least 10^{19} in units of gauss × ev)^2. The total energy that has been emitted by the electrons n the form of synchrotron radiation since A.D. 1054 is at least 0^{48} ergs. The present volume of the expanding nebula (the shell f which is moving outward at about 1,100 km. per second) is $= 10^{56}$ c.c. The most conservative estimate of total energy in he plasma is obtained by equating the magnetic energy ($B^2V/8\pi$) o that given to the particles. In this case B is approximately 10^{-3} auss, and the calculation shows that 10^{49} electrons with energies ver 100 Bev have been produced in the supernova.

The region must be electrically neutral on the whole; hence, ositively charged nuclei must be as abundant as the electrons. he nuclei would be accelerated more efficiently than the electrons, nd to higher energy, since they are too heavy to lose energy by adiating light; they would leak out into the galaxy as cosmic ays. It has been hypothesized that nuclear collisions of these articles are the means by which the supply of high-energy elec- rons is replenished within the supernova, since the drain on elec- ron energy due to synchrotron radiation makes direct acceleration f the electrons more difficult. If this hypothesis is correct, the nergy released by such a supernova in the form of galactic cosmic adiation is over 10^{50} ergs, about 1% of the nuclear energy re- eased in the explosion. The high efficiency of conversion of ydrodynamic energy into relativistic particles was accounted for in theories proposed in 1960) by the behaviour of shock waves nitiated by the explosion. Two mechanisms, both of which eemed capable of high efficiency, were considered in these theories. ne is the sweeping up and accelerating of cosmic rays already xisting in the interstellar medium around the star. The other is irect acceleration of gas in the mantle of the star by the shock ave.

6. Other Supernova Remnants.—Besides the Crab nebula, emnants of five other supernovae can be seen in the visible part f the galaxy: Cassiopeia A, the explosion of which was observed 369 A.D. and which is still the source of the strongest radio aves reaching the earth from outside the solar system; "Kepler's ova" of 1604; "Tycho's nova" of 1572; and the supernovae of 006 and 185 A.D. Of these, four are still strong radio sources. t is estimated that on the average, the number of such occurrences n the whole galaxy is about one per 100 yr., providing about × 10^{40} ergs per second of cosmic radiation. This figure should e compared with the supply rate of 10^{41}–10^{42} ergs per second hich is needed to maintain the observed flux of cosmic rays roughout the galaxy. Within the accuracy possible in estimating ese figures, they may be considered equal. (*See* NOVA AND UPERNOVA.)

7. "Unusual" Stars.—Not only supernovae but also red giants nd young, active stars of the T Tauri type are suspected of being ffective sources of cosmic radiation. The infrequent solar emis- ions and the analysis of supernovae demonstrate that production f high-energy cosmic rays is not a normal phenomenon in ordi- ary stars, but occurs at times and places where events of unusual iolence are happening.

8. The Jet in Galaxy M87.—About 40,000,000 light-years way in the Virgo cluster there is a spherical galaxy designated 87. In it is a segmented jet-like luminosity with dimensions of out 400 by 4,000 light-years, roughly 10,000,000 times as big volume as the Crab nebula. This jet is not just a star but a zable part of a galaxy. The whole area emits radio noise and continuous spectrum of polarized light, like the Crab nebula, ut much more intensely, and so is inferred to be a fantastically otent source of cosmic rays.

9. Galactic Magnetic Fields.—In view of the discreteness of smic-ray sources, the observation that cosmic rays ordinarily ap- roach the earth equally from all directions obviously required n explanation.

In 1949 Enrico Fermi first suggested the probable existence of weak magnetic fields in interstellar space, stirred up and carried about by turbulent clouds of rarefied, highly ionized gas. Astron- omers were aware of moving galactic clouds of gas and dust; they later found evidence for the fields by observing that light from distant stars is slightly polarized, as would result from scatter- ing by dust grains magnetized and aligned by a magnetic field.

Fermi proposed that the deflection of cosmic rays by magnetic clouds would not only account for the isotropy of cosmic rays, but also provide a means of storing and accelerating them. Suc- cessive reflections would make the particles follow extremely tortuous paths, losing all sense of their initial directions and prolonging their life in the galaxy. Since the clouds are in mo- tion, cosmic rays would gain a little energy on the average in every reflection, just as a ball can gain speed by bouncing off a moving wall.

10. The Galactic Halo.—Radio astronomers discovered that the earth's disk-shaped galaxy, as well as other spiral galaxies, is surrounded by a spherical region, about 50,000 light-years in radius, which is a source of radio noise though not of visible light. This noise is evidence of the existence of charges and fields in the spherical halo, and hence of ionized matter, less dense than in the arms of the galaxy but in more rapid motion. The radio noise was identified with synchrotron radiation emitted by elec- trons of energy 10^8–10^9 ev. These electrons are believed to be produced by nuclear collisions of cosmic-ray protons that are trapped in the magnetic field of the halo.

Assuming the cosmic-ray energy density to be the same as near the earth, in the volume of 0.6×10^{69} c.c. the total energy is 10^{57} ergs. The average gas density is believed to be 10^{-2} atoms per cubic centimetre in the halo and 1 per cubic centimetre in the central disk, hence the mean lifetime of the protons before nuclear collisions is 5×10^{16} sec. (1.5×10^9 yr.). Each collision transfers 5%–10% of the energy to electrons through meson pro- duction and decay. Therefore the rate of energy transfer to high- energy electrons is computed to be about 10^{39} ergs per second. The observed power in the synchrotron radiation from the galaxy is 2.5×10^{38} ergs per second. Thus the model accounts very well for the measured radiation. This is essentially the same model that was applied above to account for the light and radio waves from supernovae and the galaxy M87. Its quantitative success in explaining phenomena in our own galaxy encourages confidence in this interpretation.

11. Extragalactic Sources.—Because of the magnetic fields, cosmic rays from external galaxies have as much difficulty in entering our own galaxy as the local cosmic rays have in escap- ing. But the abundance of heavy nuclei in cosmic rays implies that the particles can escape from the galaxies in which they are created in times on the order of 10^8 yr. Therefore intergalactic space acquires an appreciable flux, and some interchange be- tween galaxies occurs. The expansion of the universe limits the effective time of filling up intergalactic space to about 2×10^{10} yr., and the space is about 10^4 times larger than that in the galaxies; hence the cosmic-ray density outside the galaxy is prob- ably less than that inside by a factor of 10 to 100. Therefore, extragalactic sources are probably not as effective in supplying ordinary cosmic rays as are intergalactic sources near the earth. But other galaxies may supply the rare particles of greatest en- ergy, exceeding 10^{18} ev, which are less efficiently contained by galactic fields, and for which there does not appear to be a large enough source in our own galaxy.

12. Isotropy and Upper Energy Limit.—There are several reasons for expecting anisotropy in cosmic rays of extremely high energy. The sources of such particles are relatively rare in the universe. Ultimately the magnetic fields in interstellar space should be unable to reflect the particles and so randomize their directions. For instance, in the estimated field strength of 5×10^{-6} gauss the radius of curvature of a 10^{19} −ev proton is 7,000 light-years. If regions of consistent field direction are smaller than this, the particle cannot be reflected. Also, the mag- netic fields, gas and cosmic rays are presumably distributed with some nonuniform structure in space, analogous to the distribution

of visible material. When the energy is high enough for the field to change appreciably in one radius of gyration of the particles, preferred directions of motion should be apparent. Thus, the energy at which anisotropy begins to appear should afford a measure of the structure of galactic magnetic fields.

There should also be an upper limit to cosmic-ray energies, because of the finite size and field strength of the sources. When a particle cannot be repeatedly reflected in the magnetic field of the source, the particle escapes and is no longer accelerated. Thus, determination of the upper energy limit should give a measure of the size and energy density of the largest cosmic-ray sources.

Many experiments have sought to detect the anisotropy and upper energy limit of cosmic rays. At 10^{15} ev the isotropy was found to be good to at least 1 part in 1,000; at 10^{17} ev, to at least 10%. The scarcity of particles above 10^{19} ev in energy made it hard to measure their isotropy quantitatively, but the small numbers of observed particles seemed to be random in direction. As for the upper energy limit, the shape of the curve of number of particles per unit area per unit time v. particle energy as the energy approaches the highest value observed by 1961 (about 3×10^{19} ev) gives no hint that the upper limit is near: the number continues to decrease with energy in the same way as at much lower values.

It is interesting to try to visualize the dimensions of the natural accelerator that is required to produce particles of such fantastic energies. The field strength can hardly exceed 10^{-2} gauss since the gas density must be low. To contain the particles long enough to accelerate them, the dimensions must be at least 100 times the radius of gyration of the particles. Therefore the diameter of the source must be at least 100 times the distance from the earth to the nearest star beyond the sun.

IV. PARTICLES DISCOVERED IN SECONDARY RAYS

All known elementary particles are present in secondary cosmic radiation. They are produced by interactions between highly relativistic primaries and nuclei in the air, and by subsequent nuclear interactions or radioactive decay of the initial products. Many of the particles do not occur in nature except when created by cosmic rays, because of instability against radioactive decay and the concentration of energy required to create the masses. They can be produced in laboratories by means of accelerators; however, many of them were first discovered among cosmic rays, because high energies were available in cosmic rays before the accelerators were built, and because of the exploratory rather than selective nature of cosmic-ray experiments.

In this section, brief descriptions will be given of several of the elementary particles which were not known until their discovery among cosmic rays. For more detailed information on these and other elementary particles, *see* ELECTRON; NEUTRON; PARTICLES, ELEMENTARY; PROTON.

1. Positrons.—The positron was discovered in 1932 by C. D. Anderson, who used a cloud chamber in a strong magnetic field. A positron is the same as an electron except that its charge is positive instead of negative. It is a stable particle in a vacuum, but when it slows down in matter it unites with an electron and they are annihilated, giving rise to two quanta of radiation.

Positrons are often produced in cosmic rays by pair production, the inverse of the annihilation process: a high-energy photon interacts with the electric field of a nucleus (*i.e.*, with virtual photons) and is absorbed, while an electron and a positron are created, sharing the energy of the photon. A second means of production is the decay of positive μ mesons, discussed below. Positrons constitute about 10% of the charged cosmic rays at sea level, and 20% to 30% at mountain or airplane altitudes; they are almost as numerous as the electrons.

2. μ Mesons.—Positive and negative μ mesons were discovered during the years 1933–38 by the combined weight of evidence from many experimenters. They all used cloud chambers with magnetic fields, and measured the momentum of the particle plus an additional parameter (specific ionization, range or shower-producing ability) to establish the approximate mass. The μ mesons have the longest ranges of any particles except neutrinos. That is why they constitute three-fourths of the charged cosmic rays at sea level, and are the only charged cosmic rays that penetrate more than a few metres into the ground. Some of them have been detected after passage through as much as 2 mi. of rock.

It might be expected that μ mesons, being unstable with a mean lifetime of 2.2 μ sec., would all decay in the atmosphere. This actually happens to some of them and accounts for most of the positrons and electrons among the cosmic rays at sea level. Because of relativity, however, time passes more and more slowly for particles of greater and greater energy (*see* RELATIVITY: *Special Theory of Relativity*). The factor by which the time scale changes, called the Lorentz factor, γ, equals $1 + E/mc^2$; where E is the kinetic energy of the particle and mc^2 its rest energy (0.106 Bev for μ mesons). Thus, particles having a speed v and mean lifetime T travel an average distance γvT before decaying. For μ mesons of 3 Bev energy, $\gamma = 29$, and the average range before decay is 18 km; this allows many of them to reach sea level even though they are produced at high altitudes.

3. $\pi^{\pm}$ Mesons.—Positive and negative π mesons were discovered with nuclear emulsions by C. M. G. Lattes, G. P. S. Occhialini and C. F. Powell in 1947. The type of event that led to their discovery was a π^+ meson coming to rest in an emulsion and undergoing radioactive decay. Negative π mesons look different from positive ones at the ends of their ranges in emulsions, because π^- mesons are attracted into nuclei before decaying and cause disintegrations of the nuclei. The visible result is a star at the end of the track of each π^- meson. In the air, however, both π^+ and π^- mesons decay before being captured. The mean lifetime is 2.56×10^{-8} sec., and the decay products are a μ meson and a neutrino.

The mass of $\pi^{\pm}$ mesons is 1.32 times that of μ mesons. The extra mass is released upon decay as kinetic energy of the new particles. When π^- mesons are absorbed in nuclei, the mass becomes excitation energy and is carried off by nuclear fragments.

The $\pi^{\pm}$ mesons are copiously created in cosmic rays by collisions of primary and secondary nucleons (*i.e.*, protons and neutrons) and other $\pi^{\pm}$ mesons with nuclei of air; smaller numbers are made by nuclear absorption of photons. They have also been produced artificially by similar encounters in cyclotrons and synchrotrons.

When $\pi^{\pm}$ mesons are produced in the air they soon decay, unless their energies are exceptionally high, because of their short mean lifetime. Those that escape decay are mostly absorbed by interacting with nuclei. As a result, $\pi^{\pm}$ mesons constitute less than 1% of the charged cosmic rays at sea level. However, their decay is the principal means of creation of μ mesons, the major component of sea-level cosmic radiation.

4. π^0 Mesons.—The neutral π meson was predicted theoretically in 1948, before its experimental discovery; its lifetime was calculated to be very short for decay into two photons, which in turn would create electrons and positrons by pair production. The theory offered a happy solution to two anomalies that had existed in cosmic rays: the great abundance of positrons and electrons at high altitudes in spite of their scarcity in the primary radiation, and the observed origin of positrons and electrons near nuclear interactions in which charged π mesons were created. It was even possible to determine the mass of the π^0 meson from the energy spectrum of photons near the top of the atmosphere. However, because π^0 mesons exist so briefly and are neutral, they could not be detected directly; conclusive evidence for their reality was not obtained from cosmic rays, but with the Berkeley cyclotron and synchrotron in 1950.

The mass of the π^0 meson is about 4% less than that of charged π mesons. Its mean lifetime is about 2×10^{-16} sec., as determined by measuring the microscopic distances from nuclear interactions where π^0 mesons are produced to the points where they decay.

V. TRANSITIONS IN THE ATMOSPHERE

In this section will be outlined the processes by which the cosmic rays change in composition and in number of particles as they filter through the atmosphere. The facts are pieced together from

observations of individual transformations that take place in cloud chambers and nuclear emulsions, and from measurements of the numbers of cosmic rays of various types as a function of depth in the atmosphere and earth.

Throughout the discussion, the unit g./cm.^{2} (grams per square centimetre) will be used as a measure of the path traversed: a distance in these units equals the length in centimetres times the density in grams per cubic centimetre, and thus measures the weight in grams of a column of the substance one square centimetre in cross section. The thickness of the atmosphere above a point of observation in the vertical direction is 1,030 g./cm.^{2} at sea level, and decreases approximately by a factor of 2 for each 5 km. or 16,000 ft. of elevation, so that at 16 km. or 10 mi. elevation the residual atmosphere is 100 g./cm.^{2}

The unstable particles heavier than π mesons will be neglected, since they are produced comparatively rarely; and their brief existence, before decaying into the various components which will be discussed in detail, is unimportant to the major transitions in the atmosphere. Antinucleons will be neglected too, because of their infrequent production.

1. Fate of Heavy Primaries.—Heavy primary nuclei lose energy by ionization faster than protons in proportion to the square of their charge; hence, most of them are stopped by ionization losses near the top of the atmosphere. The more energetic ones interact with other nuclei and are thereby broken up into protons and neutrons, which behave thereafter like the more numerous primary protons. The larger the nucleus, the shorter the mean path length traversed before breakup; the mean length varies from 45 g./cm.^{2} for alpha particles to 20 g./cm.^{2} for primary silicon nuclei and 14 g./cm.^{2} for iron. This explains why heavy primary nuclei are only detected at very high altitudes, and justifies omitting special mention of them in further discussion of atmospheric transitions.

2. Interactions of Primary Protons.—The typical initial interaction of a primary in the atmosphere is the collision of a proton with a nucleus of nitrogen or oxygen. The immediate effects are the following: (1) a number of $\pi^{\pm}$ and π^0 mesons are produced, in approximate ratio 2 to 1, the total number depending on the primary energy but being typically between 2 and 10; 2) the original proton continues with reduced energy, together with one or two nucleons of the struck nucleus which were given high velocities by the collision; and (3) the residual nucleus is left in an excited state, from which it recovers by emission of slower protons and neutrons in any direction, or by breaking up into deuterons, tritons and alpha particles. These fragments typically have energies on the order of 10 Mev and are called evaporation products.

3. Absorption of Evaporation Products.—The progress of each kind of particle emerging from the initial nuclear interaction will now be followed, beginning with the evaporation products. The charged ones ionize heavily and lose their energy in less than 1 g./cm.^{2} of air. The neutrons lose no energy by ionization and travel much farther before absorption, through 5% to 10% (by weight) of the atmosphere. They are gradually slowed down by collisions with atoms of oxygen and nitrogen; and with decreasing velocity, their chance of being captured in a collision increases. Most of them reach energies of about $\frac{1}{4}$ ev before they are finally captured by a nitrogen nucleus, which then emits a proton and becomes radioactive carbon, C^{14}.

4. Interactions of Secondary Nucleons.—Secondary nucleons of energy large compared with a Bev, whether they are protons or neutrons, behave like the primary radiation, undergoing nuclear collisions from which further mesons, fast secondary nucleons and evaporation products emerge. This stepwise multiplication of mesons and nucleons through successive nuclear interactions is known as a nuclear cascade. The average distance between steps is about $\frac{1}{3}$ of the vertical atmosphere by weight, or 80 g./cm.^{2} How many steps are possible depends on the primary energy; and how far a given cascade proceeds also depends on chance fluctuations of the distance traveled between collisions. Some nuclear cascades are still proceeding vigorously at mountain elevations; but the number decreases rapidly as sea level is approached, changing by a factor of 2 in every 82 g./cm.^{2}, or by a factor of 13 in the last 10,000 ft.

Secondary nucleons of energy less than 2 Bev usually undergo nuclear interactions that yield only charged nuclear fragments of rather short range, plus neutrons that continue until they make another star in which only evaporation products are emitted.

5. Fate of $\pi^{\pm}$ Mesons.—Primaries of extreme energy, more than 10^{13} ev, may produce $\pi^{\pm}$ mesons of more than 10^{11} ev. For these, the relativistic time dilatation is so great that they may travel long distances, far enough to experience nuclear collisions instead of decaying. The effect of these mesons is like that of the high-energy secondary nucleons: they contribute to the nuclear cascade, producing further $\pi^{\pm}$ and π^0 mesons and fast secondary nucleons as well as evaporation fragments.

Much more common, however, are $\pi^{\pm}$ mesons of less than 100 Bev energy. These usually decay without further interactions and thus give rise to $\mu^{\pm}$ mesons and neutrinos. The neutrinos have no observed effect except for the disappearance of energy and momentum which they carry with them.

6. Fate of μ Mesons.—The μ mesons retain about 80% of the energy of the $\pi^{\pm}$ mesons, and very seldom lose it by nuclear collisions. Instead, there is a gradual loss of energy by ionization, amounting to about 2 Bev on the average before a μ meson reaches sea level, since most of them are produced in the uppermost 200 g./cm.^{2} of the atmosphere.

Many of the μ mesons, including a small fraction of those having tens of Bev of energy, decay during flight through the atmosphere. About two-thirds of the energy and momentum is then taken away by neutrinos, but the remainder is given to a high-energy electron or positron, the behaviour of which will be discussed later. Fast μ mesons also generate a minor fraction of the high-energy electrons in the atmosphere by occasional close collisions with electrons belonging to atoms in the air. The particles so produced are called "knock-on electrons."

However, most of the μ mesons of many Bev energy survive until they reach the ground, and dissipate the remainder of their energy by ionizing atoms along their paths into the earth. The rate of energy loss is about 2.2 Mev per g./cm.^{2}, and the density of the earth's surface is about 2.7 g./cm.^{3}; hence a meson of 20 Bev, for instance, penetrates 110 ft. before coming to rest.

7. Fate of π^0 Mesons; Cascade Showers.—The π^0 mesons produced in primary and secondary collisions have such short lifetimes that they travel negligible distances before decaying, each into two photons, which share the rest energy and kinetic energy of the meson. Each photon travels on the average only 48 g./cm.^{2} in air before undergoing pair production while passing near an atomic nucleus. The positron and electron thus produced generate new photons along their paths by radiation as they pass near nuclei; each radiates a photon of about half its own energy, plus numerous photons of lesser energy, in traveling about 40 g./cm.^{2} The new photons in turn make new pairs of electrons and positrons, and these radiate additional photons. Thus a cascade shower or electronic cascade develops, the average energy per particle decreasing as the number grows. This is the principal means by which the secondary photons, electrons and positrons are created. Ultimately the energies of the photons become too small to make pairs, while the energies of the electrons are too low to permit radiation of further high-energy photons; the remaining photons are then lowered in energy by Compton scattering (*see* Compton Effect) and ultimately absorbed by the photoelectric process, while the energy of the electrons is absorbed by ionization.

Charged particles other than electrons and positrons do not directly initiate electronic cascades with significant probability; the radiation process requires sudden acceleration in the electric field of a nucleus and only electrons and positrons are light enough to be accelerated sufficiently. Their ratio of charge to mass is 207 times greater than that of their nearest competitor, the μ meson. Cloud chambers are often equipped with lead plates; one of the chief purposes of this is to make possible the detection of photons and the recognition of positrons and electrons by their unique ability to produce cascade showers.

In a heavy, condensed material such as lead, the mean distance

between successive generations (called the "radiation length") is only 0.5 cm.; hence, electronic cascades develop rapidly and are usually absorbed within 5 to 10 cm. In contrast, the distance per generation in nuclear cascades or penetrating showers is 14 cm. in lead, and the total range is on the order of 1 m. Typical ranges of μ mesons are even longer. Therefore electronic cascades are called "soft showers."

8. Soft and Hard Components.—Cosmic rays have often been divided roughly into two classes by the experimental distinction of whether or not they penetrate through 10 to 15 cm. of lead. From the above discussion, it may be concluded that the nonpenetrating or soft component includes almost all the photons, electrons and positrons, while the hard component includes most of the μ mesons. The other particles discussed above are not so cleanly divided, but fall partly in the hard group and partly in the soft one, depending on their energies. These particles, however, are comparatively rare at sea level, where the marked distinction between soft and hard components was one of the clues that led to the discovery of the μ meson.

9. Transition Curves.—Graphs of the counting rates of the various kinds of particles as functions of depth in the atmosphere are called atmospheric transition curves. The transition curve of the total number of charged particles reflects the combined effect of all the processes discussed above. Instruments carried in rockets have shown that above 40 km. (25 mi.) altitude, corresponding to 2 g./cm.^{2} of residual air, there is practically no variation of counting rate until the Van Allen radiation belts are reached. Below 40 km., the rate rises until an altitude of 12.5 to 14 km. is reached (depending on the latitude). There the rate is a maximum. Below that altitude the rate decreases steadily, but more and more slowly as sea level is approached.

The maximum in the atmospheric transition curve is due to the multiplication of particles through the mechanisms of multiple meson production, nuclear cascades and cascade showers. At the top of the atmosphere the number of new particles produced exceeds the number of primaries absorbed, because the average energy is high. Lower in the atmosphere, the number of particles capable of the multiplicative processes is much smaller, and absorption predominates over new production. Near the maximum in the transition curve, the most abundant charged particles are positrons and electrons, while photons and slow neutrons are present in comparable number. At the top of the atmosphere the particles are all primary protons and heavier nuclei. Near sea level, the primaries are gone, the soft component has been mostly absorbed, and the most abundant remaining particles are μ mesons.

The relative counting rates at the top of the atmosphere, at the maximum of the transition curve and at sea level, reflect the total multiplying power of the primaries and the penetrating power of their secondaries. The ratios therefore are indicative of the average primary energy and vary with latitude as expected. At the equator the three counting rates are in the ratio 3:20:1, while at latitude 41° the ratio is 7:28:1 and at 60° it is 24:35:1.

10. N-component.—N-component is the name given to those particles that are capable of producing nuclear interactions (stars and penetrating showers) with high efficiency. Like the names hard and soft components, the term is useful in making an experimental classification before the actual identities of all the particles are established. Primarily the N-component includes high-energy protons, neutrons and charged π mesons. The amount of N-component is found to vary in a particularly strong and yet simple way with depth in the atmosphere; namely, there is a continual exponential decrease, equal to a factor of 2 in every 82 g./cm.^{2} The slow-neutron intensity varies similarly with depth, except very near the top of the atmosphere, where the first ones are generated.

11. Extensive Air Showers.—The most marvelous and complex of all cosmic-ray phenomena is what is known as an extensive air shower. It is what occurs when a primary of extremely high energy, 10^{13} to 10^{19} ev or more, enters the atmosphere. The individual events occurring in extensive air showers are just the same, qualitatively, as those outlined previously in this section. But the primary energy is so high that the cascade processes of creation of particles can go on and on without exhausting the energy, until huge numbers of particles have been produced. All kinds of elementary particles have been found in extensive air showers, but by far the most numerous are photons, electrons and positrons. In some instances, the number in a single shower was found to exceed 10,000,000,000.

The particles in air showers do not all proceed in exactly the same direction; hence the adjective "extensive." There is a core near which many particles are densely clustered, but others are scattered and travel to the sides. Particles in single air showers have been detected more than 1,000 m. apart. The majority, however, land in an area 70 m. in radius (at sea level), and within about $\frac{1}{10}$ μ sec. of each other. Of course, small showers containing just a few particles are much more frequent than the large ones; but the biggest air showers stir the wonder of scientists, for these showers represent macroscopic energies carried to the earth by submicroscopic particles. How high the energy can be is a challenging experimental question, and how to explain the acquisition of such energies is a disturbing physical and cosmological problem.

VI. IMPORTANCE OF COSMIC RAYS

Cosmic radiation originally received the attention of scientists simply because the phenomenon posed a challenge to the understanding. But the study has led to findings of widespread interest in other areas of human knowledge, and even to concern about the effect of cosmic rays on life itself. (For the latter, *see* RADIATION: BIOLOGICAL EFFECTS; SPACE EXPLORATION.) It has long been known that cosmic rays are related to the origin of the aurora borealis, and to sporadic changes in atmospheric ionization that affect radio communications. Some other areas into which the study of cosmic radiation branches are discussed in the following paragraphs.

1. Exploring the Distant.—Each type of radiation striking the earth carries with it some information about the place where it originated and the space through which it traveled on its way. The equality of primary cosmic rays approaching the earth in all directions led to the previously mentioned suggestion by Fermi that interstellar space contains extensive magnetic fields associated with the gas clouds. The degree of uniformity of high-energy cosmic rays tells something about the extent and strength of these fields. The amount of secondary radiation accompanying the charged primary nuclei is related to the average density of matter in the space traversed by cosmic rays. The atomic composition of the primaries is related to the temperature in the region of their source. The existence of high-energy particles is indicative of extremely violent processes going on in distant nebulae, and the energy spectrum of the cosmic rays specifies some of the detailed conditions in those turbulent regions. Thus, the study of cosmic radiation is part of astronomy.

2. Exploring the Tiny.—The high energies possessed by some cosmic rays make them a unique probe for investigating nature on a small scale, as in the interior of a nucleus, and in the structure of elementary particles themselves. Associated with particles having a momentum p is a wave length equal to h/p (where h is Planck's constant, 6.6×10^{-27} erg-sec.). This wave length divided by 2π is the smallest length that plays a role in the interactions of the particles (*see* QUANTUM MECHANICS). One of the reasons that high-energy particle accelerators are constructed is to attempt to resolve this length. A proton of energy 30 Bev, the highest artificially produced energy in 1961, upon colliding with another proton yields a resolution of 5×10^{-15} cm. Cosmic-ray energies extend beyond 10^{10} Bev, providing resolution in such collisions, in principle, to 3×10^{-19} cm.

It had not yet been possible by 1961 to take full advantage of this resolution, but numerous details of matter on a fine scale had been brought to light by the cosmic rays. They led to the discovery of many of the known elementary particles. They provided the first evidence of positron-electron pair creation and the cascade showers predicted by electromagnetic theory. They illustrated in many ways Albert Einstein's principle of mass-energy equivalence as well as other predictions of special relativity,

such as the change of length and time scales at velocities close to that of light. And they have revealed, at least approximately, the energy exchanges and multiple production of new particles that occur in the ultraenergetic nuclear collisions mentioned above.

3. Tracing the Past.—Nuclear collisions of cosmic rays in the atmosphere leave in their wake a substantial number of radioactive atoms—not enough to add significantly to the natural radioactivity of terrestrial origin, but enough to provide a usable, steady source of tracer elements which can be used to study various natural processes of circulation, mixing and separation occurring on earth.

The first use of such a tracer was developed by W. F. Libby and his co-workers in 1946, using the radioactive isotope most abundantly produced by cosmic radiation, carbon-14 (C^{14}). Radiocarbon dating (*q.v.*) may be likened to reading a clock that is wound up by cosmic rays. High in the atmosphere, secondary neutrons produced by cosmic rays are captured by the nuclei of nitrogen atoms, creating C^{14} atoms, which are thereafter oxidized to carbon dioxide. The carbon dioxide is absorbed from the air by plants, which are in turn consumed by animals, and thus the radioactive carbon becomes a part of all organic matter.

Many other tracers besides C^{14} are produced by cosmic rays, mostly through spallation (*see* NUCLEUS: *Nuclear Reactions*) of atoms of nitrogen, oxygen and argon in the atmosphere. In meteorites and tektites, still further isotopes are produced by cosmic-ray interactions with the natural magnesium, silicon, aluminum, nickel, iron, cobalt, etc., of the meteoritic material. The table lists discovered isotopes which in air or in meteorites are principally of cosmic-ray origin.

Isotopes of Cosmic-Ray Origin and Their Half Lives

Isotope	Half life	Isotope	Half life	Isotope	Half life
*Cl^{39}	55 min.	Co^{60}	5.2 yr.	Ni^{59}	0.10 million yr.
*P^{32}	14.3 days	*H^3	12.3 yr.	Ca^{41}	0.11 million yr.
*P^{33}	24.4 days	Ni^{63}	125 yr.	Fe^{60}	0.3 million yr.
*Be^7	53.6 days	Mn^{53}	140 yr.	Cl^{36}	0.31 million yr.
*S^{35}	87.1 days	Ar^{39}	265 yr.	Al^{26}	1.0 million yr.
*Na^{22}	2.6 yr.	*Si^{32}	700 yr.	Be^{10}	2.7 million yr.
Fe^{55}	2.6 yr.	Ti^{44}	1,000 yr.	Ar^{38}	stable
Ar^{42}	≧3.5 yr.	*C^{14}	5,700 yr.	Ar^{36}	stable
				*He^3	stable

*Production detected in atmosphere. (The others have been observed in meteoritic material.)

Dating by cosmic-ray-produced radioactivity depends upon knowledge of the average intensity of cosmic rays during the time when the isotope was being produced. Currently, a periodic variation of cosmic-ray intensity over the 11-year solar cycle is noticeable, but there is no firm evidence for a long-range trend. The amount of C^{14} on the ocean floor has shown that the average intensity of cosmic rays 30,000 yr. ago was equal to the present value within 10% to 20%, and the amount of Be^{10} indicates that over a period of 3,000,000 yr. the progressive change has been less than a factor of 2.

Most of the cosmic-ray-produced tracers were discovered in the years since 1954, and dating techniques are still being perfected. As it is learned how to read all these time clocks with accuracy and reliability, they will open to mankind a more and more complete record of both recent and ancient physical history on the earth, on the moon and planets and in the space beyond.

4. Cosmological Effects.—Cosmic radiation also seems to play a part in physical evolution on a cosmological scale. In the galaxy (*q.v.*) there exist magnetic fields, turbulent motions of ionized gases, cosmic rays and a gravitational field. All of these forms of energy and pressure interact on each other, and the total energy in the galaxy in each of these four forms is believed to be nearly the same, about 10^{57} ergs. Therefore each of these types of energy plays an important role in the dynamical equilibrium of the galaxy and in its slow evolutionary changes.

The detailed interrelations between these forms of energy are complex and are not thoroughly understood, but may be summarized roughly as follows. Stellar explosions and galactic rotation, tapping reservoirs much greater than the four forms of energy listed above, feed energy into turbulent hydrodynamic motion of plasma (highly ionized gas) clouds. These motions generate magnetic fields because of the conductivity of the plasma, and the changing magnetic fields accelerate cosmic-ray particles. The cosmic-ray acceleration damps the turbulent motion and associated fields until the energy per unit volume in these three forms is about the same. Gravitational contraction, which would increase the rotational velocity and the rate of star formation, is resisted by the resulting pressures due to the turbulent gas motion, magnetic fields and cosmic rays. Hence the evolutionary process goes slowly, as energy is gradually lost in radiation, viscous effects and leakage of cosmic rays from the galaxy. Meanwhile, the close interconnection of the various forces maintains an approximate energy balance.

A fifth quantity of energy in the galaxy, nearly equal to the four listed above, is the energy in starlight, but in this case the near equality may be coincidental. Nuclear processes in stars convert much more energy into light than into cosmic rays, but the light escapes from the galaxy in straight lines with no appreciable resistance, while the cosmic rays are restrained by the magnetic fields. These two large inequalities (*i.e.*, in production and in rate of escape) nearly compensate for each other, so that the energy density of starlight in the earth's region of the galaxy is less than that of cosmic rays by only a small factor. *See* STAR.

VII. UNDISCOVERED PRIMARY COMPONENTS

The primary cosmic rays detected prior to 1961 were all charged particles which (except for those produced at the sun) had traveled for a long while in a medium occupied by irregular magnetic fields. The random deflections experienced in transit remove information from such cosmic rays about when and where they originated. Trying to resolve details of the distant universe with this radiation is like attempting visual astronomy through a dense atmospheric haze. But scientists were confident that there are weaker components of the cosmic rays which are neutral and therefore travel in straight lines through space. These components are high-energy photons and neutrinos. It was possible to predict in 1961 that success in detecting these components would be achieved before many years had elapsed, and that this radiation would convey important new kinds of astronomical information.

1. Evidence of Neutral Components.—As explained earlier, the gamma rays and neutrinos, as well as electrons, are a secondary effect of charged cosmic rays, produced abundantly in the atmosphere by decay of π and μ mesons, which are created when the primary nuclei collide with nuclei in the atmosphere. Such collisions occur also in the regions of the cosmic-ray sources, and in the rarefied gas of the interstellar medium in which the charged cosmic rays wander. Evidence of the electrons arising in this way is given by the synchrotron radiation received from interstellar space and from numerous discrete sources. Independent evidence of nuclear collisions undergone by the cosmic rays before reaching the atmosphere lies in the presence of lithium, beryllium and boron among the cosmic rays, despite the virtual absence of these elements in stars.

2. Predictions of Intensity.—The intensity and energy spectrum of the photons and neutrinos from at least one extraterrestrial source—namely, the nuclear collisions of cosmic rays with gas in the galactic disk—could be predicted fairly accurately in 1960 because both the density of gas and the flux of cosmic rays in this region were moderately well known. The average number of photons or neutrinos from this source that have energy exceeding E Bev was computed to be $5 \times 10^{-6}/E^{1.64}$ per square centimetre-second-steradian. The computed intensity coming from the direction of the centre of the galaxy was about 20 times this.

The computed intensity arising from other regions was subject to great uncertainty because of possible errors in the estimated density of matter and of cosmic rays in those regions. Measurement of this radiation is expected to help in establishing the density of matter and cosmic rays in distant regions, and in proving or disproving various theories about the conditions prevailing in supernovae and other unusual stars and galaxies.

3. Problems of Detection.—Detection of the primary photons was difficult prior to 1960 mainly because their number is less than 1% of the photons produced in the atmosphere by charged

cosmic rays. Space vehicles reduced the difficulty by enabling measurements to be made outside the atmosphere, although care had still to be exercised to avoid recording secondary photons produced in the vehicles themselves.

Detection of the neutrinos has the special difficulty of a very small cross section for interactions by which the neutrinos can be observed. The theoretical cross section at a neutrino energy of 1 Bev is only 10^{-38} cm.^{2} per nucleon in the instrument. Hence even if the counter were 10 m. thick, only 1 neutrino in 100,000,000,000 would be detected when it entered the counter. A bizarre method that has been suggested for studying astronomy with high-energy neutrinos is to erect a gigantic counter in a mine far underground, so as to avoid other kinds of radiation, and to wait patiently for very infrequent counts; these counts would signal events that had their origin many trillions of miles from the earth.

See also references under "Cosmic Rays" in the Index volume.

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COSMOGONY, the branch of astronomy concerned with the evolutionary behaviour of the universe and the origin of its various characteristic features. While early cosmogonical theories were limited to the problem of the origin of our planetary system, modern cosmogony embraces the study of the origin of giant stellar galaxies, single and multiple stars, planetary systems in general and, finally, the origin of atoms of various chemical elements which constitute the universe.

The cornerstone of modern cosmogonical theories is the assumption that the system of galaxies scattered through the vast space of the universe is in the state of progressive expansion or dispersal. This conclusion, based on the observation of a red shift of spectral lines in the light coming from distant galaxies (*see* COSMOLOGY: *The 20th Century: Red Shifts*), led G. Lemaître in 1927 to formulate a broad cosmogonical hypothesis according to which the present high degree of differentiation of matter in space and the complexity of forms of various astronomical objects must have resulted from a violent explosion and subsequent dispersal of an originally highly compressed and intensely hot homogeneous material.

For almost three decades after its formulation, the theory of the expanding (or dispersing) universe suffered from an annoying contradiction: the age of the universe, as estimated from the observed rate of expansion (*i.e.*, the mutual recession velocities of galaxies), was considerably shorter than the age of Earth as estimated by reliable geological methods and the age of stars of the Milky Way as given by more recent astrophysical studies. The discrepancy was not removed until 1952, when W. Baade showed that the distances between the galaxies are actually 2.5 times greater than was previously believed, which increases by the same factor the period of time which was necessary for the galaxies to reach their present separations. These new values of intergalactic distances give for the age of the universe the value of 5,000,000,000 (5×10^9) years, which is in perfect agreement with the age of stars and the age of Earth as given by the improved astrophysical and geological methods. Close coincidence among the figures obtained for the age of the universe, stars and planets indicates that all major astronomical features of the universe originated rather early in the beginning of its evolution, and that nothing very exciting has happened since then (except, of course, organic evolution).

Although the notion of an expanding universe is now accepted by the majority of scientists associated with this class of problems, there are a few who prefer to believe in a stationary universe and consider the observed red shift not as the result of recession of galaxies but rather as a consequence of some as yet unknown property of light quanta that causes them to lose a part of their energy in traveling over long distances. However, none of the proponents of that point of view have been able to formulate any reasonable and consistent physical theory for such an energy depletion of light quanta. From the point of view of cosmogony, the abolishment of the expansion theory would be quite catastrophic, since it would deprive scientists of a natural explanation of the coincidence of ages of different characteristic features of the universe; in fact, if the universe was not created 5,000,000,000 years ago it was certainly very extensively reorganized at that time, and the stationary cosmology cannot provide any reason for such reorganization.

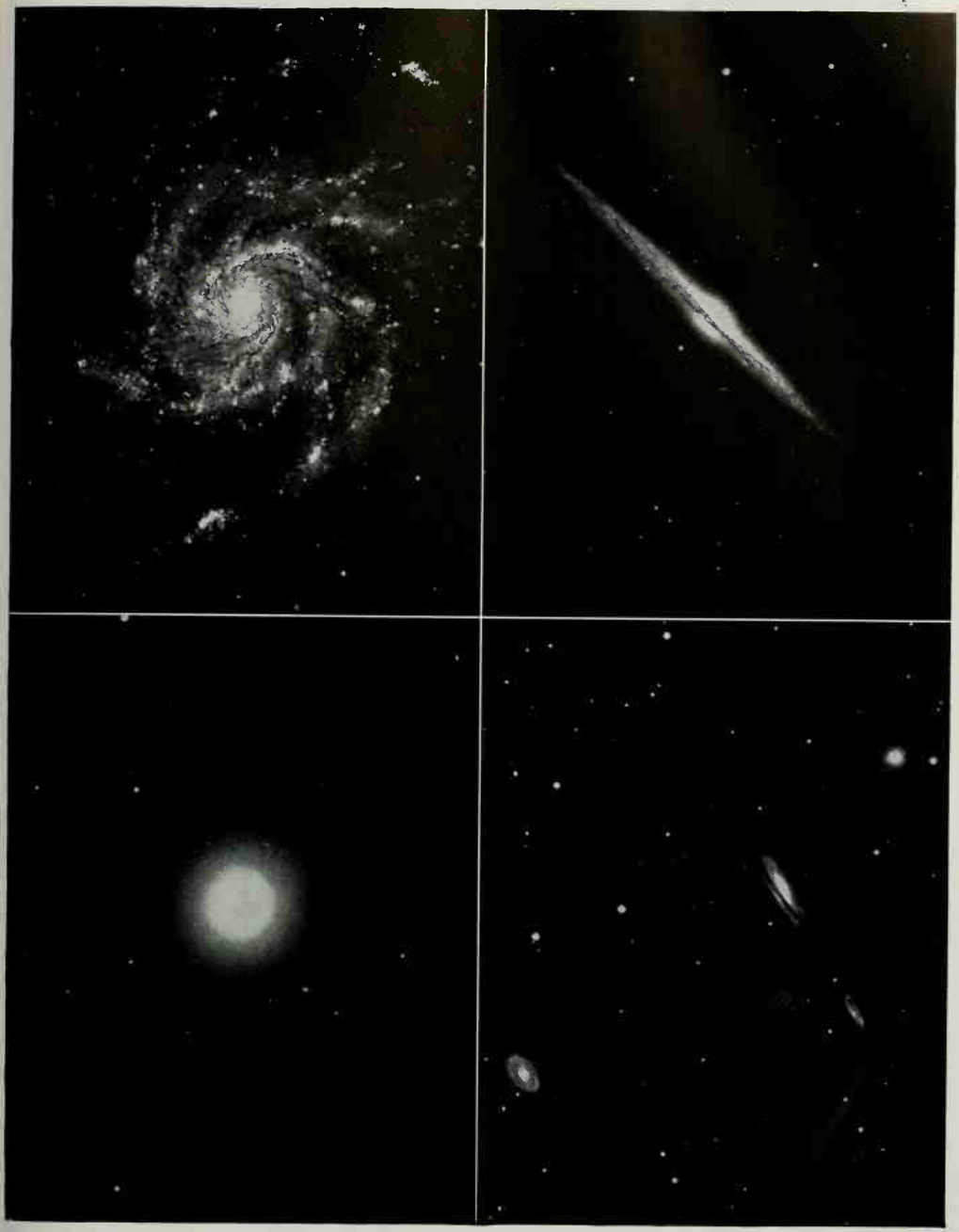
Origin of Galaxies According to "Conventional" Cosmogony.—The original ideas of Lemaître concerning the evolutionary development of the universe from a certain starting point in the past were further developed (in 1948 and later years) by G. Gamow, who emphasized the importance of the gravitational effect of radiant energy during the early stages of expansion. According to Albert Einstein's principle of equivalence of mass and energy, light quanta possess a ponderable (*i.e.*, gravitating) mass which is numerically equal to the amount of their energy divided by the square of the velocity of light, ($M = E/c^2$). Under ordinary circumstances, the "weight" of light can be neglected; thus, for example, on a bright sunny day the total weight of light quanta traversing one cubic kilometre of atmospheric air is only $\frac{1}{100,000,000}$ mg. However, the density of radiant energy increases very rapidly with the absolute (Kelvin) temperature T (proportionally to T^4), and at very high temperatures, such as are encountered in the centre of the sun or in the core of an exploding atomic bomb, the weight of light quanta (in this case, high-frequency γ-rays) may be as high as one gram per litre. Using cosmological equations of the general theory of relativity (*q.v.*) and the basic laws of the thermodynamics of radiant energy, Gamow was able to show that during the first 250,000,000 years of the evolution of the universe the mass density of radiant energy was so high that it exceeded the density of ordinary matter. Under these circumstances, particles of matter could not aggregate into localized concentrations, and matter must have been dispersed uniformly through the space of the universe in the form of a thin gas. According to that theory, the temperature and density of the gas were given by:

$$T = \frac{1.5 \times 10^{10}}{t^{1/2}} \text{ ° K., and } \rho = \frac{10^{-3}}{t^{3/2}} \text{ g./cm.}^3$$

where t is time in seconds counted from the date of the "beginning." Thus, for example, at the end of the first week the temperature of space was about the same as that found now in the centre of the sun, and the density of matter in it was comparable with the density of atmospheric air at an altitude of 100 mi.

As the expansion progressed, the density of radiation dropped faster than that of matter, and after 250,000,000 years the densities became equal to one another; at this time the temperature of space was well below the freezing point of water, and the density was somewhat lower than the present density of the interstellar gas (one hydrogen atom per cubic centimetre). Further expansion made matter gravitationally more important than radiant energy and gave rise to the first step in the differentiation of the originally homogeneous gas.

The breakup which followed can be described in terms of the principle of gravitational instability of extensive gas masses, which was first formulated, in a somewhat different connection, by Sir James Jeans. According to Isaac Newton's original idea, each piece of matter attracts every other piece by a force of gravity; however, the force is negligibly small unless at least one of the two bodies is very massive (*see* GRAVITATION). The earth attracts the moon, forcing it to follow a circular orbit; the moon attracts Earth, producing ocean tides; Earth attracts an apple, making it fall down from a tree; an apple also attracts another apple hanging on the neighbouring branch, but in the last case the force is so small that it could be noticed only by using the most sensitive physical instruments. Similarly, gravitational air-to-air attraction in Earth's atmosphere can be neglected so that terrestrial gravity is considered to be the only acting force.



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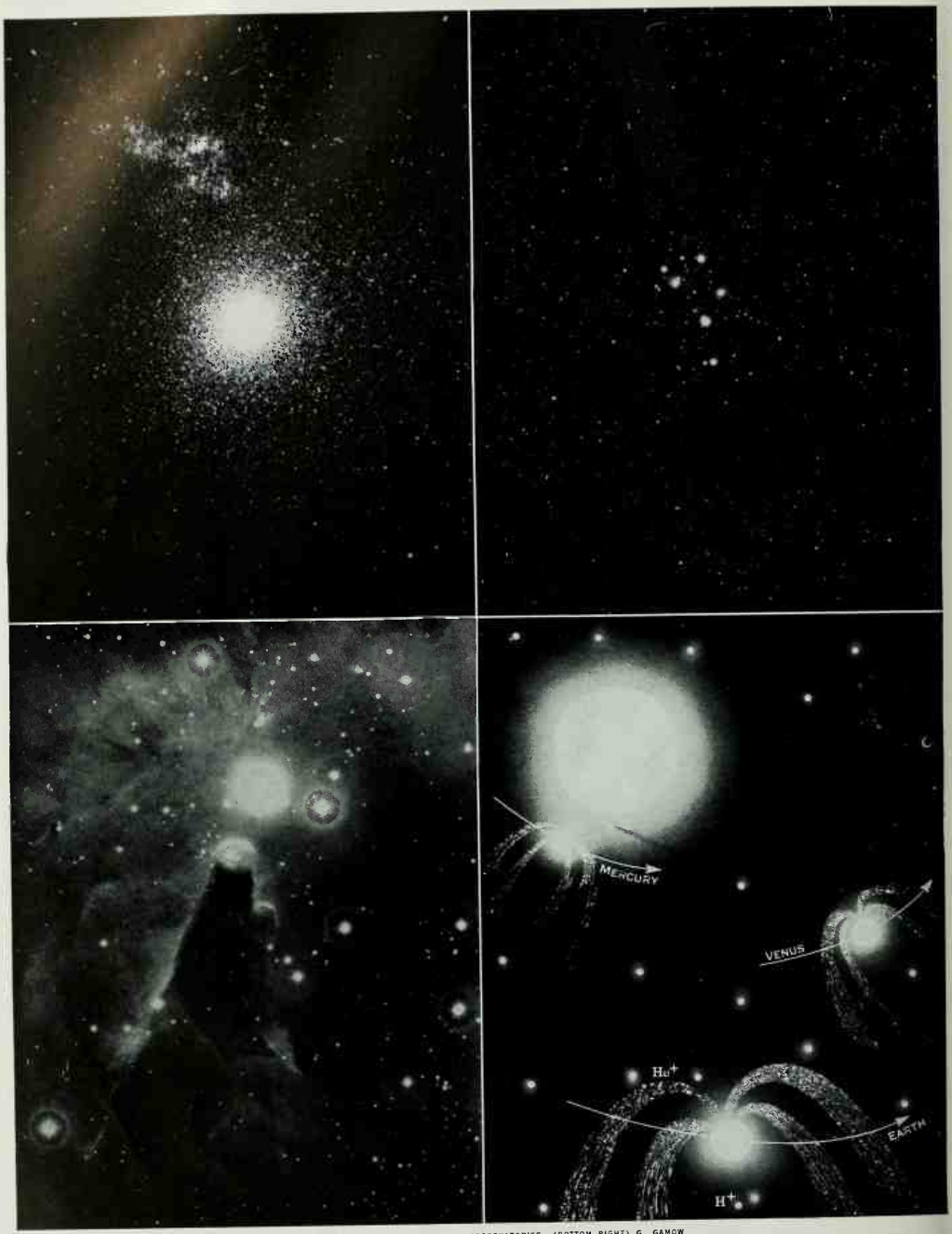
Top left: Spiral galaxy in Ursa Major as seen from the top. The central elliptical body contains only stars (stellar population, or type, II), while the spiral arms are formed by both stars and gas (stellar population I) from which new stars may be formed

Top right: Spiral galaxy in Coma Berenices as seen edge on. Again, the central body is formed by stars alone. The dark band along the edge is caused by obscuration from dust clouds in the arms

Bottom left: Globular galaxy in Virgo. Formed by stars only (population II) with no gas or dust at all

Bottom right: A cluster of galaxies in Leo showing spiral and elliptical types

COSMOGONY



BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM LEFT) MOUNT WILSON AND PALOMAR OBSERVATORIES, (BOTTOM RIGHT) G. GAMOW

Top left: Globular cluster in Serpens located outside the arms of the Milky Way. Typical example of stellar population II

Top right: Galactic cluster (Pleiades) located within spiral arms. An example of stellar population I, showing illuminated gas clouds

Bottom left: Nebula in Monoceros, a region of the Milky Way containing large amounts of stellar dust

Bottom right: Drawing of the origin of the solar system. The sun, coming to life, is blowing off gaseous envelopes of protoplanets. (After G. P. Kuiper)

When dealing with gas masses spread over the unlimited expanses of the universe, however, this cannot be done, and the Newtonian attraction between different sections of the gas must be taken into consideration. Jeans showed that in this case the interplay of gravitational forces will lead to a breakup of homogeneous gas into individual gas clouds, and he gave simple formulas for calculating the masses and sizes of these clouds as a function of the density and temperature of the original gas. Applying Jeans's formulas to the conditions which must have existed in the expanding universe during the epoch when matter took over the leading role and gravitational instability came into play, Gamow found that the mass and size of individual gas clouds formed at that time were comparable with the average mass and size of stellar galaxies as they exist today. By that time space was dark and cold, and so were the newly formed gas clouds, or proto-galaxies, which were destined to develop into the shining stellar galaxies of today by the process of secondary condensation within their giant cool bodies.

Origin of Galaxies According to "New" Cosmogony.—In 1948 an entirely new and revolutionary theory was proposed in Cambridge, Eng., by H. Bondi, T. Gold and F. Hoyle, which, apart from its purely philosophical and mathematical merits, also circumvented the above-mentioned (and now nonexistent) discrepancy between the age of the universe as estimated from recession velocities and the age given by astrophysical and geological data. The new theory, known as steady-state cosmology, assumes that progressive dispersal of galaxies does not lead to rarefaction of the space of the universe because their place is taken by younger galaxies which condense from new matter that is being continuously created (from nothing) all through the intergalactic space. Since the rate of creation of new matter is assumed to be equal to the observed rate of dispersal of galaxies, the density of the galactic population of space remains constant in time, and the show goes on without beginning or end. As in the previously described theory, formation of new galaxies is ascribed to Jeans's gravitational instability, the new element being provided, however, according to D. W. Sciama, by gravitational action of the already existing galaxies. Since according to the steady-state theory the galactic population of space must represent a mixture of galaxies of all possible ages, scientists can choose for the age of our own galaxy any figure indicated by geological and astrophysical data. In fact, the present agreement between the geologically estimated age and the figure derived from the observed red shift must be considered in the new theory as coincidental.

The above-mentioned difference in conclusions concerning galactic ages between the conventional and new cosmologies (and corresponding cosmogonies) represents a very good testing point for comparison with the observed facts. According to conventional theory all galaxies were formed at about the same time, so that the galactic population in any region of space must be found in the same stage of evolution, progressively changing with time. On the other hand, the new theory predicted that in any given region of space there should be found a mixture of all possible evolutionary stages and that this mixture should remain invariant in time. Investigators in the early 1960s did not yet have any well-developed theory of evolutionary changes of stellar galaxies resulting from the evolution of individual stars. It should be expected, however, that the age of a galaxy will be revealed by its stellar content (upper limit of stellar luminosity, relative number of stars of different spectral classes, etc.). Thus, according to the conventional theory, the stellar content of galaxies located in our neighbourhood must be similar to that of the Milky Way, while, in more distant groups of galaxies, there should be a different stellar content, since, because of the finite velocity of light, scientists observe them now as they were a long time ago. According to the new theory stellar content of the galaxies in our neighbourhood must vary considerably corresponding to the variety of their ages (with the average age being one-third the age of the Milky Way), while, on the other hand, there should be no difference between the mean stellar contents of the neighbouring and more distant galaxies (because of the steady-state hypothesis).

In 1961 Martin Ryle of Cambridge university published a paper which presented further evidence against the steady-state theory. Using a powerful radio telescope, he observed numerous point sources of cosmic radio waves (radio stars) which presumably arise from collisions between the galaxies (such as Cygnus A, which was identified optically by the 200-in. Palomar reflector). If observations at distances of 8,000,000,000 light years can be assumed to be equivalent to looking 8,000,000,000 years back in time, Ryle's observations indicated that, in contradiction to the steady-state theory, the mean density of matter in the universe decreases with the age of the universe. Thus, observational evidence available in the early 1960s seemed to support the first set of theoretical conclusions and to contradict the second set.

Galactic Shapes and Turbulent Motion.—When protogalaxies were formed (whether in a unique or a continuous process) by gravitational condensation of the homogeneous expanding gas, they must have continued to recede from each other, being left to themselves to proceed with their own internal evolution. It can be shown that, as long as they remained gaseous, the newly formed protogalaxies must have been undergoing steady contraction, losing their gravitational energy to the radiation filling the intergalactic space, and that this contraction could be stopped only by secondary condensation of the original gaseous material into a multitude of stars. During these early contractive stages, protogalaxies must have assumed their characteristic elliptical shapes, since, as was shown by Jeans, various observed galactic forms correspond to equilibrium configurations of rotating gas masses, and since, on the other hand, after the formation of stars the galaxies must have lost the internal coherence of material necessary for assuming regular geometrical shapes. Indeed, it can be easily shown that, whereas the mean free path of a molecule (*i.e.,* the average distance traveled between collisions) in gaseous protogalaxies is very small compared with galactic dimensions, the mean free path of stars in the galaxies as they exist today is much larger than these dimensions; thus the regular shapes of the galaxies as seen at present cannot be ascribed to the statistical interaction between individual stars. Therefore it may be said that present stellar galaxies represent the "fossilized forms" of the original gaseous protogalaxies, in the same sense that petrified wood is a fossil retaining the shape of the original plant.

In order to explain the formation of rotating condensations in the expanding primordial gas it is necessary to assume that, apart from the uniform expansion, this gas was also in the state of rather violent internal motion; *i.e.,* in the turbulent state. Such an assumption also helps to explain the fact that, apart from regular recessional velocities, galaxies also possess randomly distributed translational velocities which overlap on the simple pattern of the general dispersive motion. Indeed, the study of turbulence in fluid materials shows that this motion can be considered as an interplay of individual eddies of widely varying sizes, with the total energy about equally distributed between their translational and rotational motions. It may be added that the assumption of a violent turbulence in the primordial gas also helps to explain the origin of local fluctuations of density (compression and rarefaction eddies) which are necessary for application of Jeans's principle of gravitational instability.

Assuming the existence of turbulent motion in the original gas which condensed into the galaxies, a natural question is: What was the cause of this turbulence? The general answer is that turbulent motion is a natural state of any fluid material extending over a sufficiently large region of space and is to be expected to be present in all such cases, whether in the terrestrial atmosphere, in interstellar gas clouds or in the endless universe itself (*see* MECHANICS, FLUID: *Laminar and Turbulent Flow*). A more detailed picture of origin of turbulent motion in the homogeneous gas condensing into galaxies is rather different in the conventional and in the new cosmogony. According to the former, the inhomogeneity in the distribution and motion of primordial gas may have originated during the transition from the radiation era to the matter era in the early history of the expanding universe. According to the latter, the turbulence in the universe is a self-perpetuating process and is produced by the movement of already

existing galaxies through the masses of newly created gases.

Origin of Stars.—If the protogalaxies were condensed from a gas in a turbulent state of motion, it is natural to expect that after their formation turbulence continued to exist in their interiors. Thus, by repetition of the gravitational condensation process under the conditions of higher density, and probably lower temperature, further differentiation leading to the formation of individual stars could have taken place. The details of these processes, which led to the transformation of cool and dark gaseous protogalaxies into the shining stellar galaxies of today, are still a challenge to cosmogonical thought, but there is very good empirical evidence that all stars forming the bulk of the galactic population were formed almost simultaneously and very early in the history of the universe (probably within a few hundred million years after the formation of protogalaxies). To understand the situation requires studies of various galactic types and their stellar content. Most of the galaxies scattered through the space of the universe have regular spheroidal shapes ranging from almost perfect spheres to elongated ellipsoids; they are known generally as elliptical galaxies. Considerably rarer, but much more conspicuous, are the spiral galaxies, consisting of an ellipsoidal central body and a pair of shining spiral arms spreading out along the equatorial plane (*see* GALAXY). Studies by W. Baade showed that there are striking differences in respect to stellar population and interstellar material between these two types of galaxies:

Population (or Type) I.—The region of the spiral arms, which comprises comparatively small fractions of the number of all stars (best known to astronomers because we on Earth live inside a spiral arm of our galaxy), contains about half its material in the form of stars and another half in the form of interstellar material (gas and dust). It also contains blue giant stars which are so bright that no nuclear energy sources could have kept them going since the formation of our galaxy 5,000,000,000 years ago; evidently these stars were condensed from interstellar material at a more recent date.

Population (or Type) II.—Central bodies of spiral galaxies, and all elliptical galaxies, contain no interstellar material whatsoever, and their stellar content is limited to stars which can live for 5,000,000,000 years or more. Studies by M. Schwarzschild and A. R. Sandage led to the conclusion that the stars of population II must have originated at the same time (5×10^9 years ago) and are observed now in various stages of evolution depending on their different life spans, which in their turn depend on their original masses (same "calendar age," but different "genetic ages"). The conclusion, then, is that the process of star formation in elliptical galaxies and central bodies of spiral ones was 100% completed very early in the history of the universe, whereas spiral arms may represent, at least partially, later formations in which the process of condensation of interstellar material into stars is still going on.

While the formation of the main bulk of stars constituting population II was not yet clearly understood by the early 1960s, some advances had been made in the theory of stellar formation from the interstellar material of spiral arms. The first steps in this direction were made by Jeans, who developed for this purpose the above-mentioned theory of gravitational instability and was able to show that, with reasonable assumptions concerning the density and temperature of the interstellar gas, correct values are obtained for the masses of condensing stars. Later, the original Jeans theory was extended by L. Spitzer and by F. L. Whipple, who stressed the importance of the radiation emitted by the already existing stars on the formation process of the new ones. It is well known that light incident on any material object produces a force in the general direction of incidence. In most cases this radiation pressure is negligibly small; *e.g.*, nobody worries about the effect of floodlights on tennis balls during a night tournament. However, under cosmic conditions, with dust particles of about one micron in diameter, the effect of radiation pressure becomes quite important. In the case of a single particle in interstellar space, the net effect of stellar light falling on it from all different directions will be zero, but if there are two such particles, each of them will cast a shadow, and in the shadow there is no radiation to produce a force. The fact that no radiation pressure acts on the faces of two particles turned to one another results in a net force pushing them together, and it can be shown that, for particles of the size of interstellar dust, this force may be hundreds of times stronger than the force of gravity between them. In this way radiation pressure of the existing stars can accelerate a comparatively slow condensation process caused by gravitational instability alone.

It may often happen that in the process of condensation of such a cloud, the cloud will possess too much rotational momentum to develop into a single stable star. In such cases the formation of two or more stellar bodies bound together by gravitational forces may be expected, and this accounts for the fact that among the stars in our galaxy double and multiple systems represent a rule rather than an exception. (*See* INTERSTELLAR MATTER; STAR.)

Origin of Planetary Systems.—As mentioned in the beginning of this article, the problem of the origin of the planetary system represents the oldest and, originally, the only problem of cosmogony. According to the original ideas of I. Kant and P. S. de Laplace the planets condensed from the primordial solar nebula, a flat, fast-rotating, gaseous disk which must have surrounded our sun during the early days of its existence. During the second half of the 19th century the Kant-Laplace hypothesis was subjected to severe criticism by J. C. Maxwell, who showed that, if all the matter contained in the known planets were once distributed around the sun in the form of such a disk, the shearing forces of differential rotation would have prohibited the matter from ever condensing into individual planets. The expected result of condensation would be rather a multitude of very small bodies, such as those forming the rings of Saturn. As the result of Maxwell's criticism, the Kant-Laplace views were rejected from planetary cosmogony and replaced by the so-called collision theory proposed independently by Jeans and by T. C. Chamberlin and F. R. Moulton at the beginning of the 20th century. According to this theory, which is similar to the views expressed by G. Buffon in the 18th century, planets were formed as a result of a violent collision between the sun and some other passing star. Since such collisions between two stars represent extremely rare events in the stellar traffic within our galaxy, our planetary system was supposed to be unique, or at least one of the few, in the entire stellar system of the Milky Way.

The collision theory, which dominated planetary cosmogony during the first decades of the 20th century, was finally disposed of in 1944 by the work of C. F. von Weizsäcker, who brought the problem back to the "parthenogenetic" ideas of Kant and Laplace by indicating that the old Maxwell criticism cannot hold in view of new knowledge concerning chemical constitution of the material forming the universe. In fact, in Maxwell's time, and up to the end of the third decade of the 20th century, it was generally believed that the sun, stars and interstellar material have the same constitution as Earth, being principally composed of silicon, iron, oxygen and a few other elements forming different abundant minerals. The great turnabout in astrophysics occurred when it was found that this is not true, and that the most abundant terrestrial elements form less than 1% of the average composition of the cosmos. The remaining 99% is provided by a half-and-half mixture of hydrogen and helium gases. Thus, argued Weizsäcker, the original solar nebula must have had a much larger mass than that contained in the planets today, the excess of hydrogen and helium being somehow lost after the formation of planetary bodies. With the total mass of the original solar nebula increased almost a hundredfold, Maxwell's old argument was no longer valid, and it was possible to return to the old ideas of Kant and Laplace, which visualized the formation of planets by gravitational condensation in the primordial solar nebula.

These basic ideas of Weizsäcker were further developed and brought into the form of a self-consistent theory by G. P. Kuiper. He estimated that the original solar nebula possessed a mass of about 10% of the solar mass, and that its breakup caused by gravitational forces must have led to individual condensations, known as protoplanets, each with a mass of about 1% of the solar mass. These protoplanets must have had the same chemical constitution as the original interstellar material, being formed by 99% hydrogen and helium gases and only 1% (or even less) of the most abundant terrestrial elements in the form of fine dust. The dust particles gradually settled toward the centre of the protoplanets, forming solid spherical cores. The important point of Kuiper

theory is that the formation of protoplanets took place in darkness, since the sun itself was not yet sufficiently condensed to emit any appreciable light. When, later on, the body of the sun contracted to almost its present size, and its surface temperature went up to several thousand degrees, it began to pour intensive radiation into the space around it. Under the action of the radiation pressure of sunlight (mostly ultraviolet rays) the hydrogen-helium envelopes of the protoplanets, especially of those which were nearest to the sun, were gradually blown off into interstellar space, and for a while the planets looked very much as the comets do today, with giant luminous tails trailing behind their bodies. In the case of planets located closer to the sun (Mercury, Venus, Earth and Mars) the original hydrogen-helium envelopes were completely blown off, and the planets were left in the form of solid rocky bodies with negligibly small layers of atmosphere. (Present atmospheres of Earth and inner planets are presumably of later origin, being formed by oxygen and nitrogen gases liberated from the solid crust.) In the case of the outer planets, such as Jupiter and Saturn, a considerable part of the original envelopes was left over, and their giant bodies, as seen on photographs, are actually nothing but gaseous spheres composed of hydrogen and helium, with small solid cores hidden in their deep interiors. Kuiper also showed that formation of planetary systems can be considered as a special case of the formation of binary or multiple stars when, because of the distribution of velocities and angular momenta in the body of the original contracting nebulosity ("protostar"), it breaks up into one very large and several much smaller bodies. Extrapolating observational data concerning the number of binaries with different mass ratios, he concluded that formation of planetary systems similar to ours must take place in 1 out of 100 cases. Considering that there are approximately 10^{11} stars in our galaxy, it must be concluded that 10^9 of them possess planetary systems, and on millions of those physical conditions may be very close to those encountered on Earth. Most likely life is flourishing on them too.

Origin of Satellites and the Moon.—The process of formation of satellites around the planets of the solar system must have been similar to, though on a smaller scale than, the process of formation of the planets themselves, and it will not be discussed here in any detail. A peculiar situation arises, however, in the case of the moon, which stands apart from other satellites because of its comparatively large mass; in fact, whereas the masses of all other satellites are several thousand times smaller than the masses of their parent planets, the moon is only 81 times lighter than Earth. It seems that the formation of the Earth-moon system should be rather compared with the formation of a binary star, in which two independent cores are formed within the original gaseous envelope. If this is true, the moon and Earth must have been very close together during the early time after their formation—a conclusion which is substantiated by the classical work of G. Darwin on the secular motion of the moon. Indeed, Darwin showed that dissipation of energy by lunar tides in terrestrial oceans is slowly driving the moon farther and farther away from Earth, and, extrapolating back in time, he came to the conclusion that a few thousand million years ago Earth and the moon were indeed very close neighbours.

Origin of Chemical Elements.—One of the methods for estimating the age of the universe is based on the study of certain natural radioactive elements—uranium-238, uranium-235 and thorium-232—and their decay products, lead-206, 207 and 208 (*see* RADIOACTIVITY). Starting with present abundances of these atomic species and extrapolating back in time, using the known decay constants, reveals that in the past there were smaller and smaller amounts of lead isotopes and larger and larger amounts of radioactive elements. Such an extrapolation breaks down, however, if one tries to go back farther than 5,000,000,000 years, since at that date the extrapolated amount of lead-207 (the end product of the fastest-decaying uranium isotope, 235) becomes zero; if uranium-235 had been steadily decaying for a longer time than that, it would have produced more lead-207 than is actually found. Of course, this method gives only an upper limit for the age, since some lead-207 could be due not to the decay of uranium-235 but to independent production along with all other elements. Nevertheless, the date of formation of natural radioactive elements, and presumably of all other elements, may be set close to the date of the "beginning" as estimated by other methods.

Since, according to "conventional" cosmology, early stages of the evolution of our universe were characterized by extremely high temperature and comparatively high densities, it is logical to venture a hypothesis according to which the present relative abundances of various chemical elements and their isotopes were determined, at least partially, by thermonuclear reactions which must have taken place in those early days (*see* NUCLEUS: *Nuclear Reactions*). Calculations in this direction were carried out in 1947 and in following years by R. Alpher, H. Bethe, G. Gamow and R. Derman. Noticing that, under the physical conditions involved, the material of the young universe must have consisted entirely of a mixture of free neutrons, protons and electrons (*ylem*, or *hyle*, according to an old term used by Aristotle), these men visualized the formation of heavier elements as a progressive aggregation process, which must have started when the originally very high temperature dropped to a value at which nuclear bonding between protons and neutrons became possible. Using data on neutron-capture cross sections, they were indeed able to show that the theoretical curve giving relative abundances of elements in the universe is in reasonably good agreement with the empirical curve. In particular, the sharp drop of the empirical curve for the first half of the periodic system and its approximate constancy for the second half come as a direct result of the observed variation of neutron-capture cross sections with the atomic number of the bombarded element. Further calculations in this direction were carried out by E. Fermi and A. Turkevich, who limited themselves to only the lightest nuclei (neutrons, protons, deuterium, tritium, helium-3 and helium-4) but took into account all the details of expected thermonuclear reactions. They came out with the result that, by the end of the aggregation process, about 99% of matter would be roughly a half-and-half mixture of hydrogen and helium (in good agreement with observed facts) and about 1% would be in the form of deuterium and helium-3 which should serve as the centres of further aggregations. These calculations, however, came to a serious difficulty of building up the elements beyond helium, because of the absence of any stable nuclei with a mass number of five. It is interesting to note that, according to this theory, formation of elements took place during the first half-hour of the existence of the universe. It should not sound so incredible, however, if it is remembered that half an hour stands in the same ratio to 5,000,000,000 years as one microsecond, representing the nuclear reaction period in an exploding atomic bomb, stands to a few years' period, after which radioactive fission fragments are still noticeable at an atomic-bomb explosion site.

It must be noted also, however, that although the main processes of element formation (in particular the establishment of the hydrogen-helium ratio) could have taken place during the very early stages of the evolution of the universe, some further adjustments undoubtedly have taken place during subsequent periods. Thus, for example, spectroscopic data clearly indicate that stars of population I have, at least in their atmospheres, a hundred times larger percentage of heavier metallic elements than do the stars of population II (*see* SPECTROSCOPY, ASTRONOMICAL). Also, in some stars are found spectral lines belonging to the unstable element technetium (atomic number 43), which has been produced artificially in nuclear reactors and whose longest living isotope has a half-life of only 200,000 years. It is difficult to say whether these differences are due to some kind of nuclear reactions involving neutron production that take place in the central regions of stars, or whether purely surface effects caused (for example) by high-energy cosmic-ray bombardment are responsible.

Another interesting fact is that the exponential decrease of the luminosity of supernovae has a half-life of 55 days, which coincides exactly with the half-life period of the transuranium element, californium-254, which undergoes spontaneous fission with the liberation of 220 Mev of nuclear energy. It is possible that

californium-254 is produced during the explosions of supernovae, and that its slow decay supplies the energy for the later stages of supernovae. (*See* NOVA AND SUPERNOVA.)

In contrast with the above-described considerations based on the "conventional" cosmology, the steady-state theory, according to which matter is continuously created in the form of thin hydrogen gas, has to look elsewhere for the aggregation process leading to the formation of heavier elements. According to F. Hoyle, formation of heavier elements is taking place in the interiors of supernovae, and these newly formed elements are scattered around and mixed with the interstellar hydrogen gas by the force of explosion. In 1957 a considerable amount of work on the origin of elements in stars was carried on by Hoyle, and by E. Margaret Burbidge, G. R. Burbidge and William A. Fowler. Their work made it seem plausible that heavy elements may be produced in supernovae explosions, even though the number of supernovae which must have flared up since the origin of our galaxy seems to be by several orders of magnitudes too small to account for all heavy elements present in our galaxy.

See NEBULA; SPACE-TIME; *see* also references under "Cosmogony" in the Index volume.

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(G. Gw.)

COSMOLOGY, in the broadest sense of the word, is that branch of learning which treats of the universe as an ordered system. The name is derived from the Greek *kosmos* ("order," "harmony," "the world"), plus *logos* ("word," "discourse"). Cosmology is that framework of concepts and relations which man erects, in satisfaction of some emotional or intellectual drive, for the purpose of bringing descriptive order into the world as a whole, including himself as one of its elements. As such, it is confined to a *description* of the salient features of the observed universe, in terms of such categories as space and time and matter, leaving questions concerning the origin, inner nature and purpose of the universe to the related branches of cosmogony, ontology and teleology (*qq.v.*).

The cosmologies which man has set up at various times and in various localities inevitably reflect the physical and intellectual environment in which he lived, including above all the interests and the culture of that particular society to which he belonged. For in attempting to bring order into the universe as a whole, he must hew to those lines of thought by which he has already brought order into that portion with which he is most familiar. The resulting cosmology will accordingly reflect the sociological, philosophical or scientific predilections of the individual and his group.

Cosmologies, as may therefore be expected, run the gamut from simple pictures projected from the everyday objects of a primitive society, through the metaphysical constructs of various philosophers, to the sophisticated mathematical models presented by modern science. In keeping with this viewpoint and with the fact that western man has for some time been immersed in an era characterized by the scientific outlook, the present account will be devoted mainly to the growth and present status of cosmology as a branch of natural science.

HISTORY

Early Cosmologies.—Man finds himself on an earth, inhabiting a land mass surrounded by seas and blanketed by a gaseous atmosphere. By day the sun dominates his sky, followed at night by the moon and the host of stars, among which wander the five erratic planets. Imposed upon this regularity are the passing phenomena of clouds and rain and lightning, of shooting stars and occasional comets, and of the frightful moments when the light from the sun or moon is wiped out by an eclipse. Faced with this confusing multiplicity, beyond his physical power to control, man seeks to master it symbolically by reducing it to order—by constructing a cosmology relating its parts with each other and with man himself, welding them into a conceptual whole.

In primitive cultures, man has sought to attain this symbolic mastery by picturing the universe in terms of objects familiar to him in his everyday life. Thus one of the primitive tribes of ancient India pictured the earth as a huge tea tray, supported on the backs of three giant elephants, which in turn stood on the shell of an enormous tortoise. To the Egyptians the sky was a heavenly Nile, along which the sun-god Ra sailed from east to west each day, to return at night to his starting point through the subterranean abode of the dead; this god was occasionally thrown into eclipse when his boat was attacked by a great serpent.

Of more interest to the western tradition is the primitive cosmology of Babylonia, for from it can be traced both the scientific view which dominates modern times and the rival mythological view which threatened the eclipse of the scientific approach in the dark ages of Europe. In it the central earth is a great mountain, hollow underneath, surrounded and supported by a vast ocean—the deep—and under it is the abode of the dead. Above the earth is the solid vault of heaven—the firmament—resting on the waters of the deep and dividing the upper waters from the lower; across the firmament move the sun and moon and the heavenly host of stars. (*See* ASTRONOMY: *History of Astronomy.*)

Contributions of the Greeks.—Greek physical science arose in the Mediterranean colonies in the 6th century B.C., flourished on the mainland during the next two centuries, whence it passed on to Alexandria—and shortly after the dawn of the Christian era stagnated until resurrected in the Renaissance. These golden centuries saw great advances in observational astronomy and mathematics and with them the emergence of cosmological theory from the mythological form impressed upon it by the Babylonians and the Egyptians. Physics had failed, however, to keep pace with its sister sciences; lacking a firm mechanical base and constrained by metaphysical dogma, Greek cosmology developed in the direction of ever more intricate geometrical models.

Throughout the main line of development, from Thales of Miletus (*c.* 600 B.C.) to Ptolemy of Alexandria (*c.* 150 A.D.), it was taken for granted that the earth was the immobile centre of the universe about which the heavens daily rotated. The chief importance of those who took exception, such as Heracleides Ponticus (4th century B.C.) and Aristarchus of Samos (*c.* 270 B.C.), seems to have been to supply a classical source upon which the innovators of later centuries could call for support, for their views were firmly rejected at the time on spurious reasoning or on dogmatic grounds. A second, even more grievous fault was that the idealistic philosophies of the Pythagoreans and of Plato required that the motions of the heavenly bodies be explained in terms of uniform motion in circles. In the case of the stars this could readily be done merely by assuming that they were attached to a great sphere which rotated daily about the earth but to account for the more irregular motions of the seven wanderers (*i.e.,* the sun, the moon and the five planets then known) led to great complications. The attempt by Eudoxus (408–355 B.C.) to solve this problem in terms of motion on homocentric spheres required 27 spheres, and in the form adopted by Aristotle (384–322 B.C.) 55 were required. But no such solution could account for the apparent changes in the distance of some of the bodies from the earth. The geocentric motions were augmented by motion in eccentric circles and in epicycles—the latter being uniform motion in circles whose centres were themselves in uniform circular motion about the earth. This cosmological model attained its most perfect expression in the work of Ptolemy, in which form it was handed down, with minor modifications by the Arabs, through the centuries to the reawakening west.

With this legacy went other positive contributions of the Greeks—the sphericity of the earth, the nature of the moon's light and some estimates of the sizes and distances of the principal heavenly bodies. From the difference in the declinations of the sun observed from two different points on the earth, Eratosthenes of Alexandria (*c.* 276–*c.* 192 B.C.) computed the circumference of the earth to be 252,000 stadia, which gives as the radius of the earth a figure

nly 25 mi. short of its true polar radius. From observations of he breadth of the earth's shadow during a lunar eclipse, the work f Hipparchus (fl. 146–127 B.C.) enables calculation of values of he moon's radius and distance, in terms of the earth's radius, which are within 8% of their true values; his distance for the sun, owever, was only about one-tenth the true value. No estimate of he distance to the starry vault could be given, but it was generally eld to be immense, though limited to a finite value.

The Copernican Revolution.—With the onset of the dark ges, cosmology was cast back into the primitive state from which Greek science had raised it. "Pagan" views were denounced as t variance with scripture. But with the rise of scholasticism the Hellenistic learning was in part brought back, and by the end of he 13th century Aristotle was firmly established in the schools, vith church approval. Beyond this the scholastics would not go, vith the exceptions of such rare minds as Roger Bacon (*c.* 1214–94), and the breakthrough to free thought in natural science had n addition the heavy blanket of the new Aristotelianism to throw off.

This breakthrough was initiated by Nicolaus Copernicus (1473–1543) in his immortal *De revolutionibus* (1543). In it he adopted he rotation of the earth to account for the diurnal motion of the tars and deposed the earth from its position as the centre of notion of the universe by allowing it and the other planets to nove about the sun. A few in the succeeding generations seized pon Copernicus' views, and two of them, Thomas Digges and Giordano Bruno, took the further step of assuming an infinite universe populated with an infinity of worlds. But the times were ot ripe for the general acceptance of the Copernican system; for ne thing, the sterile Aristotelian mechanics had not yet been eplaced by a more profound understanding of the nature of motion, and for another the Renaissance had ground to a halt in he bitter conflict between the church and the reformers, neither f whom would countenance such heterodoxy.

Bold as was his willingness to shift the centre of the universe rom the earth to the sun, Copernicus was still bound by the Greek ogma that the motions of the heavenly bodies must at most be combination of uniform circular motions. His system was in onsequence little better than Ptolemy's in accounting for the pparent motions of the planets, as judged from the vantage point f the earth. The discrepancies were made more acute by the uperb observations of Tycho Brahe (1546–1601), who himself spoused a geocentric system in which the planets described picyclic orbits centred upon the moving sun, an ingenious improvement of the Ptolemaic system and one equivalent in its redictions to the Copernican.

Tycho's observations were handed on to his brilliant assistant ohannes Kepler (1571–1630), who devoted his life to the problem f determining the organic structure of the solar system, under ıe inspiration of a neo-Pythagorean metaphysics. Kepler's exaustive study of the motion of Mars led him to the conclusion ıat it described an ellipse at one focus of which the sun was tuated. This empirical discovery, extended to the other planets, id away once and for all with the artificial restriction to uniform ircular motion imposed a priori by the Greeks, and at the same me established the sun as the natural point of reference of the lanetary system. Kepler's later investigations on the relative zes of the planetary orbits led him (1619) to his third law, that ıe squares of the periods of revolution of the planets are proortional to the cubes of their mean distances from the sun (*see* RBIT). Superimposed on this hard kernel of fact was a penumbra f fancy which history has mercifully passed over, including a ıystical computation of the radius of the solid sphere upon hich the stars are mounted, recalled here only to emphasize the idening celestial horizons of the intervening centuries. Kepler stimated the radius of this ultimate sphere at 60,000,000 earth adii, about 2,560 times the mean radius of the earth's orbit, or modern units about one twenty-fifth of a light-year—where ıe light-year is the distance light travels in one year, the disnce from the sun to the earth being about eight light-minutes ıd the actual distance to the nearest star about four light-years.

The Copernican revolution may be said to have been completed with Galileo Galilei (1564–1642), whose telescope revealed the satellites of Jupiter and the rings of Saturn, stripping the earth once and for all of the claim to being the only body about which all others must be considered to rotate. Galileo's observations thus assured the sun of its central position among the planets, but at the same time his resolution of the Milky Way into a great collection of stars presaged the subservient position to which the sun itself was to be relegated by later observation.

The Newtonian Era.—In the year of the death of Galileo was born Isaac Newton (1642–1727), the genius destined to bring order into the solar system and to furnish the tools—the new science of dynamics and the law of universal gravitation (1687)—for the extension of this order throughout the visible universe. The solid spheres, already shattered by the moons of Jupiter and the clearly extraterrestrial comet of 1577, were swept away and replaced by scientific law which accounts at once for terrestrial gravitation, the motion of the moon around the earth, of the earth and the other planets around the sun and of multiple stars around their centre of mass (*see* CELESTIAL MECHANICS; GRAVITATION).

The time was now ripe for the demotion of the sun itself and its eventual recognition as a minor member of that great system of stars that makes up the Milky Way. Newton himself promoted the cosmological and cosmogonical speculations initiated a century earlier by Digges and Bruno. In a letter written to Richard Bentley he stated, "But if the matter were evenly disposed throughout an infinite space . . . some of it would convene into one mass and some into another, so as to make an infinite number of great masses, scattered great distances from one another throughout all that infinite space. And thus might the sun and fixed stars be formed, supposing the matter were of a lucid nature." Thus arose the long line of scientific cosmogony, leading through Thomas Wright, Immanuel Kant and Pierre Simon de Laplace to the modern theories.

Observation did not lag behind theory. Foremost among the observers was Sir William Herschel (1738–1822), a musician by profession and an astronomer by choice, who launched an attack with telescopes of ever increasing power designed to extend knowledge beyond the confines of the solar system in an effort to discover the structure of the universe. Herschel discovered a seventh planet, Uranus (1781), and pushed on to the study of double stars, extending the rule of Newtonian gravitation into stellar space. Telescopic observation showed that the dimmer stars, as well as those visible to the naked eye, tend to cluster about the plane of the Milky Way, forming a lenticular figure whose thickness is but a small fraction of its diameter. Since the time of Edmund Halley it had been known that some of these "fixed" stars had proper motion, and Herschel concluded that the sun itself had such a motion relative to the body of the system.

This completed the relegation of the sun to a relatively minor status among the stars of the galaxy, and it was natural to consider this stellar system as constituting the universe. But among the apparently nonstellar objects discernible to the unaided eye are two luminous patches, the nebulae M31 in Andromeda and M33 in Triangulum, to which the early Portuguese navigators added the two Magellanic Clouds visible from southern latitudes. The early telescopic observations showed that similar objects are quite common; Herschel compiled a list containing around 2,500, to which his son Sir John Herschel (1792–1871) added almost as many more. Sir William at first played with the idea that these lucid patches were in fact "island universes" comparable with the Milky Way in structure and content, but the proof of this hypothesis had to await a more profound knowledge of our own system and the development of the giant telescopes of the 20th century. It is known that a few of the nebulosities considered by the Herschels are in fact clouds of dust and gas within our own stellar system, but that the vast majority, including the elliptical and spiral nebulae, are truly extragalactic objects; it is with these extragalactic nebulae alone that the remainder of this article is concerned. (*See* GALAXY; NEBULA.)

Distance was the essential clue lacking to bring this grandiose picture into focus, a picture in which our own galaxy takes its place as only one of a collection of perhaps 1,000,000,000 similar

systems within range of the 200-in. Hale reflector telescope on Palomar mountain in California. But whereas the Greeks had a quite accurate knowledge of the distance to the moon, even the order of magnitude of the distance to the sun was not known with certainty until the time of Newton, and further centuries were to elapse before the distance to even the nearer stars could be measured. The modern era in astronomical measurement may be said to have begun with G. D. Cassini, who in 1672 placed the sun at 87,000,000 mi. from the earth—a figure about 6% below the true mean value. This opened the way for determination of the distances to the nearer stars, for as the earth moved around the sun the apparent position of a star should show an annual shift or parallax (*q.v.*), the amount of which depends on the ratio of the distances to the sun and to the star. It was not until 1838 that this trigonometrical method was used with full success, when F. W. Bessel placed the star 61 Cygni at the comparatively enormous distance of 11 light-years (65,000,000,000,000 mi.).

The distances of only the nearest stars can be obtained by this method; other criteria had to be found before man could measure the full extent of even the visible universe. Such an attempt had already been made by Sir William Herschel, by assuming that all stars had the same intrinsic brightness as the sun and attributing differences in apparent brightness to the effects of distance—a poor criterion, because it was later found that stars vary enormously in intrinsic brightness, and the sun is quite far down in the scale. Nevertheless, brightness is the essential clue which led from the modest parallactic distances through the visible portions of the galaxy to its nearer neighbours, the Magellanic Clouds and Andromeda, thence to the nebular field and eventually to the great clusters of nebulae at the utmost limits of the 200-in. telescope—a span estimated at the almost inconceivable distance of 2,500,000,000 light-years, 600,000,000 times the distance to the nearest known star. The new tool of radio astronomy (*q.v.*) promises the possibility of revealing even greater distances than this, perhaps through the evidence of more distant sources similar to that provided by two colliding nebulae in Cygnus.

THE 20th CENTURY

Distances of Nebulae.—The impetus to the development of this brightness clue to the distances of extragalactic nebulae was the discovery in 1912 by Henrietta Leavitt at Harvard of a remarkable relation between the periods and luminosities of certain variable stars in the Small Magellanic Cloud, called Cepheids because of their similarity to the variable δ Cephei within our own system (*see* STAR: *Stellar Variability*). By the year 1923 Cepheids were discovered in the Triangulum and Andromeda nebulae by J. C. Duncan and by E. P. Hubble at Mt. Wilson and, with the aid of the period-luminosity relation perfected in the meantime by H. Shapley, were judged to be almost 1,000,000 light-years away, well outside the confines of the galaxy. A yet more powerful tool for the extension of distance stems from the discovery in 1917 by G. W. Ritchey of novae in Andromeda and other nebulae, a tool whose range was later vastly increased by the recognition of the class of supernovae, stars such as Tycho's star of 1572 which at their brightest rival an entire nebula in the rate of output of energy (*see* NOVA AND SUPERNOVA). Largely through the work of Hubble there were added to these brightness criteria of distance certain types of supergiant stars and finally nebulae themselves. Later a major recalibration of these distance scales was found necessary, beginning with a reconsideration of Cepheid magnitudes by W. Baade and extending to the bright-star criteria, which in turn forced a recalibration of the nebulae used as distance criteria. This work resulted in a trebling of the distance assigned to the remoter nebulae.

The problem of determining time scales is intimately bound up with this problem of distance, with the velocity of light in some cases forming a bridge between the two. It is clear that the actual period of a few decades over which detailed observations have been possible is but an instant in the life of a nebula; astronomers are accordingly confined, with the exception of such transient phenomena as novae, to the observation of states and trends. From these data, such as Hubble's constant discussed below, times which must play an important role in nebular theory can indirectly be inferred. In this category may be included times implied by theories of stellar structure, such as the age of 5,000,000,000 years attributed by M. Schwarzschild and his collaborators to the population II stars, which predominate in elliptical nebulae and in the nuclei of spiral nebulae. Furthermore, distance itself here is of assistance, because light being observed left the more distant nebulae thousands of millions of years ago. Observations should therefore result in data relevant to the evolution of nebulae, even if these all had a common time of origin. A promising excursion into this field was made in 1948 by J. Stebbins and A. E. Whitford, who found that the light from certain nebulae showed a progressive reddening with distance, over and above that caused by the red shift.

Red Shifts.—Further evidence for the island-universe hypothesis is given by the fact that the light from a typical nebula, resolved into its component colours with the aid of a spectrograph, is found to be very similar to that from stars within our own system; the similarity includes the pattern of absorption lines indicating the presence of hydrogen, calcium and other chemical elements in gaseous form. This result, first noted by J. Scheiner in 1899, was firmly established at the Lowell observatory in 1912 by V. M. Slipher, who interpreted the slight displacements of the absorption lines from their standard positions as a Doppler shift caused by a component of motion of the nebula along the line of sight (*see* SPECTROSCOPY, ASTRONOMICAL: *Radial Velocities*). Although the shift from a few of the nearer nebulae turned out to be toward the violet end of the spectrum, indicating a motion *toward* the observer, the overwhelming majority of the spectra Slipher examined during the succeeding years showed a shift toward the red, interpreted as a motion of recession. The velocities inferred from these shifts ranged up to 1,800 km. per second, far greater than the velocity of escape from the galaxy, thus furnishing additional support for the view that these nebulae were indeed independent systems. On comparing Slipher's red shifts with Hubble's distances, for nebulae common to the two lists, H. P. Robertson noted in 1928 that the data were consistent with a linear velocity-distance relationship, as had been foreshadowed on theoretical grounds about five years before by H. Weyl. This proportionality of velocity with distance was found independently in 1929 by Hubble, who extended it during the next few years to vastly greater distances with the aid of the magnificent red-shift measurements on faint nebulae by M. L. Humason at Mt. Wilson.

Recognizing the importance of this relation for cosmology, the Mt. Wilson and Lick observatories initiated in 1935 a program to explore the red shift as thoroughly and as deeply into space as modern instruments would permit; in 1952 the new equipment on Palomar mountain was tied into this program. The results, comprising the measurement of red shifts on more than 800 different nebulae, were analyzed and published by M. L. Humason, N. U. Mayall and A. Sandage in 1955. Included in the survey were 44 faint cluster nebulae, whose red shifts indicated velocities of recession ranging up to one-fifth the velocity of light. On the basis of the new distance scale, the linear term (*i.e.*, the proportionality constant) in the velocity-distance relationship indicated that the velocity of distant nebulae increased 55 km. per second for each 1,000,000 light-years of distance from the earth. A better appreciation of the meaning of this number, H, which came to be called Hubble's constant, is given by its reciprocal $1/H = 5{,}400{,}000{,}000$ years, interpretable as the time in the past at which all the nebulae would have started from a common spatial origin, provided the red shifts are taken to represent actual velocities which are directly away from the earth and which have not changed during the course of the motion. A most interesting fact revealed by the new investigation is that the red shifts of the faint cluster nebulae, extending out to a distance of 850,000,000 light-years, in fact increase faster with distance than would be implied by the linear law—as should be expected if the nebular motions are being slowed down by mutual gravitational attraction.

Distribution of Nebulae.—The Herschels' catalogues showed the nebulae to be distributed more or less at random over the sky except for a conspicuous avoidance of the lower galactic latitudes

Succeeding surveys confirmed these observations and led to the conclusion that the nebulae are in fact scattered at random over the heavens, the apparent dearth in their numbers near the plane of the Milky Way being attributed to absorption of light by the dust clouds known on other grounds to be an important part of our own galaxy. This is not to say that there are no considerable irregularities in their apparent distribution; there is indeed a marked tendency to cluster in groups numbering from a few to more than a thousand members. One of the lesser examples of this clustering is the local group consisting of the galaxy itself, the Magellanic Clouds, the great nebulae in Andromeda and Triangulum and about a dozen others.

The apparent distribution over the sky, however, is only one aspect of the problem; it must be supplemented by an analysis of the actual distribution in depth. The material for this analysis is given by the extensive surveys to different apparent magnitudes carried out since 1920 at the Harvard, Lick and Mt. Wilson-Palomar observatories. This aspect of the problem is a much more difficult one, whose solution depends on the various distance criteria. It would appear from these criteria that, subject again to fluctuations associated with the clustering effect, the distribution in depth is also by and large a random one.

The Nebular Universe.—The study of the structure of our own galaxy has in some important respects lagged behind that of at least our nearer neighbours, a situation attributable in large measure to our position near the plane of the galaxy and to the obscuring matter lying between the earth and significant features of the system. This deficiency is to some extent rectified by the development of sophisticated methods of making allowances for the effects of the dust clouds on light coming to the earth from the stars, and by the rise of radio astronomy, which enables the mapping of hydrogen clouds in our galactic neighbourhood. The view which emerged in the middle 1950s was one in which the galaxy is itself a large spiral nebula, very similar in size, structure and content to Andromeda, one whose diameter is about 60,000 light-years and whose mass is that of about 200,000,000,000 suns. Nebulae as large as these are not uncommon, but the average is considerably smaller, with a mass of around 10,000,000,000 suns, including the mass of the dark clouds as well as that of the luminous matter.

The search for a fixed centre of the universe as a natural point of reference resulted in a shifting by stages from the geocentric position adopted by theology and early science to ever more distant objects, finally only to dissolve in the realization that there is no intrinsic distinction discernible between any one region of the nebular universe and any other. The planet earth was displaced by the sun, but it was then recognized that the sun was itself but a relatively minor outrider of that great collection of stars whose nearer members were visible as the Milky Way. The development of the large telescopes in turn revealed hundreds of millions of systems comparable with our own, distributed more or less at random through a sphere whose radius is estimated in billions of light-years.

While the search for a preferred *position*, or even for a preferred *direction*, led to the realization of the macroscopic uniformity of the universe, it revealed on the other hand the existence of a preferred *state of motion* in each sufficiently large region of the nebular universe. Typical of the motions of individual stars within the galaxy is that of the sun, which moves at the cosmically modest speed of 150 mi. per second about the galactic centre, located 25,000 light-years away in the direction of the constellation Sagittarius. The relative motions of the nebulae within the local group hardly exceed this, and even in the giant clusters the relative motions rarely exceed 1,000 mi. per second. In contrast with these modest speeds are the ever-increasing velocities deduced from the red shifts of distant nebulae, which have been measured up to 38,000 mi. per second—a respectable fraction of the absolute standard of velocity, that of light. It would thus appear that in each sufficiently large region of space there exists a standard state of motion, from which the motions of individual nebulae differ by at most a fraction of 1% of the speed of light. It is to be noted that this apparent motion of the nebulae away from the galaxy does not in itself single it out as a unique centre from which everything else flees. For if the effect is due either to an attrition of light during its long journey or to an actual radial motion of the nebulae, the phenomena referred to any other nebula as the centre would appear the same.

COSMOLOGICAL MODELS

The development of a more complete view of the universe unfolded by these observations requires an excursion into theory, in continuation of the process begun by Newton in extending to the far away and long ago the laws which have proved successful in ordering the here and now. The principles upon which modern science is based call for economy, in unproved hypotheses and *ad hoc* assumptions, in bringing new phenomena within the purview of its laws. Thus, since motion is the only hitherto known cause of the type of shift of spectral lines observed in the light from the nebulae, economy bids that it be tried as the effective cause here. Since gravitation is the only hitherto known universal action between macroscopic masses, principle bids that the laws of gravitational attraction, which have proved successful in ordering terrestrial, planetary and galactic motions, be extended to the nebulae. Since conservation of mass and energy has been an effective tool in ordering physical and chemical phenomena in the laboratory and in the stars, caution bids that it not be surrendered until the need to do so is quite definitely established. Strict adherence to these guide lines, however, has led to difficulties, particularly with respect to the time scale, and modifications of one or another of them have at times been proposed in order to bring prediction into agreement with observation.

Science progresses by paring a problem down, stripping it of all cumbrances judged not germane to the main issue. The result of the application of this method is a *model* which helps to explain the connections among the various elements of prime interest, which serves as a first approximation to the complex physical situation and which can be adjusted as required to trace the influence of those factors which have at first been set aside. In the present instance the elements which the model is to portray are the nebulae, treated as equal particles distributed uniformly throughout space, and the light which they emit, taken as obeying the smoothed-out velocity-distance relationship inferred from the empirical data; the laws to be applied are those governing the gravitational and electromagnetic fields.

Cosmic Space and Time.—The existence of a preferred state of motion in each sufficiently large neighbourhood of space-time makes it possible significantly to separate the four-dimensional world of events in the model into a three-dimensional *cosmic space* and a one-dimensional *cosmic time*. The nature of the geometry of cosmic space is quite closely circumscribed by the assumption of spatial uniformity: from this it follows that the geometry must be either the flat Euclidean geometry of antiquity or one of the non-Euclidean geometries developed by Johann Bolyai, N. I. Lobachevski and G. F. B. Riemann in the first half of the 19th century. These latter geometries are characterized by a *curvature* K, which may be either positive or negative; the curvature may for convenience be written in the form k/R^2, where $k = \pm 1$ indicates its sign and the radius of curvature R is a characteristic length. In the case $k = +1$ space is said to be *closed*, as its total volume has the finite measure $2\pi^2R^3$ (or π^2R^3 if so-called antipodal points are identified). For $k = -1$ space is *open*, having an infinite extent, as has also the flat Euclidean space $k = 0$. That physical space might turn out to be one of these non-Euclidean types, instead of the Euclidean space hitherto tacitly assumed in philosophy and science, was recognized from the time of their discovery. The first serious attempt to evaluate the curvature of astronomical space was made by K. Schwarzschild in 1900 on the basis of observations then available; he concluded that if space is open its radius of curvature R must be greater than 64 light-years, and that if closed R must exceed 1,600 light-years. (*See* GEOMETRY: *Non-Euclidean Geometry;* RELATIVITY; RIEMANNIAN GEOMETRY; SPACE-TIME.)

The cosmic space thus introduced is that collection of events having a common cosmic time t; the geometry of successive spaces

may therefore change with time, as foreseen by the philosopher A. Calinon in 1889. Under the present assumptions a cosmological model capable of representing the expanding universe of nebulae must in fact have a radius of curvature $R(t)$, *i.e.*, an R which is a function of t—or in the Euclidean case a scale factor $R(t)$—which is now increasing with time in a manner prescribed by the law of the red shifts. The present value of the specific velocity $\dot{R}/R$, where $\dot{R} = dR/dt$ is the time rate of change of R, must equal Hubble's constant H, and the specific accelcration $\ddot{R}/R$ is determined by the deviations from linearity observed at great distances. The work of Humason, Mayall and Sandage implies a value of $-2.6\ H^2$ for the specific acceleration, where H is 55 km. per second per 1,000,000 light-years.

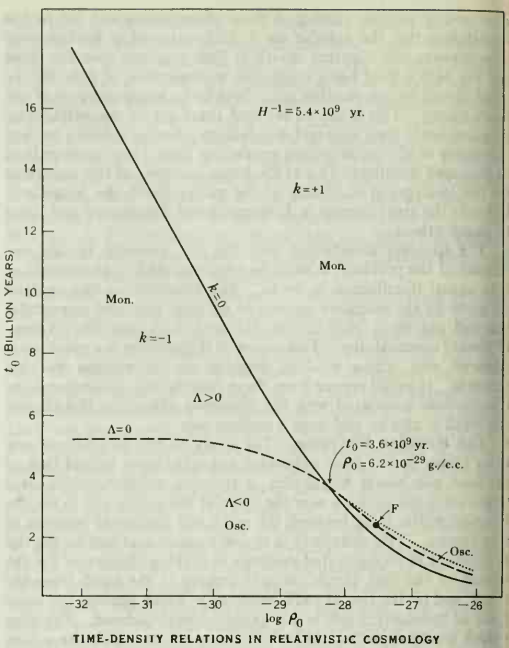
The problem of setting up a complete cosmological model thus reduces to that of determining the sign k of the curvature of cosmic space, and the course in cosmic time of its radius of curvature or scale factor $R(t)$. Observations such as those on the red shift give some information on the present value and trends of R, but in order to extrapolate from these to its behaviour in the past or future some form of physical law must be imposed. Present field theories of gravitation achieve this by relating the kinematics of the model to the physical content; that is, to the nature and amount of matter and energy found in that part of the universe accessible to observation.

Newtonian physics does not adapt itself to the cosmological problem, as formulated above, because of its inability to treat relatively accelerated nebulae as dynamically equivalent and to treat light in accordance with the principle of optical relativity. But even aside from this, the early efforts to describe an extended universe, uniformly populated with galaxies more or less at rest with respect to one another, ran into the difficulty that there existed no static solution of the gravitational field equations, or that such a solution was at best an uneasy equilibrium between indeterminate forces. A further difficulty was that of accounting for the comparative darkness of the night sky, for, as pointed out by H. W. M. Olbers in 1826, in a uniform distribution of stars the luminosity contributed by those within a spherical shell of given thickness should be independent of the radius of the shell. The total luminosity would accordingly build up to an intolerable magnitude, limited only by the absorption of light by intervening matter or by the exhaustion of the energy supply.

General Relativistic Models.—Interest in cosmology was stimulated by the realization that the spiral and elliptical nebulae were extragalactic objects, during just that decade (1911–20) in which the general theory of relativity was being developed. Already in 1917 Albert Einstein turned his attention to the cosmological problem, in an effort to establish E. Mach's hypothesis that the inertia of matter is due to the totality of other matter in the universe. Einstein found that, as in the Newtonian theory, his original field equations would not admit a static solution for the problem. He therefore modified his equations by the addition of a "cosmological term," characterized by a constant Λ having the physical dimensions of $[\text{time}]^{-2}$; for positive Λ this in essence adds a repulsive force $\Lambda R/3$ beteen the nebulae.

Einstein Model.—The addition of the cosmological term makes it possible to obtain a static model, of spatial curvature $K = 4\pi G\rho_0/c^2$ determined by the mean density ρ_0 of matter. Here G is the Newtonian constant of gravitation and c is the speed of light; the cosmological constant is given by $\Lambda = c^2/R^2$. For a mean density of 10^{-29} g. per cubic centimetre, which is of the general order of magnitude to be expected if all matter were spread out uniformly, the radius of curvature of the universe would be 11,000,000,000 light-years. This solution of the cosmological problem offers little advantage over the classical, beyond eliminating the indeterminacy inherent in all open models. Subsequent investigation further showed that the static Einstein model is unstable; a slight relaxation of the assumed uniformity conditions will result in a collapse or a blowing up of the model.

Lemaître-Eddington Model.—Within the decade, however, the general expansion of the nebular universe came to be recognized, and attention turned to dynamical solutions of the relativistic field equations as offering more suitable models. Among these



TIME-DENSITY RELATIONS IN RELATIVISTIC COSMOLOGY

solutions, first found by the Russian mathematician A. Friedmann in 1922, was one put forward by G. Lemaître (1927) and A. S. Eddington (1930) as representing an expanding nebular universe arising by perturbation from the unstable Einstein model. Its principal attraction lay, at a time when the inverse of Hubble's constant was considered to be less than 2,000,000,000 years, in the practically unlimited time scale the model offers. However, as in any model in which the repulsive cosmological force dominates the gravitational attraction, the specific acceleration $\ddot{R}/R$ is positive, in conflict with the later red-shift data. Nor does it avoid Olbers' paradox mentioned above.

De Sitter Model.—All models in which $\Lambda > 0$, such as that of Lemaître and Eddington in which the cosmological term eventually dominates, expand without limit toward a state in which the density of matter becomes negligible. This ideal limiting case is represented by a model based on a solution put forward, on other grounds, by W. de Sitter in 1917. In the simplest form suitable for the present purpose it is characterized by a Euclidean cosmic space provided with a distance scale $R(t) = e^{Ht}$, where $e = 2.718\ldots$ is the base of the system of natural logarithms. The accelerated nebulae eventually escape over the observer's horizon, a sphere of radius $c/H = 5{,}400{,}000{,}000$ light-years; light emitted by a nebula which has passed through this horizon will never reach the observer.

Other Models Utilizing Λ.—Einstein's original reasons for introducing the cosmological term, essential to the above models, are no longer considered valid, and he and others accordingly advocated its rejection. Its principal phenomenological function has been to extend the time scale implied by the nebular red shift, to allow time for such astronomical processes as the evolution of population II stars, believed to require about 5,000,000,000 years, and for the laying down of radioactive by-products found in terrestrial rocks and in meteorites, estimated to require up to 5,000,000,000 years. As such, it borders on those *ad hoc* hypotheses which good scientific methodology says to reject. But if the term is rejected there is still some trouble with the time scale, in spite of the upward revisions. Under these circumstances it would seem prudent provisionally to retain the cosmological term, and instead of seek

ing a definitive model, to display the range of models offered by the extended gravitational theory.

The choice offered is a threefold one, from which a particular model may be selected by specifying three independent data—say Hubble's constant H, the present mean density of matter ρ_0 and the present epoch t_0. Taking $1/H$ as 5,400,000,000 years, the general nature of those models which start from the singular state $R = 0$ may be read off the accompanying figure, in which a point with abscissa log ρ_0 and ordinate t_0 represents that model defined by these values of density and epoch; its position in the diagram indicates the signs of k and Λ, and whether the model is monotonically expanding (*i.e.*, expanding independently of H, ρ_0 and t_0) or oscillating. To adjust the diagram to any other value $f \times 5{,}400{,}000{,}000$ years for $1/H$, it is necessary only to slide the abscissa scale a distance 2 log f to the right and to multiply the ordinate scale numbers by f. All these models avoid Olbers' paradox almost trivially—there simply has not been time enough for the luminosity to build up indefinitely, and it is further reduced by the weakening effect of the red shift. Two models of passing interest, in which the cosmological constant Λ is set equal to zero, are the following:

Einstein–De Sitter Model.—In this model, a special case of the Friedmann solution singled out by Einstein and De Sitter in 1932, space is taken as Euclidean; it is represented in the diagram by the point of intersection of the two curves along which Λ and k vanish, respectively. The present epoch is 3,600,000,000 years and the present mean density 6.2×10^{-29} g. per cubic centimetre. The radius of curvature R varies with $t^{2/3}$—and consequently $\dot{R}/R$ is positive, in conflict with the red-shift data.

Friedmann Model.—Demanding that the model also fit the second order red-shift data amassed by Humason, Mayall and Sandage shoves the representative point farther down on the curve $\Lambda = 0$ to the point F on the diagram. The resulting model is a closed, oscillating one with the improbably low age of 2,400,000,000 years and the high density of 3.2×10^{-28} g. per cubic centimetre. The gravitational retardation would bring the motion to a halt in a further 2,700,000,000 years, when contraction would set in.

All the models so far considered have been based on the tacit assumption that the density of radiant energy in the universe is negligible in comparison with that of matter. Although this assumption is justifiable in the present state, since the former is perhaps only 1% of the latter, this may well not have been true in the very early stages. This circumstance was exploited by G. Gamow in his theory of the formation of chemical elements and of protogalaxies during the early stages of the expansion (*see* Cosmogony).

Steady-State Theory.—The only expanding cosmological model satisfying the additional requirement that the intrinsic structure of space-time be independent of cosmic time is that described above as de Sitter's. This was adopted as the background of a steady-state theory of cosmology by the British group associated with H. Bondi, T. Gold and F. Hoyle. But whereas the de Sitter model is empty of matter when treated in accordance with Einstein's general theory of relativity, matter is introduced in the steady-state theory, and in view of the expansion must be assumed to spring into being uniformly throughout space at just the rate necessary to replace the continuing loss of nebulae over the observer's horizon. The age of the universe itself is therefore infinite, but the age of each bit of matter in it is finite and is at any given time on the average just equal to $1/3H$, or 1,800,000,000 years. This theory is subject to direct observational test, as it predicts that in any sufficiently large region of space nebulae are found in every stage of development and that there should be no systematic change with distance, such as that indicated by the Stebbins-Whitford effect mentioned above.

See also references under "Cosmology" in the Index volume.

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COSMOS, the scientific and common name of a genus of tropical American herbs of the family Compositae (*q.v.*), several annual species of which are popular as ornamentals. The genus comprises about 20 species, chiefly Mexican. They are late-flowering annuals or perennials with long-stalked showy flower heads borne singly or in clusters. The best known species is the common garden cosmos (*C. bipinnatus*), 7–10 ft. high, extensively grown in gardens. It has a smooth stem bearing finely cut, narrow-lobed leaves and flower heads with a yellow centre encircled by pink, crimson or white rays. The plant thrives best in sandy, not-too-rich soil and germinates readily; in the northern U.S. best results are obtained by sowing the seed indoors in April and transplanting when danger of frost is past.

COSSA, FRANCESCO (DEL) (1436–1478), Italian painter who, through his seven years' residence in Bologna, exercised a profound influence on the course of Bolognese painting, was born at Ferrara. His name first occurs in a contract for a "Pietà" on the choir screen of Ferrara cathedral. A letter addressed by Cossa to Borso d'Este on March 25, 1470, refers to frescoes executed by him in the Palazzo Schifanoia at Ferrara and complains of the inadequacy of his payment. After receiving an unfavourable reply, he left Ferrara for Bologna, where in 1472 he was commissioned by Giovanni Bentivoglio to restore and complete a miraculous fresco by Lippo di Dalmasio in Sta. Maria del Baraccano. Immediately after (1474) he painted an altarpiece for the Foro della Mercanzia (now in the Pinacoteca Nazionale, Bologna). He died at Bologna in 1478, while working on the frescoes of the Garganelli chapel in S. Pietro; these were completed by Ercole de' Roberti.

Trained at Ferrara, he was, like his contemporary Cosimo Tura, influenced by the work of Andrea Mantegna at Padua and by Piero della Francesca, as well as by the cursive drawing style of local illuminators. His debt to Piero della Francesca is most clearly apparent in a painting of Autumn in the Kaiser Friedrich museum, Berlin. Other early works reflect the influence of Florentine art ("Virgin and Child with Angels" in the National Gallery of Art, Washington) and Rogier van der Weyden, who was in Ferrara in 1450 ("Pietà" in the Musée Jacquemart-André, Paris). In the Schifanoia frescoes, probably commissioned in 1469, Cossa develops a personal style of great coherence and vitality. Illustrating a humanist program, which may have been devised by Pellegrino Prisciano, as astrologer and poet at the Este court, they represent in three tiers allegorical scenes, astrological symbols of the months and scenes representing the daily life of the ruler of Ferrara, Borso d'Este. Cossa was solely responsible for the frescoes on the east wall representing March, April and May. The salone of the Palazzo Schifanoia ranks, with Mantegna's Camera degli Sposi at Mantua, among the most striking examples of Renaissance secular decoration.

In or after 1470 Cossa began work on an altarpiece of the Annunciation for the Osservanza at Bologna (now in the Gemäldegalerie, Dresden). A second polyptych of the same date, painted for the Griffoni altar in S. Petronio at Bologna (frame commissioned 1473), has been disassembled. The lateral panels, now in the Brera gallery, Milan, in which the saints are depicted on rocky platforms against low distant landscapes, are Cossa's most successful panel paintings. Among Cossa's last works in Bologna were frescoes on the ceiling of the Garganelli chapel (destroyed) and the cartoon for a circular stained glass window of St. John on Patmos in S. Giovanni in Monte. A less vivid imagist than his contemporary Tura, Cossa was Tura's superior in the rendering of movement and architecture.

Bibliography.—E. Gardner, *The Painters of the School of Ferrara* (1911); R. Longhi, *Officina Ferrarese* (2nd ed. 1956); S. Ortolani, *Cosmè Tura, F. del Cossa, Ercole de' Roberti* (1946). (J. W. P.-H.)

COSSACKS. The Turkic word *kazak* means "adventurer" or "rebel"—figuratively a "free man." This name was first given in the middle ages to the fugitives from the central Asian Turkic states who preferred a nomadic life in the steppes north of the Black sea to serfdom. Later, when Poland ruled the western part of what is now the Ukraine, the same phenomenon occurred and the same name was applied to the peasants who were escaping from

their landlords "beyond the cataracts" (*za porohy*) on the lower Dnieper. Thus, in a no-man's-land, was born the *Zaporizhska Sich* or Zaporozhian clearing—an embryo of the Ukrainian state. By extension, all peasants of the southeastern borderland of Poland, or *ukraina*, became known as Cossacks (Pol. *kozacy*). The Ukrainians, therefore, were first known as Cossacks, but not all the Cossacks were Ukrainians; many of them belonged to the Turkic peoples, many were of mixed races.

At the beginning of the 16th century, to protect their states against the incursions of the Tatars, the Polish kings started to organize military Cossack-manned frontier forces. Bohdan Chmielnicki (*q.v.*), however, himself a Pole, succeeded in setting up a practically independent Cossack state for a short time. In mid-17th century, when the Ukraine was partitioned between Poland and Russia, the Russian tsars followed the Polish example on a much larger scale in using their Cossacks (Russ. *kazaki*) first as border defenders and later as advance guards for the extension of Russia beyond the Urals, the Caucasus and the Caspian sea. Ermak Timofeevich, the conqueror of Siberia, was a Cossack. When the tsars or local landlords tried to reduce their freedoms, the Cossacks often revolted. The most famous rebels of the 17th and 18th centuries—Stenka Razin (*q.v.*), Kondrati Bulavin and Emelyan Pugachev (*q.v.*)—all came from the ranks of the *kazachestvo*. In international affairs the most important Cossack leader was Ivan Stepanovich Mazepa (*q.v.*).

The Cossacks were endowed with certain privileges and bound in return to give military service, which was compulsory for all men for 20 years, beginning with the age of 18. The primary unit of the Cossack community was the *stanitsa*, or village. Every *stanitsa* had an elected assembly. The *stanitsy* were grouped in *okrugi* (districts) and a number of those formed the *voisko* (army) headed by an *ataman* or hetman appointed by the central government. The land was held by the village as a commune, but from 1869 Cossack officers and civil servants were allowed to acquire land as personal property. In addition both the officers and the communes were permitted to rent their land to outsiders. Thus already existing social distinctions deepened.

At the beginning of the 20th century there were in Russia 12 Cossack *voiska* (*see* table). The total area of the Cossack territories was about 230,000 sq.mi. with a total population of about 12,000,000, of whom more than 5,000,000 possessed special Cossack status. In peacetime about 55,000 Cossacks were under arms, in wartime about 180,000.

Cossack Voiska *in Russia at the Beginning of the 20th Century*

Voisko	Headquarters	Cossacks	*Voisko*	Headquarters	Cossacks
Don	Novocherkassk	1,500,000	Siberia	Omsk	180,000
Kuban	Ekateriodar*	1,350,000	Amur	Blagoveshchensk	50,000
Ural	Uralsk	900,000	Semirechye	Verny‡	45,000
Orenburg	Orenburg	530,000	Astrakhan	Astrakhan	40,000
Terek	Vladikavkaz†	270,000	Ussuri	Vladivostok	34,000
Traosbaikal	Chita	270,000	Yenisei	Irkutsk	30,000

*Now Krasnodar. †Now Ordzonikidze. ‡Now Alma Ata.

During the Russian civil war of 1918–20 the Cossacks were divided and fought on both sides. In the campaign against Poland in 1920 Red Cossack units under S. M. Budenny played a considerable part. On the collapse of the Russian "White" armies about 30,000 Cossacks went abroad. Some Cossack units were also revived during World War II, but their old communities were dissolved and merged into new administrative divisions of the U.S.S.R.

There exists a great deal of literature describing the spirited Cossack life. Among novels N. V. Gogol's *Taras Bulba*, Lev N. Tolstoi's *Kazaki* and H. Sienkiewicz's *Ogniem i mieczem* ("With Fire and Sword") are the most famous.

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(K. Sm.)

COSTA, LORENZO (*c.* 1460–1535), painter of the school of Ferrara-Bologna, was born at Ferrara and was trained there, probably under Cosimo Tura. From at least 1485 he worked at Bologna, latterly in close connection with Francia, whose mild and sleepy style led him to eliminate his native robustness. His best works are several altarpieces which remain in the churches of Bologna.

In 1506, soon after the expulsion of the Bentivoglio family from Bologna, he was summoned as court painter to Mantua to succeed Andrea Mantegna. He had already painted (1504–06) one elaborate allegory for the marchioness of Mantua (now, with its companion, in the Louvre) and spent his last years in the service of the Gonzagas doing religious and historical pictures, but few survive.

Costa died at Mantua on March 5, 1535.

See Giorgio Vasari, *Vita di Lorenzo Costa*, ed. by A. Stanghellini (1912). (E. K. We.)

COSTA BRAVA CATALANA, the "rugged coast" of Catalonia, northeastern Spain, lies between the French frontier at Port Bou and Blanes, 66 km. (41 mi.) up the coast from Barcelona. It is in the province of Gerona (*q.v.*). This part of the Spanish coast, almost unknown to tourists until after World War II, subsequently became very popular—the fishing village of Lloret de Mar possessed more than 100 hotels in the 1960s. The attraction of the Costa Brava largely results from the grandeur of the coast line and the warm seas, but even at the height of summer the evenings are comparatively cool because of the proximity of the Pyrenees. The average mean temperature in winter (November–March) is 57° F. and in summer (April–October) 74° F. The mimosa and spring flowers are in bloom from January onward and subtropical plants also flourish. Agriculturally the area is one of the richest in Spain, and it is also the most important cork-growing region, supplying the wine-producing areas of the world. The Costa Brava can be reached by train from Port Bou or Barcelona or by car via the coast road at Port Bou or the mountain pass between Le Perthus (France) and La Junquera. (D. F. H.)

COST ACCOUNTING. This term includes the entire range of theories, methods and procedures for accumulating, measuring and reporting the cost of obtaining specific objectives. The theoretical framework of cost accounting is borrowed from political economy and the methods are adapted from financial accounting and statistics. The boundaries of the field are not clearly defined; its content is shared with management, engineering, economics, financial accounting and more recently with operations research and the behavioural sciences. (*See* also MANAGEMENT SCIENCES.)

An understanding of the work of cost accountants requires some understanding of the nature of general accounting (*q.v.*). The usual meaning of "to account" connotes an objective and a responsibility for measuring and reporting the extent of accomplishment of the objective. The forms and reports of accounting tend to reflect the types of accountabilities involved. Simple scorekeeping in a game, for example, accounts for and reports winners, losers and individual performances. Accounting for bailee activities is related to the function of safeguarding and locating physical properties. Ordinary business accounting is concerned with the more complex objectives of liquidity, profitability and efficiency.

In cost accounting the primary objective is to measure and report actual sacrifice—effort exerted in terms of cost—and projecting acceptable standards of sacrifice for accomplishing specific goals. The consumer who is deciding to allocate more of his limited resources for transportation and less for shelter is comparing benefit in terms of sacrifice. Similarly the worker who compares additional leisure obtained by working fewer hours with the probable decrease in income is utilizing cost accounting techniques.

Accountants are not able to attack the problem of individual sacrifice on the psychic level except through somewhat artificial techniques and have therefore adopted the practice of measuring and expressing effort exerted in monetary terms. This practice sometimes leads to difficulties. For example, in times of changing price levels historical costs lose their relationship to sacrifice in current terms. To fail to modify the historical cost figures and

revise the measuring unit may lead to unsound decisions. Furthermore, there are often substantial differences between cost to a business enterprise and cost to society; minimum enterprise cost may not lead to minimum social cost. The costs to society of a dingy manufacturing neighbourhood, for example, seldom appear in private accounting records.

Further assumptions limit the field of cost accounting to an even more restricted list of activities and techniques. Accountability for costs is usually restricted to a specific area of interest and costs are related to the activities of those who are responsible for attaining the objectives of the organization. Departments are established to correspond with areas of authority and responsibility, and cost centres are set up within departments to help record costs by activities. Activity is sometimes represented by operations, tasks and time periods, or by units of production. For example, the activity unit for measuring costs may be the labour or machine hour, the space-time unit, the customer call, the ton delivered, the invoice rendered or the unit machined. If the costs are accumulated by periods with respect to similar units of output, and departments and centres are established to determine the cost of each major process or activity, the system is known as process costing. If costs are accumulated with respect to jobs or diverse products, the system is a job-order cost system.

Accounting for costs may take the form of routine day to day accumulating and periodic reporting or the form of cost studies for special purposes when the need arises. The former approach coincides with the narrow definition of cost accounting and is used when objectives are stable and managerial decisions require only periodic reports of accomplishments and costs. Traditionally, cost accountants have simplified their routine costing by avoiding imputations and hypothetical charges and including among routine day to day costs only those sacrifices that involve expenditures, other assets given up at fair market values or capital stock issued at current value. Economists, engineers and some accountants have encouraged the inclusion of imputed costs—interest, profits, rents and salaries—but the prevailing attitude has been to exclude these items from day to day costing and to add supplementary reports with imputations on an intermittent basis when specific decisions require them. Such supplementary reports include economy studies for asset exchanges, plant shutdown or expansion and the selection of lot sizes. Clearly alternatives foregone (opportunity costs) are directly relevant to these problems and direct imputations cannot be avoided.

The assignment of cost to activities requires analysis to determine whether changes in costs can be associated with changes in activity. This associative approach to cost allocation with its assumption of responsibility is the primary basis for assignment and is necessary for making decisions about output and prices. If an activity is clearly associated with the decline in service value of an asset and receives the benefit of such service the cost is said to be direct. Thus, direct labour and materials in a machine shop can be traced to activities directly on a responsibility basis, and the cost of a library building may be said to be direct with regard to the library department. It is ordinarily not feasible to trace all responsibility costs directly, and therefore several smaller variable costs are often lumped together and assigned to an activity by means of a combined variable rate or even through the general overhead rate.

It is difficult to assign all costs on the basis of direct short-run responsibility. For example, considerable sacrifice is necessary to keep an establishment ready to do business. These costs are often common to all departments and seldom vary with changes in the production rate. These fixed establishment costs may change in amount from period to period but the variation in a fixed cost must be independent of the activity under consideration. Some fixed costs, such as general supervision, are common to all activities. Other fixed costs, such as the cost of shelter for the machine shop, are direct with regard to the total activity of machining but are indirect with respect to individual jobs or specific machining activities. As a rule, fixed costs are common to several activities and do not vary with the rate of production.

There is disagreement in the cost accounting profession and among economists and engineers about the need for assigning common costs to activities and jobs. To those who advocate direct (marginal) costing the assignment of establishment costs except as a deduction from periodic revenues serves no decision-making purpose and may obscure relevant information for short-run decisions on prices and output. Other accountants favour the "full costing" approach and feel that such assignments give a better guide to long-run cost of production, to expansion and contraction problems, and, when combined with marginal costs, to more effective short-run pricing and output decisions. The usual cost accounting standard for assigning fixed overhead costs is the basis of relative benefit. Shelter cost, for example, is usually distributed under the assumption that benefit can be approximated by a space-time factor, and assignment to a job or activity is in accordance with space-time utilized. Supervision may be allocated on the assumption that benefit is proportional to the number of men or man-hours supervised. This and similar costs are sometimes assigned on the basis of time studies and the relative time spent is assumed to be an acceptable approximation of relative benefit. The justification for fixed cost assignment according to benefit is clear if individuals are involved and equitable billing is an objective. In addition, the benefit distribution sometimes serves as a crude approximation of long-run responsibility and as an imperfect expression of scarce-factor utilization.

Control of Costs.—Cost accounting and related performance budgeting are useful for income determination, inventory valuation and pricing, but it is generally conceded that their greatest contribution is in the area of cost control. Standard costs have implications of normative behaviour and indicate what the sacrifice ought to be to accomplish organizational objectives. Actual costs are accumulated for each activity and variations between standard or allowed cost of accomplishment and actual cost are brought to the attention of the management for investigation and possible remedial action. Careful preliminary studies and even modification of the organizational structure are usually necessary to locate and fix personal authority so that the responsibility for variances may be assigned and investigated. Major variances such as those for the cost of materials, materials usage, labour effectiveness, wage rates, idle or excess capacity, departmental operating efficiency and overhead budget management are often isolated in separate accounts with appropriate details shown in supporting statistical exhibits. In a few cases variances are presented and analyzed statistically with no standards or variances shown in the formal accounts.

The determination of standards for prices, usage, activity and efficiency is a delicate job that often requires the co-operative effort of time-and-motion experts, production and personnel men, psychologists, engineers, statisticians, accountants and perhaps other specialists. Some managers still insist on ideal standards with chronically unfavourable variances, but most psychologists feel that standards should represent attainable goals that can be reached by efficient performance. There is some disagreement on the need for frequent changes in standards between those who use currently attainable performance levels and those who use basic standards with supplementary analysis to account for intervening price and technological changes. A few engineers and accountants feel that the reduction of certain variances (*e.g.*, efficiency and idleness) to monetary units serves no purpose.

Standards are by no means the only weapons for control. Cost accountants usually install invoice and voucher techniques that encourage the prompt, accurate and efficient payment of obligations. Timekeeping and payroll devices are used to assure management that workers are actually on the job and are being paid according to wage agreements. Devices to assure adequate quantities of materials and to disclose shortages and excesses of materials, tools and machines come under the cost accountant's jurisdiction. The techniques of flexible performance budgeting and related charting are also considered to be a part of cost accounting. The responsibility for issuing orders to initiate more effective control is, of course, a responsibility of management, but sometimes authority to correct minor irregularities is delegated to

cost accountants and budget masters.

Historical Development.—The origin of cost accounting, along with the origin of bookkeeping itself, is unknown. Attempts to keep manufacturing accounts have been traced to the time of Henry VII and to the Medici. The account books of Christophe Plantin, a French publisher, showed some understanding of job-lot accounting before the 16th century. Manuals for double-entry bookkeeping before the 19th century were common, but little or no mention was made of manufacturing or costing methods until Charles Babbage in England (approximately 1830) presented a paper that emphasized the need for serious cost accounting. The French, led by Anselme Pagen and Louis Mézières, were active in the early part of the 19th century and in 1841 Armand Malo won a prize of 1,000 fr. for his manual of agricultural accounting for primary schools.

In the period from 1870 to 1900 engineers took the lead in developing cost accounting methods and in 1900 Alexander Hamilton Church, president of the Institute of Cost and Works Accountants, set forth the modern approach to production centres and idle capacity charges. Fixed-variable analysis of business costs is credited to Dionysius Lardner (1850) and was developed in France by C. Adolphe Guilbault about 1865, in Great Britain by John Manger Fells (1877) and Alfred Marshall (1890), and in Germany by Eugen Schmalenbach (1900). Attempts to set and use standards were made in the textile industry by G. P. Norton (1889), but developed standards date from F. W. Taylor (*Shop Management*, 1903), John Whitmore (1908), and Harrington Emerson (1909). Profit charts and modern flexible budgeting were presented by Fells in 1903.

It is generally conceded that the structure of modern factory cost accounting was established before World War I. Beginning about 1930 businessmen and economists became impressed with the magnitude of the costs of distribution and cost accountants therefore began to extend their factory techniques to cover the control of distribution activities. Costs are accumulated and compared for size of order, method of delivery, line of distribution, customer call, ton warehoused and a myriad of office activities.

The investigations of the Federal Trade commission and the passage of the Robinson-Patman act in the United States accelerated the development of distribution cost methods by insisting that differences in selling prices over a large segment of business activity be justified in terms of differences in costs. Toward the middle of the 20th century, retail stores developed expense-centre accounting, which is a highly developed method of determining the cost of merchandising activities, and they extended the older retail accounting to a more comprehensive fixed-variable structure by developing merchandise management accounting.

During World War II emphasis on cost control was reduced, and temporarily attention returned to the older objective of compilation for billing purposes. Postwar competition, however, led to a rapid return to cost control and to the birth of managerial accounting with renewed emphasis on enterprise goals and accomplishments.

The extension of cost accounting techniques and principles to governmental units in the United States was a development of the middle of the 20th century. Difficulties arose with regard to the measurement of certain governmental and institutional services, and unfortunately many costs exhibited erratic behaviour. Many institutions and governmental units that were using budgets primarily as expenditure controls installed performance budgeting, which combines financial controls with standard costing. Many school systems, universities, hospitals and clubs rapidly adopted similar types of performance budgeting. The problem of costing has been studied by the government in Great Britain, particularly in relation to the cost of medical services.

The growth of uniform cost systems has been comparatively rapid even outside the totalitarian countries where uniform methods of costing are necessary for effective over-all planning. In the United States uniform costing has been sponsored by trade associations, which collect reports and compile statistical measures that serve as norms against which each member firm can appraise its performance. These associations have been active in recommending specific cost systems for their members and have carried on educational work designed to impress their members with the importance of knowing production and distribution costs for intelligent pricing and effective control. European productivity teams have repeatedly expressed their surprise at the interest in costs shown by U.S. businessmen, and the display of competitive spirit directed toward bringing their costs within budgeted standards or below those reported by their competitors.

The professional status of cost accounting is encouraged by organizations such as the National Association of Accountants, Controllers Institute of America, Institute of Cost and Works Accountants, Society of Industrial and Cost Accountants of Canada and similar groups.

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COSTA MESA, a city of Orange county, Calif., U.S., is located on a bluff overlooking the Pacific ocean, 40 mi. S.E. of Los Angeles. It was incorporated in 1953. Originally an agricultural area and the location for the Santa Ana army air base during World War II, its growth was due largely to the availability of land for light industries, of which 140 are located within the city limits. Industries include electronics, boatbuilding, machine tools and the fabrication of articles of fibreglass, such as fishing rods. The construction of freeways reduced driving time to Los Angeles and stimulated residential expansion. Costa Mesa is the site of the Orange County fair and the seat of Southern California college (Assemblies of God), founded in 1920, and Orange Coast college, a public junior college, founded in 1947, with a full-time enrollment of over 3,000 on a 243-ac. campus. For comparative population figures *see* table in CALIFORNIA: *Population.*

(G. T. BR.)

COSTA RICA, a republic of Central America lying between Nicaragua and Panamá. Its land area of 19,652 sq.mi. makes it the second smallest country in Central America (next to El Salvador). Its population of a little more than 1,000,000 makes it the least populous of the Latin-American states. Costa Rica (literally "rich coast") is known in the markets of the world chiefly for the high quality of its coffee. Costa Ricans also take pride in their country's achievements in education and in the practice of democratic government. The nation's capital and largest city, San José (*q.v.*), had a population of more than 100,000 in 1960.

This article is organized according to the following outline:

I. Physical Geography
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  3. Climate
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II. Geographical Regions
III. The People
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IV. History
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  3. Transportation and Communications

an José, capital of Costa Rica, seen from one of the many modern buildings n the city. Lying at the foot of the Cordillera Central in a fertile valley, an José is the industrial and commercial centre of Costa Rica

Helicopter spraying banana plants to prevent Sigatoka, a disease that wiped out the banana plantations of the Caribbean lowlands in the early 930s. Most of the bananas exported from Costa Rica come from new planta- ions in the Grande de Térraba and Coto plains

aling abacá, one of Costa Rica's chief exports, grown on former banana lantations in the Caribbean lowlands

The Pan-American highway between San José and Cartago in the Meseta Central, a region of rolling, well-drained and productive soils derived from lavas and volcanic ash

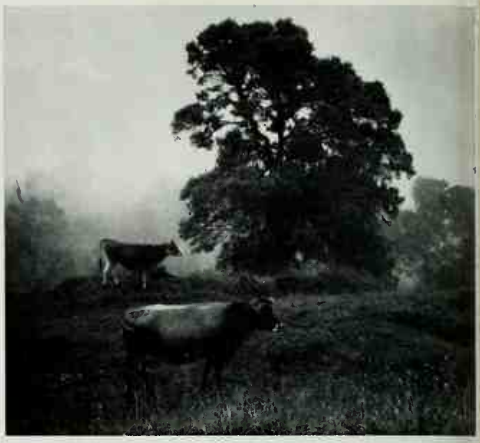
Puntarenas, one of Costa Rica's main shipping ports, located along the Pacific coast on a narrow strip of land jutting three miles into the Gulf of Nicoya. It is a popular summer resort, noted for deep-sea fishing

VIEWS OF COSTA RICA

Y COURTESY OF (BOTTOM LEFT) UNITED FRUIT CO.; PHOTOGRAPHS, (TOP LEFT) STOPPELMAN—PIX FROM PUBLIX, (TOP RIGHT, BOTTOM RIGHT) HERBERT LANKS FROM BLACK STAR, (CENTRE LEFT) ARILYN SILVERSTONE FOR STANDARD OIL CO. (N.J.)—NANCY PALMER AGENCY

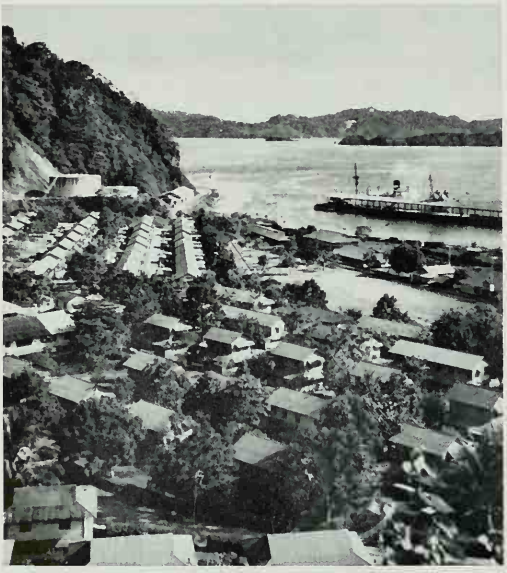
COSTA RICA

Crater of Irazú, one of several volcanoes in the Cordillera Central. Along with Poás, it is still mildly active



Dairy cattle grazing in the pasture on the slope of the Irazú volcano. The dairy industry has become increasingly important in Costa Rica in recent years, particularly in the Meseta Central

Drying coffee beans on a plantation in central Costa Rica. Coffee is the country's leading cash crop and constitutes about 50% of its total exports



Banana boat docked at Golfito, port located on a sheltered inlet of the Gulf of Dulce. Most of Costa Rica's banana crop is exported from the Pacific coast ports of Golfito and Quepos

Ox carts loaded with sugar cane along the Pan-American highway near Grecia. Sugar cane is raised in the provinces of Alajuela and Cartago and is grown primarily for domestic consumption

SCENES IN COSTA RICA

BY COURTESY OF (CENTRE RIGHT) PAN AMERICAN UNION; PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) HERBERT LANKS FROM BLACK STAR, (TOP RIGHT) STOPPELMAN—PIX FROM PUBLIX, (BOTTOM LEFT) EVANS FROM THREE LIONS

I. PHYSICAL GEOGRAPHY

1. Geology.—The higher parts of Costa Rica's two largest peninsulas, Osa and Nicoya, are complex Mesozoic metamorphic rocks. The lower parts of these peninsulas and the coastal range in the southwest, the upper Río Diquis (Río de Térraba) basin and the Pacific lowlands consist of Oligocene sandstones and limestones with much volcanic ash overlain in places with recent alluvium. In northwestern Costa Rica is the narrow Cordillera Volcánica (Miocene volcanic range, flanked by Miocene marine sediments with much volcanic materials), with several dormant volcanoes ranging in height from 4,500 ft. to the highest, Miravalles, 6,627 ft. In southeastern Costa Rica is the wide Cordillera de Talamanca. It consists of precretaceous granite and metamorphic rocks, flanked on both sides by Miocene-Oligocene conglomerates, shales, sandstones and admixtures of volcanic materials, and is cut by many porphyritic dikes. It has no low passes and its highest peak, Chirripó Grande, is 12,533 ft. The Cordillera Central has several high Tertiary volcanoes, largely dormant: Poás (8,875 ft.), Barba (9,533 ft.), Turrialba (10,919 ft.) and Irazú (11,260 ft.). West of the Cordillera Central is the Meseta Central, an intrusive cretaceous granite tableland, deeply mantled with volcanic ash. The foothills and lowlands of northeastern Costa Rica consist of Oligocene-Miocene sandstones, shales and limestones, and recent alluvial deposits.

2. Relief and Drainage.—The Caribbean coastal plain, from 2 to 5 mi. wide in the south and 70 mi. wide in the extreme north, is level and poorly drained near the coast. It makes up about one-fourth of Costa Rica's land area. Several large rivers cross these plains and empty into the Caribbean. The Sixaola for part of its course forms the international boundary with Nicaragua. The Reventazón rises on Irazú volcano and drains the eastern part of the Meseta Central before turning east toward the Caribbean; its valley constitutes the only railway and highway route from the Caribbean lowlands to the Meseta Central. The Chirripó also rises on Irazú volcano and joins the Colorado river, one of the mouths of the San Juan. The Arenal-San Carlos rises in Lake Arenal west of the Cordillera Volcánica and empties into the San Juan. Only the San Juan, which for part of its course forms the international boundary, is navigable. The three cordilleras are very rugged, but their slopes descend within a few miles to low foothills and plains. The Meseta Central is rolling. On the west coast the Osa and Nicoya peninsulas, the coastal range and the upper Grande de Térraba river basin are hilly. The Pacific and broad Guanacaste plains are level and for the most part well drained. The large rivers emptying into the Pacific are the Grande de Térraba, Grande de Tárcoles, which drains the western part of the Meseta Central, and the Tempisque and Bebedero, which drain the Guanacaste lowland.

3. Climate.—Areas below 3,000 ft. have mean annual temperatures of about 80° F., with little monthly variation from the annual averages but with diurnal ranges of 15° F. or more. Mean annual temperatures decrease from about 74° F. at 3,000 ft. to 69° F. at 5,000 ft.; the mean annual temperature at San José (altitude 3,806 ft.) is 67°, with extremes of 47° minimum and 94° maximum. Above 5,000 ft. mean temperature ranges are 57° to 41°, with frosts occurring in several months; this altitude zone is known as *tierra fría* ("cold land"). Precipitation varies greatly with elevation and exposure to the northeast trade winds. East of the continental divide rainfall is heavy; in some areas the mean annual rainfall exceeds 200 in. No month has less than six inches and rain may fall on more than 260 days per year. West of the divide rainfall is less; at San José in the Meseta Central the mean annual rainfall is 71 in., with each month from December to April receiving less than 2 in.; the northwestern plains and hills get from 50 to 80 in., with five months very dry; and the southwestern plains and mountain slopes have from 80 to 130 in., with three very dry months.

4. Vegetation.—The natural vegetation of Costa Rica includes five types of forests and three types of grasslands. Two forest types are minor: species of palms in fresh-water and brackish swamps along the Caribbean coast, and broad belts of mangroves along the Pacific shore and tidal streams. Broadleaf evergreen forests cover 60% of the country; less than 3% has been cleared for agriculture (principally banana lands) and for forest products. The evergreens grow in areas that are rainy all year—west of the palm swamps to about 6,500 ft. and on intermediate slopes on the west side of Cordillera de Talamanca to the shores of Osa peninsula. This forested area contains more than 1,000 species, of which 200 grow to heights of 70 ft. or more; they include mahogany, Spanish cedar, lignum vitae, balsa, rosewood, ceiba, nispero, zapote, Castilla rubber, brazilwood and others. Between this forest and about 10,000 ft. on the Cordilleras Central and de Talamanca are mountain rain forests dominated by large oaks with unimportant admixtures of other species. The high peaks of these cordilleras are covered with *páramos*, or alpine grasslands, consisting of mats of scrubby plants, sphagnum moss, blueberries and other plants of the Ericaceae. Broadleaf deciduous open oak woodlands and temperate grasslands once occupied the Meseta Central but it is now largely devoted to crops and pasture. Northwestern lowlands and hills, with a long dry season, have patches of deciduous tropical forests and large savannas. Common drug and medicinal plants are ipecac, arnica, copaiba, camomile, wormseed and tamarind.

5. Animal Life.—Native animal life is abundant. Deer, squirrel, opossum, tapir and porcupine are present in many areas. There are many species of reptiles: crocodiles, lizards (giant iguana and others), snakes and turtles. Rodents include agoutis, rats and mice. There are numerous species of water and land birds, many beautifully coloured; and many species of butterflies, moths, beetles, bees, wasps, bats, caterpillars, ants, flies and mosquitoes—most of them with varied protective coloration. Fresh-water and salt-water fish and mollusks are abundant; tuna, swordfish, marlin, dolphin, shark and others are caught in quantities in Pacific coastal waters.

II. GEOGRAPHICAL REGIONS

Costa Rica may be divided into four distinct geographical regions: (1) the Caribbean lowlands; (2) the highlands; (3) the plains of Guanacaste and northern Puntarenas provinces and the hilly land of the Nicoya peninsula; and (4) the southwestern plains and the Osa peninsula, coastal range and upper Grande de Térraba basin.

The Caribbean lowlands, narrow in the south and wide in the north, hot and rainy all year, are densely forested, except where they have been cleared for farm land along the railway lines inland from Limón. Embracing one-fourth of the national area, these lowlands are sparsely settled and have only 6% of the country's population. The inhabitants live in scattered lumbering camps and along railway lines in former banana districts that now grow cacao, abacá, rubber, corn, yucca, fruits and other foodstuffs.

The highlands, relatively narrow in the northwest, but wide in the central and southeastern parts, consist of the Cordilleras Volcánica, Central and de Talamanca and the Meseta Central. The rugged, rainy and forested Cordillera Volcánica is sparsely settled. The high, rugged, rainy, cold, and mostly forested Cordillera de Talamanca is very sparsely settled. The Meseta Central at an altitude of from 3,000 to 4,500 ft., the southwestern volcanic slopes of Cordillera Central and the Upper Turrialba and other valleys have 70% of the population of Costa Rica and all the large cities. Its population is mostly white, of Spanish descent. This small region is the economic, cultural and political heart of the country. The region has much rolling well-drained land, productive soils derived from lavas and volcanic ash, pleasant subtropical temperatures, an annual rainfall of 60 to 75 in., of which about 70% falls from May to November, and sunny dry weather from December to April. It has all but 17% of the nation's improved highways and has direct access to both coasts—by railway to the Caribbean at Limón and by railway and modern highway to the Pacific at Puntarenas. It produces all the coffee grown in Costa Rica and most of the tobacco, onions, tomatoes, potatoes, corn, beans, sugar, pineapples, oranges and dairy products. It has half the country's cattle, swine and poultry and produces most of the manufactured goods.

The plains of Guanacaste and northern Puntarenas provinces and the hilly land of the Nicoya peninsula, in places moderately densely settled, have about 15% of the country's population. The annual precipitation of from 50 to 80 in. is the least received anywhere in Costa Rica and the dry season in this area is longest and most pronounced. Nevertheless, this region is important agriculturally. More than half the country's beef cattle, marketed chiefly in highland cities, graze on natural savanna and planted pastures in this area. The region also supplies significant quantities of rice, sugar, corn, beans, sesame seed and products from the considerable remaining stands of broadleaf deciduous forests. In addition, Pacific waters contribute most of the fish taken in Costa Rica.

Southwestern Costa Rica has about 9% of the country's population. This population is located chiefly in the Pirrís, Paquita and Naranjo valleys near the coast in central Puntarenas province, and in the lower Grande de Térraba and Coto plains in southern Puntarenas. When the banana plantations in Caribbean lowlands in the early 1930s went out of production because of the Panama disease, plantations were established in the first group of valleys. However, these valleys now produce chiefly African oil palms, rice, cacao and corn. Nearly all the bananas exported from Costa Rica come from new plantations in the Grande de Térraba and Coto plains. The upper Diquis basin, the Osa peninsula and the coastal range are rainy nearly all year, are covered with broadleaf evergreen forests and are largely uninhabited. However, the Inter-American highway, crossing the upper Grande de Térraba basin from the southeastern corner of San José province to Panamá, opened up areas for settlement and development. (C. F. J.)

III. THE PEOPLE

1. Racial Types.—Costa Ricans are proud of their racial homogeneity. It has been estimated that 97.6% of Costa Rica's people are either white or mestizo. Nearly all Costa Ricans boast some Indian ancestry in the remote past, but the Spanish heritage predominates because the original Indian population was scattered and small. The early Spanish settlers came largely from the Estremadura and Andalusia districts and were later supplemented by immigrants from Castile. The Indians, estimated at about 4,000 in 1956, live in remote mountain districts. Negroes are also few—perhaps 2% of the population—and live chiefly in the coastal banana-producing regions.

2. Languages.—Except for the Indians, all Costa Ricans speak Spanish. French, long the second language of educated Costa Ricans, is rapidly being replaced by English. Because of their use of diminutives, such as *chiquitico* for *chiquito*, the Costa Ricans are called "Ticos" by their Central American neighbours.

3. Religion.—Ninety per cent of the Costa Ricans are affiliated, though in many cases only nominally, with the Roman Catholic Church. The virtual extermination of the Indians kept the practice of Catholicism free of Indian rites and folklore. Priests are few in proportion to the population, and relatively few are native Costa Ricans; many are German, Spanish or Italian. Protestant missions are active but have made relatively few converts.

4. Customs and Culture.—The culture of the Costa Ricans, like their racial background, is relatively homogeneous. The basic Spanish Catholic pattern, developed into a peculiarly national one during centuries of comparative isolation, persists in spite of changes brought about by contacts with German planters and priests, French, Belgian and North American teachers, and foreign goods and motion pictures. This basic pattern is evident in the great importance attached to family ties, in sedate, ritualized conventional behaviour, and in the yearly round of festivals, such as the colourful and solemn Holy Week processions.

Although folk arts and crafts are not highly developed, one picturesque element of rural culture is peculiarly Costa Rican: the oxcart, its solid wooden wheels and sides gaily painted in elaborate designs. The custom of the *retreta* is also typical of Costa Rica. While a band plays classical and light music in the central square of the town, boys and men stroll around the square in twos and threes in one direction, girls and women in the other.

LANKS FROM BLACK STAR

CHURCH OF OUR LADY OF THE ANGELS AT CARTAGO, COSTA RICA, REBUILT AFTER THE 1910 EARTHQUAKE THAT DESTROYED THE CITY. THE CHURCH IS THE SHRINE OF THE BLACK STONE STATUE "LA NEGRITA" (THE BLACK VIRGIN)

Joining a girl for a stroll around the square signifies romantic interest. Visitors find the *retreta* a good place to see the proverbially pretty Costa Rican girls.

Mass and market on Sundays are the high point of the country dweller's week, the coffee harvest and the festival of the patron saint of each village the high point of his year. City and country dwellers alike enjoy lotteries and games of chance at their fairs and festivals. Soccer is the national sport. Movies, dancing and a "carnival" or civic celebration at year's end, with bullbaiting as one of its chief attractions, are the chief urban diversions.

The Costa Rican diet, like that of other Latin-American countries, is based on Indian and Spanish-colonial staples: *tortillas* and plantains, rice and black beans. (Jo. B. B.)

IV. HISTORY

1. Discovery and Early History.—Costa Rica was discovered and probably named by Christopher Columbus, on his fourth and last voyage to America. On the Caribbean shore of Costa Rica the Spaniards found the first traces of the gold they sought in the earrings and other ornaments of gold worn by the natives. These ornaments are still prizes for archaeologists and the subject of a long controversy as to their origin and design. A settlement was planned and a small group of Spaniards headed by Bartholomew Columbus, brother of Christopher, was landed. The group remained only a short time, however, and after attack by the Indians and the loss of a number of men, set sail and joined Columbus farther down the coast. The name of the country, Costa Rica, or "rich coast," was possibly the result of Columbus' discovery of gold. Another explanation, suggested by the U.S. geographer George E. Church, is that the name is a corruption of *costa de oreja* ("earring coast").

Costa Rica was at first called Nueva Cartago before it became a province of the captaincy general of Guatemala, but by 1540 the

name Costa Rica had been generally adopted. The country had been conquered and pacified by the Spaniards by 1530 and became a province in 1540. Its limits were surveyed and fixed between 1560 and 1573 under Juan Vázquez de Coronado, one of the few able and conscientious Spanish governors in the long history of the province. Costa Rica was one of the most backward of Spanish possessions in America and, though nominally under the captaincy general of Guatemala, paid little attention to that authority. Its citizens were largely poor farmers whose only income came from the illegal sale of tobacco to Panamá or to British smugglers. Costa Ricans viewed Guatemala as the source of their poverty because taxes were levied from that city and officials were sent from there to enforce the Spanish mercantilist laws.

2. Independence.—Along with the rest of Central America, Costa Rica became independent on Sept. 15, 1821, when word was received that Mexico had successfully revolted against Spain. Although its poverty and lack of population caused Costa Rica briefly to join Mexico and, in 1824, to join the Central American Federation (*q.v.*), many citizens favoured a policy of complete separation from isthmian politics. The "Ticos," as they call themselves, felt unique among Central Americans. Because the Indian population of the country was slight there were few mestizos, and a very large percentage of the people were pure white. There was little mineral wealth and no landed aristocracy. While the general cultural and economic level during the early 19th century was low there were no sharp class distinctions. Few Costa Ricans could be considered wealthy, and there was no vast labour supply awaiting exploitation as in the Indian lands of Spanish America. These differences from the rest of Central America, coupled with distrust of Guatemalan power and size stemming from colonial times, brought about a policy of isolationism. With the dissolution of the Central American Federation the last official ties were soon broken, and in 1838 Costa Rica went its own way. Attempts among the five nations to revive the federation have met least response in Costa Rica.

Poor communication and the natural distrust of peasants brought about serious provincial rivalry that bore the meaningless terms of "Liberal" and "Conservative" but also reflected a desire to possess the capital city. In colonial times the capital city was Cartago; a brief civil war in 1823 brought the capital to San José. Rivalry between Cartago, San José and other towns led to the absurd "Ley de Ambulancia" of 1834 which provided that the government of Costa Rica be rotated every four years among the four largest towns. Much of this competition declined in later years as San José grew much more rapidly than the others.

Foreign demand for coffee brought the steady income that Costa Rica needed. Beginning in the 1840s a constant train of picturesque oxcarts carried coffee from the Meseta Central to Pacific ports and European-bound ships. British investment in Costa Rica was large. Small farmers could derive a simple, comfortable existence, and the groundwork was laid for a rural society that demanded schools and roads from its government and found political participation necessary to achieve these goals.

Costa Rica shared the San Juan river with Nicaragua and suffered from some of the canal fever and filibustering that nearly destroyed her northern neighbour. The two nations were often on bad terms because of disputes over boundaries (settled by treaty in 1896), and because the large province of Guanacaste seceded from Nicaragua and joined Costa Rica in 1825. British interest in Costa Rica and North American activity agitated this rivalry in the mid-19th century. However, when William Walker (*q.v.*) invaded Nicaragua in 1855 Costa Rica came to its assistance and under the leadership of Pres. Juan Rafael Mora defeated Walker at Rivas in Nicaragua.

3. Material Progress.—Costa Rica was not without some of the political partisanship found elsewhere in Central America, but it was less prolonged and less bitter. Material progress came about rapidly in the administration of Gen. Tomás Guardia who dominated Costa Rica by dictatorial methods from 1870 to 1882. While liberty was curtailed and heavy debts assumed, commerce in sugar and coffee increased substantially and a large program of school construction began. A new constitution was adopted in 1871 and continued in effect until 1949. The railroad building program during the 1870s and 1880s ended Costa Rica's isolation from the world. With funds borrowed mainly from Great Britain, Costa Rica began to link the Meseta Central with the seaports. The chief promoter was Minor C. Keith who made a fortune with the opening of the rail line between Cartago and Limón. Keith entered the banana business, as did about 20 other companies, on the basis of vast land grants from Costa Rica for building the railway. From this period on bananas regularly rivaled coffee as the chief source of income for Costa Rica. In 1899 the United Fruit company took over Keith's investments.

The last decades of the 19th century were marked by a gradual relaxation of Roman Catholic Church activity in secular affairs. The Jesuits were expelled for a few years; cemeteries were secularized; and public education was expanded. The constitution of 1871 provided religious toleration although the government continued to support the Roman Catholic Church. A law of 1886 required free and compulsory public education. A normal school, a museum and a national library were founded.

In spite of great bitterness, a truly democratic election in 1890 resulted in victory for José Joaquín Rodríguez—an election sometimes considered the first entirely free and honest election in Central America. It helped dramatize and strengthen the tradition of democracy for which Costa Rica is famed among Latin-American nations.

4. 20th Century.—In 1916 the United States and Nicaragua concluded the Bryan-Chamorro treaty by which Nicaragua gave the United States permission to use the San Juan river as a portion of an interoceanic canal route. Costa Rica protested that her rights in the San Juan river were being ignored. The claim, based on a treaty of 1858 and reaffirmed in an award of Pres. Grover Cleveland, was brought before the Central American court of justice. The court ruled that Nicaragua had violated Costa Rican rights, but both Nicaragua and the United States refused to accept the decision. This case was a significant factor in the destruction of the court. (*See* also FONSECA, GULF OF.)

The boundary with Panamá (originally with Colombia) was not delimited until 1941. An arbitration award by the president of France in 1900, confirmed by the chief justice of the United States in 1914, was generally favourable to Costa Rica, but was rejected by Panamá, which continued to hold part of the disputed area. Finally, in 1921, Costa Rica attempted forcible occupation of the Coto region (on the Pacific coast), which had been adjudicated to it. Large-scale hostilities were averted only by the intervention of the United States in support of Costa Rica's claim. Panamá thereupon evacuated the Coto area, but relations between the two countries were broken until 1928, and the dispute continued. A treaty of settlement was made in 1938, but opposition in Costa Rica was so strong that it was withdrawn from congressional consideration unratified. Finally, in 1941 the government of Rafael Calderón Guardia reached an agreement with Panamá delimiting the common boundary.

When Costa Rica held an election under a system of direct suffrage for the first time in 1913 no candidate won a majority and the congress then chose Alfredo González as president. One of his supporters, Gen. Federico Tinoco, became disgruntled with the tax revision and other reforms proposed by the González government and staged a successful revolution in Jan. 1917. Tinoco failed to take advantage of his popularity and behaved despotically at times. His administration was hindered by the refusal of the U.S. government to recognize regimes brought into office by force. During Tinoco's dictatorship Costa Rica declared war on Germany, but the president of the United States, Woodrow Wilson, succeeded in keeping Costa Ricans from participating in the treaty of Versailles discussions. Numerous revolts and the danger of intervention caused Tinoco to resign, and he went into exile in 1919. Julio Acosta was then elected president and was promptly recognized by the United States. Under Acosta and succeeding presidents Costa Rica acquired the reputation of being the most democratic and orderly republic in the Americas. It continued its tradition of democratic elections and nonmilitary rulers. President Acosta was followed in orderly succession by Ricardo Jiménez

Oreamuno (1924–28), who had served one previous term, Cleto González Víquez (1928–32), Jiménez for a third term (1932–36), León Cortés (1936–40), Rafael Ángel Calderón Guardia (1940–44) and Teodoro Picado Michalski (1944–48). A literacy test for voters was adopted in 1920 and the secret ballot in 1925. The country participated for a few years in the activities of the League of Nations but withdrew in 1924. On Dec. 8, 1941, the day after Japan attacked Pearl Harbor, the Costa Rican congress declared war on Japan even before the United States did, and on Dec. 11, 1941, declared war on Germany and Italy.

The only serious political crisis since 1917 came in 1948. A faction containing some alleged Communists tried to prevent the seating of the president-elect, Otilio Ulate. A socialist landowner named José Figueres put down the rebellion and turned the government over to Ulate. A new constitution was adopted in 1949. Figueres soon turned against Ulate and was legally elected president himself in 1953. Figueres nationalized the banks and threatened the United Fruit company and power company holdings. Aided by the Organization of American States, Costa Rica in 1955 repelled an invasion mounted by exiles in Nicaragua. In 1958 Mario Echandi Jiménez was elected president to succeed Figueres. Echandi was succeeded in 1962 by Figueres-backed Francisco J. Orlich.

After 1950 Costa Rica changed dramatically. It still relied heavily on agricultural exports for income but assumed many aspects of an industrialized society. The total number of commercial and industrial establishments nearly doubled between 1952 and 1956. But by the end of 1960 the country faced the prospect of an unfavourable trade balance and serious budget problems.

In March 1963 the presidents of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panamá met with U.S. Pres. John F. Kennedy in San José. Kennedy promised that the U.S. would help strengthen those nations and help prevent subversion by Communists; he also emphasized contributions in financial aid under the Alliance for Progress to bolster the region's economy.

(T. L. K.)

V. POPULATION

Costa Rica's population was estimated at 1,171,441 in 1960, an increase of nearly 400,000 over the number reported in the census of 1950, and well over twice the population in 1927, when the last previous census was taken. Costa Rica's population is growing at one of the highest rates in the world. The birth rate per 1,000 was about 54 in the early 1960s, even higher than the previous rates of 45 in 1938 and 46.5 in 1950. The death rate meanwhile dropped and infant mortality fell rapidly. The average density exceeds 60 per square mile. Seven Costa Ricans out of ten live on the Meseta Central on 10% of the land area.

The area and population of the republic's seven provinces and the population of their respective capital cities are as follows:

Province	Area sq. mi.	Population 1960 estimate	Capital city	Population 1960 estimate
Alajuela	3,668	218,219	Alajuela	18,483
Cartago	1,004	145,503	Cartago	17,776
Guanacaste	4,015	137,058	Liberia	6,336
Heredia	1,119	72,004	Heredia	17,701
Limón	3,591	59,240	Limón	15,806
Puntarenas	4,247	137,979	Puntarenas	18,309
San José	2,008	401,438	San José	109,696

(Jo. B. B.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Government.—The constitution of 1949, the eighth since 1825, provides for a unitary state with separation of powers (legislative, executive and judicial branches) but with some characteristics of the parliamentary system. The constitution of 1871 provided that the president's ministers could attend legislative sessions but could not vote. The constitution of 1949 empowers the legislature to force the ministers to appear before it and be subjected to question and to censure. Despite this, the legislative assembly is subordinate in practice to a centralized political and governmental system headed by a powerful executive elected directly for a four-year term. The legislature consists of only one chamber; it has 45 members, known as deputies, who are elected for four-year terms.

The constitution provides for two presidential designates. If no presidential candidate receives at least 40% of the popular vote a runoff election among the major candidates must be held. Three per cent of the national budget is devoted in election years toward defraying the campaign expenditures of all parties that receive at least 10% of the total vote. Both men and women (since 1949) are permitted to vote and voting is compulsory for all eligible male citizens under 70 years of age.

Costa Rica has taken a keen interest in public administration. In 1953 the Advanced School of Public Administration (ESAPAC) was founded in San José after a meeting of the ministers of economy of the five Central American republics in Tegucigalpa, Honduras, in 1952. Assisted by the United Nations and supported jointly by the Central American republics, the school was inaugurated in 1954.

The governors of the seven provinces are appointed by the president, and the subdivisions of the provinces—cantons and districts—are strongly influenced by centralized controls.

The judicial branch is centralized. The legislative assembly elects the supreme court, which in turn appoints the justices of the appellate courts and courts of original jurisdiction. An act of 1937 provided for a type of judicial review under which the supreme court can declare that a law or executive decree is inapplicable to a particular act. This power has not been used as a check on either the powerful executive or the legislature.

The Costa Rican army was abolished in 1948 and replaced by a civil guard of 1,200 men. It was estimated, however, that about 10,000 men were mobilized in 1955 against a revolutionary uprising. In 1958 President Echandi announced his intention to abolish the country's armed forces completely.

2. Education.—Costa Rica has one of the most distinguished records in education of any of the Latin-American countries. The education budget is usually at least 20% of the total budget and is the highest of all the ministries. According to the 1950 census, 79.1% of the population 10 years of age or older was literate. By the early 1960s there were more than 198,000 students in public and over 8,000 in private primary schools; there were approximately 27,000 students in public and 5,000 in private secondary schools. There were about 4,700 students enrolled in the University of Costa Rica. The average length of primary school enrollment is only four to five years and those who have learned to read are frequently unable to practise their skill because of the lack of books, magazines and newspapers, especially in the rural areas. Elementary education is free and compulsory for children between the ages of 7 and 14 years but many do not attend school. Education follows the European model of the centralized ministry, which controls policy and administration for the entire country.

3. Labour and Social Welfare.—The social insurance system is based on the laws of 1941 and 1943 as amended. Employers, employees and the government contribute to a system which provides cash benefits and medical, maternity and dependents care. The system is administered by the department of labour and social welfare. In addition, there is a workmen's compensation program which dates back to 1924, and a system of old-age insurance.

The labour code of 1943 guarantees the right to organize, to bargain collectively and to strike. The government provides labour courts and procedures for arbitration and conciliation. The labour unions were infiltrated and at times controlled by Communists after World War II. (W. S. Ss.)

VII. THE ECONOMY

As noted above, the economy of Costa Rica rests principally upon production and processing of agricultural commodities but manufacturing and transportation made significant gains during the 1950s.

1. Production.—According to the 1950 census, agricultural land comprised 2,421,655 ac., or 18% of the country's total area. Of the agricultural land 63.7% was in permanent pasture; 13.5% in permanent crops (coffee, sugar, bananas, cacao, abacá, pineapples, etc.); 10.8% in annual crops (corn, beans, rice, vege-

tables, tobacco, etc.); and 8.8% of annual cropland lay fallow. Agricultural production is sufficient to meet most domestic needs of these products and also to provide substantial quantities of coffee, bananas, cacao, abacá and cattle for export. Forests, occupying 80% of the country's area, supply the bulk of domestic needs for forest products and also exports including cedar, cativo (soft wood used in plywood), cabinet woods and balsa. Costa Rica is the seat of the Inter-American Institute of Agricultural Sciences with headquarters at Turrialba.

Known mineral resources are meagre, but clays, cement materials, gold, salt and sulfur are produced. Fisheries employ about 200 men and 150 boats and the annual catch totals about 450,000 lb. There is a combined storage and freezing plant at Puntarenas. Tuna, turtles and shark livers are exported. As Costa Rica produces no fuel other than wood, it depends heavily upon electric power generated from water power in the highlands. The electrical industry was nationalized in 1928. Industrial plants are small and produce chiefly consumer goods. The country's first census of manufactures in 1950–51 showed 3,247 manufacturing establishments with 18,491 employees.

2. Trade and Finance.—Costa Rica's chief exports are coffee, bananas, cacao, cattle, abacá and forest products. Principal imports are machinery, transportation equipment, chemical products, textiles, foodstuffs, minerals, forest products, fuels, and iron and steel. Leading customers are the United States, west Germany, Canada and the Netherlands; chief suppliers are the United States, west Germany, the United Kingdom and the Netherlands Antilles. In 1960 Costa Rica joined its neighbours in a proposed Central American common market to promote trade.

The monetary unit is the colón, valued in the early 1960s at 17.64 cents, U.S. currency, official rate, and at 15.04 cents at the controlled free rate. The Banco Central de Costa Rica directs monetary policy, foreign exchange and facilities for credit and supervises the banking system. There are four government-owned commercial banks and one foreign-owned bank. The latter cannot accept private deposits. The public debt in 1949 was 424,879,000 colones, including external debt of 157,117,000 colones; on June 30, 1961, it was 461,995,000 colones. The main source of government revenue is the income tax paid by the United Fruit company.

3. Transportation and Communications.—In 1957 the U.S. Export-Import bank lent $9,540,000 to finance Costa Rica's share of the unfinished sections of the Pan-American highway. Motor vehicle registration in the early 1960s numbered more than 30,000 automobiles, trucks and buses. Railways include 198 mi. of public service lines and several hundred miles of private plantation lines. In 1961 the World bank and the International Development association announced a loan of $11,000,000 to Costa Rica for highway construction.

Passenger air movement in and out of Costa Rica is largely via Pan American World Airways, Royal Dutch Airlines (KLM), TACA International Airlines and the local LACSA. Their subsidiary lines link San José by daily passenger and airmail services with all important towns. El Coco, the capital's airfield, opened in June 1955, can handle the most modern aircraft.

The government operates domestic telegraph and radio stations and part of the telephone system. There are telegraph stations in San José, Cartago, Limón, Puntarenas, Quepos and Golfito. The government has 19 radiotelegraph stations in its national network. There are also international radiotelegraph circuits to Nicaragua, Honduras, El Salvador and Mexico. The government operates over 200 telegraph offices and 88 official telephone stations. Except for several hundred government telephones the telephone system is privately owned. Regular telephone services operate between San José and the six other provincial capitals. There are 28 long-wave and 7 short-wave radiobroadcasting stations. Television was inaugurated in 1960.

See also references under "Costa Rica" in the Index volume.

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(C. F. J.)

COSTA Y MARTÍNEZ, JOAQUÍN (1846–1911), Spanish jurist and historian who was also a political thinker deeply concerned with the decline of Spain in the industrial age. Born at Monzón, Huesca, Sept. 14, 1846, he was the eldest of a farmer's 11 children. He studied law, philosophy and letters at Madrid university, where, from 1874, he held a minor teaching post. After 1884 he worked at the ministry of ecclesiastical affairs and justice. The loss of Cuba in 1898 wounded his patriotism and he began to preach a regeneration of Spain. Although his sympathies were with regionalism and colonialism, he also favoured the "europeanization" of the country. The paradox of his position was expressed by his *Reconstitución y europeización* (1900), where reconstitution meant a return to ancient values and europeanization meant going forward with the rest of Europe. An advocate of revolution, he refused to accept his seat when elected to the *Cortes* in 1903, holding that republicanism would not be viable until established by force. He wrote on Hispano-Celtic literature and myth (*La poesía popular española, y Mitología y Literatura celtohispanas*, 1881), legal theory (*Teoría del hecho jurídico, individual y social*, 1880), agrarian reform (*El colectivismo agrario*, 1898) and politics (*Oligarquía y caciquismo*, 1901–02). His last years were spent in combating the law against terrorism introduced by Antonio Maura in 1908 and in writing *Ultimo día del paganismo* (1909).

He died at Graus, Huesca, Feb. 8, 1911. (Av. K.)

COSTER, CHARLES THÉODORE HENRI DE (1827–1879), Belgian author, outstanding among those of his countrymen who wrote in French during the 19th century, was born of Belgian parents in Munich, Bavaria, Aug. 20, 1827. His tastes were always those of a millionaire, his means only those of a ragpicker; and he earned a living finally as a teacher of French at the École Militaire in Brussels, where he died (May 17, 1879) before fame had come to reward his literary achievement.

His writings include *Légendes flamandes* (1857), *Contes brabançons* (1861) and a remarkable travel book, *La Zélande* (1873). His masterpiece is *La Légende et les aventures héroïques, joyeuses et glorieuses d'Ulenspiegel et de Lamme Goedzak au pays de Flandres et ailleurs*, which it took him ten years to write. Published in 1867, it was many times reprinted and translated into a number of foreign languages (Eng. trans. 1943).

The story of Ulenspiegel takes place in the 16th century, at the height of the Inquisition's reign of terror: the hero's father is burned at the stake as a heretic, and Ulenspiegel swears an oath to avenge him. De Coster presents his characters as combining heroic qualities with a typically Belgian realism. The style is highly coloured and richly archaistic, being derived from Rabelais, from Montaigne and from the 16th-century chroniclers. With its theme of resistance against oppression, the book has been called "the Bible of Flanders" and "the breviary of freedom"; yet neither the gruesome death scenes and the shrieks of the tortured, nor, on the other hand, a certain tendency to philosophize, prevent its being, as the author describes it, "a merry, jovial book, a work of art and of literature." The contrast between it and the commonplace novels of the period is sharp and striking.

See Joseph Hanse, *Charles De Coster et son oeuvre* (1928).

(J.-E.-M.-G. D.)

COSTIGAN, EDWARD PRENTISS (1874–1939), U.S. lawyer, member of the U.S. Tariff commission and senator from Colorado, was born in King William county, Va., on July 1, 1874. He spent most of his youth in Colorado, where his parents moved in 1877. He graduated from Harvard in 1899 and began his law practice in Denver the next year. His interest in good government led him to join nonpartisan organizations designed to improve municipal and state government in Colorado, including the Direct Primary league, which he helped organize. A Republican and a supporter of Theodore Roosevelt, he bolted the party to help organize the Progressive party of Colorado in 1912 and to become its unsuccessful candidate for governor in that year and again in 1914. As an attorney he represented the Denver chamber of commerce and the United Mine Workers of America in federal litigation. In 1916 he became a supporter of Pres. Woodrow Wilson, who later appointed him to the newly created Tariff

commission. He served with distinction on the commission as an advocate of a flexible tariff until he resigned in 1928 in protest against the high-tariff policies of the Coolidge administration. He re-entered Colorado politics as a Democrat and was elected U.S. senator in 1930. He proposed far-reaching legislation to meet problems created by the depression and worked effectively for New Deal measures of Pres. Franklin D. Roosevelt. He was cosponsor of the Jones-Costigan act, a sugar-quota measure, as well as of the Costigan-Wagner bill, an antilynching proposal that never became law. Ill from overwork, he gave up his senate duties in 1936. He died in Denver, Jan. 17, 1939.

(C. F. McI.)

COST OF LIVING. The term cost of living is often employed in ordinary conversation without a clear conception of its true meaning. Since official measurements of the cost of living have been used for purposes for which they were not intended, the use of this particular term was replaced in the United States in 1945 by "consumer price index" and in Great Britain in 1947 by "index of retail prices."

All measurements of the cost of living or of the level of retail prices are concerned with the calculation of the cost at current prices of purchasing, in a particular place or area, of a certain collection of consumers' goods and services. This collection of goods and services may be what some recognized authority considers to be the minimum necessary to preserve health and strength or, more commonly, may consist of those goods and services on which it has been found by an empirical investigation a particular class of people in a given area habitually spend or have spent their income. The purpose of this survey is to describe in general terms the uses for which such measurements are required and the methods by which they are made. Further discussion of the variation in methods used in different countries will follow, together with a statistical table showing the comparative movements in the cost of living or level of retail prices before World War II and from 1952 to 1959 in selected countries. The evidence should make it clear that any measurement of the cost of living or of the level of retail prices is at best a rough approximation. *See* also PRICES, STATISTICS OF.

GENERAL CONSIDERATIONS

Purposes for Which Measurement Is Required.—The earlier uses of the measurement of the cost of living were chiefly concerned with the incidence of poverty, and this involved absolute measurement rather than the comparative measurement which later became more usual. The goods and services which a family of given size required to maintain health and efficiency for work were specified and the cost of this list of commodities at prices then current was calculated. This figure then disclosed the minimum income required by the family to furnish it with the essentials of life provided that due economy was practised. Any family whose income fell below this minimum level could be said to be living in poverty ascribable to an insufficiency of income rather than to other causes. Such in broad outline were the uses to which the cost of living was put by pioneers such as Benjamin Seebohm Rowntree (in *Poverty*, 1922, and in *Poverty and Progress*, 1941) and Arthur Bowley (in *Livelihood and Poverty*, 1915, and in *Has Poverty Diminished?* 1925). Unfortunately the concept of a minimum standard is an ambiguous one. As far as food is concerned, requirements cannot be assessed purely in terms of calorific value, and for items of expenditure such as housing, furniture, etc., the list must be determined by custom rather than by strict necessity. Even if the minimum calorific needs and minimum requirements of carbohydrates and protein could be made to serve as the basis of a diet, such requirements would vary according to the kind of work that had to be performed. In spite of these objections, the use made of the ideas set forth here was fully justified by the attention which it focused on a great social evil.

The second use for which cost-of-living measurements are required concerns the comparison over a period of time of the effect of changes in retail prices on a collection of goods and services which it was customary for a specified class of people to buy in a certain (base) year. Thus, in Great Britain until 1947 calculations were made of the changes since 1914 in the cost of a collection of goods customarily purchased by working-class families in 1904. Calculations on this basis take no account of the fact that, as time passes, the collection of goods which is priced is not typical of the expenditure of the class of people on which it was originally based. Four reasons for this change in the pattern of the expenditure may be distinguished:

1. As the prices of different commodities change, there is a tendency to substitute goods that become cheaper for those that become more expensive.
2. New commodities come onto the market and obsolete goods cease to be produced or are produced in decreasing quantities.
3. Social factors cause a progressive change of tastes.
4. If the economic class of people to which the calculation refers is defined in terms such as manual workers, professional workers or farm workers, the whole class may, over the course of time, find that their incomes enable them to purchase an increased quantity of all goods.

These possibilities draw attention to the option that exists in measuring the cost of living. We may wish to measure the changes caused by alterations in retail prices in the cost of maintaining a fixed level of "economic welfare" or "satisfaction"; and in this case it is necessary, ideally, to take account of changes in the pattern of expenditure caused by (1), (2) and (3) above. Alternatively, interest may centre on the changes in the cost of the collection of goods currently purchased by a given economic class of people irrespective of the fact that some while ago they were restricted by virtue of their income to a somewhat smaller collection. If this is the case we must take account of all four of the causes operating to change the pattern of expenditure. This then is a third use for cost-of-living measurement.

Unfortunately there is no practical means of measuring the cost of goods and services affording a constant level of economic satisfaction, since to find the pattern of expenditure corresponding to such a level requires a knowledge of the money income necessary to afford the required satisfaction and this could not be calculated without prior knowledge of the level of retail prices, which is the unknown that is being sought. There is thus no general alternative to the method of pricing a fixed collection of goods from year to year and assuming away the effects of relative price changes, new commodities and changes in tastes.

No such obstacles prevent the practical measurement of the cost of goods currently purchased by a given group of people, provided that such a group can be objectively defined in terms of the occupation to which they belong or the areas in which they live. Any definition depending on income, however, would be open to serious objection, for definition by real income would again beg the question to be answered, and definition by money income would provide a group of which the level of economic welfare was falling in times of rising prices (and vice versa), irrespective of the course of money incomes in the area concerned.

In 1947 the sixth International Conference of Labour Statisticians recommended (in *Cost of Living Statistics*, International Labour office, Geneva, 1948) that in the period after World War II cost-of-living indexes should be used for measuring the changes in the cost of a pattern of expenditure typical of a given economic group before the war and for measuring the changes in the cost of the current pattern of expenditure typical of a given economic group. These uses correspond to the second and third uses described above. In addition, the conference recommended another use which is an adaptation of the first use given earlier; *i.e.*, that changes in the cost of a collection of goods corresponding to a given standard of adequacy should be calculated taking account so far as was possible of the changes in the collection of goods induced by relative price changes. Such allowances can be made in the case of food and clothing by relating the new collection to the old by ensuring that the same calorific value and the same vitamins, minerals, etc., are provided, in the case of food, and that the same general specification and purpose are satisfied for clothing.

A fourth use for cost-of-living calculations has been the com-

parison of the cost of living for members of the same economic group living in two different places or areas during the same period. Clearly the same collection of goods must be priced in the two places, but is it to be the collection appropriate to the one place or to the other or some average of the two collections? Any of these methods is equally valid, but each will not produce the same answer and in some cases the results may contradict one another.

During World War II measurements of the cost of living had secondary uses as indicators of the effectiveness of price controls. Further, in Great Britain, for instance, subsidies were paid to farmers and others to prevent the retail price of certain commodities from rising. Insofar as the cost-of-living index was calculated on the basis of an obsolete pattern of consumption, its limited movement tended to exaggerate the effectiveness of such subsidies.

The composition of the collection of goods to be priced at two different times may present difficulties. Goods for which one once had to pay may come to be supplied free by a beneficent state. Almost certainly such a development would be accompanied by increased direct taxation and in principle the goods concerned should be priced according to the incidence of taxation for this particular purpose on the group of people for whom the index is calculated. There was little evidence at mid-20th century that this problem had yet been faced, but clearly if the welfare state developed further it would be a most important one.

Methods of Measurement.—The first requirement is to make a family budget study of the economic class of people for whom the index of retail prices is to be calculated. The economic group must be carefully defined in an objective way and a sample of families must be obtained so that all the members of the group are adequately represented. This means that every family in an economic class must have either an equal or a known chance of being selected for the sample; *i.e.*, the sample of families must be chosen at random from the economic class concerned.

The families in the selected sample must then be asked to record particulars of their expenditure in certain stated periods. The periods may vary in length according to the type of expenditure concerned; thus, in Great Britain in the ministry of labour's household budget inquiry of 1937–38, nearly 9,000 households were asked to supply budgets for each of four separate weeks in Oct. 1937 and January, April and July 1938. About one-quarter of these households were also asked to supply weekly returns of their expenditure on clothing over the 12 months from Oct. 1937. In this case the economic class concerned consisted of manual wage earners generally and nonmanual workers with salaries not exceeding £250 a year. The inquiry held between Jan. 1953 and Jan. 1954 excluded households for which the gross income of the head of the family was £20 a week or over in 1953, or which were mainly dependent on national insurance pensions or public assistance. It was based on budgets supplied by 11,638 households between these limits, a sample which represented nearly nine-tenths of the households in the U.K. and where, on the average, in every 100 households, 149 persons worked for gain, 12 were retired and 94 were children.

The material so obtained must then be collated and certain items of expenditure are in practice discarded. In most countries expenditure on direct taxes is excluded but this is not the case in some, such as Sweden and South Africa. Other items often left out are insurance contributions and premiums, subscriptions to trade unions, church collections, gifts in cash and expenditure on betting. The remaining items of expenditure are grouped together in sections that contain commodities that are likely to have broadly similar price movements. The sections are then combined into groups of the same general character such as food, rent, clothing, fuel and light, household goods, etc. The proportion of total expenditure of the class of people concerned on the items included in the sections and groups can then be calculated. Where there is evidence that expenditure on certain commodities has been understated, adjustments must be made to correct this inaccuracy. Expenditure on alcoholic drinks and tobacco is likely to be underrepresented if the results of the budget study are accepted uncritically.

From each section, commodities must be chosen for which there is good price information and which are likely to show price movements typical of all the items in the class. Commodities fulfilling these requirements must be specified as accurately as possible and arrangements must be made to obtain their prices at the appropriate intervals, usually of one month. Special difficulties arise in the case of commodities with seasonal variations in supply, such as fresh fruit and vegetables; before World War II these goods were often omitted altogether. Various devices were adopted to overcome this problem in different countries and one example will be mentioned here. In Sweden, beginning in 1941, the price during the month when a new crop came on the market was taken as the current price. In the following month the price used was the average of this month's price and that of the preceding month; in the third month an average of three months' prices was taken and so on until the sixth month, when the price used was the average of the six months following the arrival of the new crop. The price used in the sixth month was unaltered for the following months until the next new crop was produced. This procedure was justified on the grounds that the housewife has the option of buying supplies as necessary or of buying several months' supply at once and preserving the fruits and vegetables for later use.

If a new type of commodity is introduced and the old type of article is no longer available, some effort must be made to take into account the change in quality. A possible solution is to ask retailers to estimate what price should be quoted for the new article in order to make it sell as freely as the old.

When price controls and rationing are in force and if there is a substantial "black market" in any commodity, the existence of this state of affairs must be reflected in the prices of the commodity concerned provided that black-market prices can be collected with sufficient accuracy.

In order to illustrate the numerical calculation of a retail price index, use will be made of an artificial and simple example. Suppose that a group of people, appropriately defined, purchase four commodities only; namely, bread, coal, cloth and housing. Family budget studies taken in three successive years I, II and III disclose that the following proportions of total family expenditure are devoted to the four commodities in the three years:

	Year I %	Year II %	Year III %
Bread	60	50	40
Coal	8	10	12
Cloth	14	19	23
Housing	18	21	25

The price information obtained shows that in years II and III the prices of the four commodities expressed as a percentage of the prices in year I are as follows:

	Year II %	Year III %
Bread	110	120
Coal	120	140
Cloth	125	150
Housing	115	125

Then the cost of the pattern of the expenditure of year I in year II as a percentage of the cost of the same pattern in year I is

$$\frac{60\times110+8\times120+14\times125+18\times115}{60\times100+8\times100+14\times100+18\times100}\times100=113\cdot8$$

Similarly the cost of the same pattern in year III as a percentage of its cost in year I is

$$\frac{60\times120+8\times140+14\times150+18\times125}{60\times100+8\times100+14\times100+18\times100}\times100=126\cdot7$$

Thus the retail price index as measured by the changes in the cost of the collection of goods bought in year I is 113·8 in year II and 126·7 in year III compared with the cost in base year I of 100.

If it is desired to take into account the changed pattern of the expenditure of the economic class of families concerned, the index could be obtained for year II as before, but for year III

the cost of the pattern of expenditure of year II in year III as a percentage of the cost in year II can be calculated. This proportion is

$$\frac{50\times120+10\times140+19\times150+21\times125}{50\times110+10\times120+19\times125+21\times115}\times100=112{\cdot}1$$

The level of prices in years I and III can be compared by the "chain method"; *i.e.*, the retail price index is 100 in year I, 113·8 in year II and $113{\cdot}8\times\frac{112{\cdot}1}{100}=127{\cdot}6$ in year III.

If further the cost of the pattern of year III in year IV as a percentage of its cost in year IV was, say, 98·0, the retail price index in year IV on year I as base would be

$$127{\cdot}6\times\frac{98{\cdot}0}{100}=125{\cdot}0$$

It is worthwhile noticing that if the cost of the pattern of year III in years I and III were compared the retail price index would be 130·1 and not 126·7. This difference is caused by the fact that the families have switched their expenditure from bread, of which the price has risen less than average, to cloth and coal, of which the price has risen more than average.

The calculation of the index number used in this illustration can be described by means of an algebraic formula. If the quantities of various goods purchased in year I are denoted by q_1, q_2, q_3, . . . , etc., and the prices by p_1, p_2, p_3, . . . , etc., and if the prices of the same goods in year II are denoted by p_1', p_2', p_3', . . . , etc., then the retail price index in year II on year I as base is

$$\frac{p_1'q_1+p_2'q_2+p_3'q_3+\cdots\cdot}{p_1q_1+p_2q_2+p_3q_3+\cdots\cdot}\times100$$

This form of index number is that derived from Etienne Laspeyres. The formula may be rewritten in a different way as

$$\frac{\left(\frac{100\ p_1'}{p_1}\right)p_1q_1+\left(\frac{100p_2'}{p_2}\right)p_2q_2+\cdots\cdot}{p_1q_1\ +\ p_2q_2\ +\ \cdots\cdot}$$

It is then seen to be the "weighted" average of the "price relatives" $\frac{100p_1'}{p_1}$, $\frac{100p_2'}{p_2}$, . . . (*i.e.*, the prices in year II as percentages of the prices in year I) with p_1q_1, p_2q_2, · · · (*i.e.*, the expenditure in year I) as the weights.

UNITED STATES

Three types of measures of cost of living are reviewed here: (1) changes in cost of living; (2) how much it costs to live; (3) differences in cost of living from place to place. Interest in the first of these measures tends to be high in periods of rising prices which bring demands for wage increases to maintain customary levels of consumption. When prices are stationary or falling, those seeking higher wages tend to stress the dollar cost of a minimum or decent level of consumption, especially for those in low-paid occupations. Differences in cost of living from place to place are considered in wage negotiation and other issues bearing on income distribution. Facts as to price changes are also important in making decisions as to monetary and fiscal policy.

Changes in Cost of Living.—The consumer price index (C.P.I.) of the U.S. bureau of labour statistics (BLS) is the most important measure of changes in the cost of living in the United States. Its retail food index (R_1) goes back to 1890 and that of all consumption categories to 1913. The index is designed to measure changes in the prices paid for a selected budget of a base year. It is based on the index formula of Etienne Laspeyres (see *General Considerations*, above):

$$R_1=\frac{\Sigma\ qo\ pi}{\Sigma\ qo\ po}$$

where the *qo*'s are the average quantities used in the base year of each of the items priced, the *po*'s are their prices in the base year and the *pi*'s are current prices. This type of index tends to indicate a greater price increase than one using the Paasche formula in which the quantity weights represent consumption in the current rather than the base year.

The consumer price index measures average changes in prices of goods and services bought by city families of wage earners and clerical workers. It is based on prices of about 300 items so selected that their prices represent the movement of prices of all goods and services purchased by the families of wage earners and clerical workers. All important items in families' spending are represented with the exception of life insurance and income taxes. The inclusion of an item is determined by its importance and its price movement. Because the ability of one item to represent the price change of other items is not widely understood, the C.P.I. includes important items even though the index would be essentially the same if they were represented by other items also priced. The pricing of a large number of items contributes to the credibility of the index as an accurate measure of price change.

TABLE I.—*Annual Average Index of Consumer Price Index in the United States, Selected Years 1915 to 1960 (1947–49 = 100)*

Year	All items	Food	Clothing	Housing total	Rent	Transportation	Medical care	Other goods and services
1915 . .	43.4	40.0	37.3	—	77.2	—	—	—
1920 . .	85.7	83.6	105.1	—	100.2	—	—	—
1930 . .	71.4	62.4	58.9	—	114.2	—	—	—
1940 . .	59.9	47.8	53.2	—	86.9	—	—	—
1950 . .	102.8	101.2	98.1	106.1	108.8	111.3	106.0	105.2
1951 . .	111.0	112.6	106.9	112.4	113.1	118.4	111.1	109.7
1952 . .	113.5	114.6	105.8	114.6	117.9	126.2	117.2	115.4
1953 . .	114.4	112.8	104.8	117.7	124.1	129.7	121.3	118.2
1954 . .	114.8	112.6	104.3	119.1	128.5	128.0	125.2	120.1
1955 . .	114.5	110.9	103.7	120.0	130.3	126.4	128.0	120.2
1956 . .	116.2	111.7	105.5	121.7	132.7	128.7	132.6	115.9
1957 . .	120.2	115.4	106.9	125.6	135.2	136.0	138.0	119.8
1958 . .	123.5	120.3	107.0	127.7	137.7	140.5	144.6	123.0
1959 . .	124.6	118.3	107.9	129.2	139.7	146.3	150.8	125.3
1960 . .	126.5	119.7	109.4	131.5	141.8	146.2	156.2	127.9

Prices are obtained in 46 cities chosen to represent all urban places in the United States, and are collected from grocery, drug and department stores, hospitals, filling stations and other places patronized by families of wage earners and clerical workers. Prices of foods, fuels and a few other items are obtained every month in all 46 cities. Prices of most other commodities and services are collected every month in the five largest cities and every three months in other cities. Almost all prices are obtained by personal visits. In calculating the index, price changes are averaged together with weights representing their importance. City data are then combined in the total index with weights based on the 1950 population of cities represented.

The items priced and their quality and weights are determined by data secured from urban families. The initial food index used data collected for the year 1901 from workingmen's families in 33 cities. The first full-scale cost-of-living index used weights based on a survey of families of wage earners and low-salaried clerical workers in 92 cities for the years 1918–19. The next major revision of the weights used data obtained from families of similar workers in 42 cities during 1934–36. Automobiles and electric refrigerators were introduced into the index at that time. During the late 1940s family surveys in a few large cities indicated that some change in commodity weights was needed, and an interim revision of the index was made in 1951 pending the comprehensive revision of 1953. Several items were added because of their increased importance, *e.g.*, frozen peas, concentrated orange juice and television sets; other items were added because of a change in relative price movements. Probably the most important change was the reduction in the importance attached to food. Because of greater increase in the price of food than of other consumer goods the importance of food in the index increased from 35% in 1935 to 40% in 1950. Yet studies showed that about 35% of family outlays in 1950, as in 1935, went for food. A large-scale survey of urban families covering the year 1950 provided data for a comprehensive revision of commodities and their weights. Among the important changes were the inclusion for the first time of restaurant meals, used cars, items for the maintenance of owner-occupied dwellings and the purchase price of dwellings. These were all items of increased importance and their price movements appeared to have certain unique features.

A general revision of the index calls for an extensive survey of

amily consumption. Between such surveys some substitutions re likely to be made. Long before the 1934–36 survey, women's igh-buttoned shoes, in general use in 1918–19, had disappeared rom shops. They were replaced in the index by the type of shoes hat replaced them in use. When such changes are made the price f the new goods is introduced with a link so that its price change nly and not the price difference between the "old" and the "new" oods affect the index. This method is also used when compre- ensive revisions introduce many new goods and change the eights.

Deliberate changes may also be made in the quality priced if he volume sold indicates a change in consumers' preference. hen this is done, the new quality is usually linked in. During orld War II this practice was modified because of what was alled "forced uptrading." A given quality of product formerly riced for the index might have been dropped because it had al- ost or completely disappeared from the stores, and been replaced y one of a higher quality. This shift was in part the result of rice controls so that the market did not respond as formerly to onsumer demand for given qualities. When it seemed probable hat consumers were forced to buy the higher-priced line, a part r all of the price difference between the "old" and the "new" uality was included in the index.

Constant study of price movements is necessary since the ability f one item to represent another may change. The use of food ubsidies during World War II led to careful scrutiny of items riced. A change in customary relations may necessitate the in- lusion of additional items and the redistribution of weights. At ne time the price movement of children's clothing was repre- ented by that of adults. A change in the correlation of their rices resulted in some items of children's apparel being added uring 1947. Because rents and the cost of housing to home wners had tended to move together, rents paid by tenant families ere used to represent the change in housing costs of home owners. During World War II, partly because of rent control, this relation- hip changed. After the 1953 revision, change in rent no longer epresented change in the cost of owner occupancy of dwellings.

During World War II and early postwar years rent control re- ulted in a downward bias in the rent index that came to be eferred to as the "new unit bias." Normally in a market free of ent control the cost of new units and existing units of compara- le quality is the same. With rent control a difference occurred. he rent index rose 6.8 points in Jan. 1950 when a correction or this bias was applied.

In the C.P.I. an attempt is made to measure price change only. n order to do this, specifications are set up so that the product riced in successive periods is similar if not identical in char- cteristics. Those for a man's shirt, for example, designate thread ount, stitches per inch and character of workmanship. Such ecifications for the most part are broad and their use in pric- g often necessitates judgment on the part of the agent who in- ects the product and obtains the price. Even so they serve to xclude from the index some of the effect of shifts to a higher r to a lower quality that may occur because of change in real come or preferences. This aspect of the index is often passed ver lightly if mentioned at all in theories of price measurement. presents many difficult problems in actual practice. What, for xample, is an "identical" woman's hat in two successive seasons? here is the identical automobile to be found when each year rings a new model? Those pricing women's hats must decide on hat is comparable in the midst of changing materials, shapes and orkmanship. Standard models of selected automobile companies e used and the significance of improvements from year to year ignored—even those that lead to a longer life of the car.

Before 1943 rents for the index were obtained from rental gencies. Because of the possibility that violations in rent ceil- gs were occurring and might not be reported by rental agencies, change was made in the method of collecting data. A sample of ntal dwellings was drawn and rents were obtained from their oc- upants. Because of the high cost of drawing an entirely new sam- e, the same dwellings were priced in many successive periods. During World War II the "little steel" wage formula of 1942 brought the index into great prominence. Between Jan. 1, 1941, and May 1942, the C.P.I. increased by about 15%. The formula limited wage increases to 15% of wages prevailing Jan. 1, 1941, apart from inequities arising from unusually low wages. Claims for wage increases beyond this 15% were made on the grounds that the C.P.I. understated the rise in the cost of living. The members of the American Federation of Labor (A.F. of L.) and the Congress of Industrial Organizations (C.I.O.) in Jan. 1944 claimed that the cost of living had risen 43.5% during a period when the C.P.I. showed an increase of 23.4%.

Early in 1943 the American Statistical association appointed a committee to appraise the C.P.I. A downward bias was reported but no estimate of its magnitude was given. In the fall of 1943 the president's committee on the cost of living was appointed with William H. Davis as chairman and with employer and union representatives. Davis appointed a technical committee to review the index with Wesley C. Mitchell as chairman. The guesses of this committee put the total downward bias at from three to four points for the period Jan. 1941 to Sept. 1944. For about three years the BLS with each month's release explained that "the index does not show the full effect on the cost of living of such factors as lowered quality, disappearance of low-priced goods, and forced changes in housing and eating away from home." One outcome of the controversy was a change in the name of the index from "index of the cost of living of wage earners and lower-salaried workers in large cities" to "consumers' price index of moderate-income families in large cities."

The C.P.I. was used in wage negotiation in peace as well as war years. General Motors and the United Automobile Workers in May 1948 agreed upon an escalator clause that adjusted wage rates up and down with the C.P.I. For a time escalator clauses were quite popular. At the end of the Korean war their use dropped markedly. By Jan. 1955 about 2,000,000 workers were under contract with escalator clauses compared with a peak of about 4,000,000 a few years earlier. By Jan. 1960 the number had dropped still further to 1,000,000 workers, mostly in the manufacture of automobiles and related products.

Many modifications and supplements for the index were proposed. Some argued that fixed weights over a long period of time were inappropriate in a rapidly changing society, and recommended a chain index with the items and weights changed annually. The need was expressed for a C.P.I. for low-income urban families. There was evidence that during inflation prices of goods customarily purchased by low-income families tend to rise faster than those of moderate-income families. There were also proposals that the mobility of population be allowed to affect the index. In 1951 the index measured price change at a given location and ignored the differences in prices paid by families moving among cities with different price levels. Those who wish an index as a deflator of national consumer expenditures to measure the change in volume of consumer goods would like to have the entire population included. However, consumer price indexes useful for one purpose might not be suitable for another. Several consumer price indexes are needed if all purposes are to be served.

Other consumer price indexes include that of the National Industrial Conference board, a private agency representing employers, which has provided an annual series since 1914. More cities are included than in the C.P.I., but fewer items are priced. The U.S. department of agriculture provides an index of "prices paid by farm families" from 1910 forward. It is a part of the formula to measure "parity" income for agriculture. The items included are those typical of farm-family consumption during 1922–24. The index is confined to food, clothing and housing. Prices are reported by mail by retailers selling to farm families. No attempt is made to relate prices to the same quality in each reporting period, and prices reported are those most frequently paid for specified consumer goods. If higher or lower real income leads to a change in quality purchased this shift is reflected in the index. These three indexes have much the same cyclical pattern but differences in items, weights, areas and system of price collection are such that none of them can be used as a check on the accuracy of another.

How Much Does It Cost to Live?—Putting this question to a random sample of families would undoubtedly elicit answers highly correlated with their current expenditures. Outlays to provide things considered essential by a family tend to be its measure of its cost of living. Thus, higher income tends in time to bring a higher "cost of living," since essentiality is determined in large measure by that to which a family has become accustomed. Conversely, continued experience with a lower income will lead to a decline in what a family looks upon as its cost of living. The measurement of cost of living, apart from such individual judgments, is essential in the administration of relief, is implicit in social insurance, minimum-wage legislation, family allowances, income-tax exemptions, and has a place in wage negotiations. Cost of living in relation to the productivity of workers has also received scattered attention, especially the cost of education and health services.

Both governmental and nongovernmental agencies have provided measures of cost of living. Among the latter are some labour unions, the National Industrial Conference board and the Heller Committee for Research in Social Economics of the University of California. The Heller committee provides such measures for three occupational groups.

An essential first step in measurement is to decide on the level of welfare to be provided. The concepts used lack precision, although there is a consensus that "subsistence" is appreciably lower than "health and decency." When the level of budget is decided, it is next necessary to select the items and their quantities. Methods for doing this are not standardized. Quantity budgets for the most part have been set up by experts acquainted with the conditions of living of the group to whom the budget is to relate and having some survey or other data about current consumption. In selecting the items they take into account what scientists have to say about adequate diets and other conditions necessary for a high level of physical health, legal requirements (for example, those relating to sanitary facilities of dwelling and extent of overcrowding), the need of families of sociability and of children to go to school. The BLS statistics in the "city worker's budget of 1948" used another method. It selected the items and their quantities on the basis of the relation of rate of increase in quantity purchased to the rate of increase in income of families. The budget was at the income level where the relative increase of quantity in relation to income, technically described as income elasticity, was at a maximum. This was accepted as a measure of relative urgency felt by the families for the various goods.

The early measures of cost of living were concerned with poverty. After an extensive investigation, Robert C. Chapin decided that the annual cost of subsistence was $800 for a family of five persons in New York city in 1909. At the close of World War I several budgets bearing on wage negotiations were set up, concerned with local situations only. In the middle 1930s the Works Progress administration set up two budgets to meet basic maintenance and emergency standards. These were priced in 59 cities. For the first budget the average cost for a family of four in 1935 was $1,261 and for the second $903. The maintenance budget was described as not so liberal as that of a health and decency level but above "minimum of subsistence." The emergency budget was looked upon as suitable only for temporary conditions. During 1939 and again during 1941, the BLS priced the maintenance budget in many cities. The city worker's budget of 1948 was developed by the BLS at the request of a congressional committee on appropriation "to find out what it cost a worker's family to live in large cities in the United States." The budget set up was described as an attempt to measure "a modest but adequate standard of living," for a family of husband, wife, a boy of 13 years and a girl of 7 years. The BLS estimated costs of this level of living in 34 cities during March 1946 and June 1947. At the later date the cost ranged from $2,734 in New Orleans, La., to $3,111 in Washington, D.C.

A need varies greatly among families. Thus, a budget designed to measure the cost of living for one family type is not suitable for others. In order to deal with this variation, early investigators set up cost scales for individual members based on age, sex and activity. In most of these, family need was measured in terms of adult equivalents, the need of an adult male being counted as one and that of other family members being expressed in terms of it. Food scales were most widely used, based on scientific findings as to need for nutrients and customary food patterns. The scales for other budget categories do not have so sound a basis. Furthermore, the scales for total consumption become complex when an attempt is made to take into account the economy that comes with larger size of consuming unit. This differs greatly, for example, between food and housing. The BLS in publishing the city worker's budget in 1948 provided an over-all scale for estimating the difference in the cost of the budget for families of varying size if the same level of welfare was provided. Two criteria were used: (1) the relative income level at which families of various sizes report a specified quality of diets; and (2) a given amount of savings. The scales are given in Table II.

TABLE II.—*Scales for Families of Varying Size*

Item	Adequacy of diets	Amount of savings
2 persons	65.1	66.4
3 persons	84.7	84.4
4 persons	100.0	100.0
5 persons	114.8	114.1
6 persons	128.6	127.0

Budgets were also prepared for other types of consuming units. In 1948 the Federal Security agency published a budget to use in appraising the adequacy of the consumption of elderly couples living by themselves. As of June 1947 its annual cost in eight cities ranged from $1,365 in Houston, Tex., to $1,767 in Washington, D.C.

Budgets to measure the cost of living of single women became necessary because of minimum-wage laws. By 1948 cost-of-living budgets had been developed in ten states and the District of Columbia. In Massachusetts a budget for a single man as well as woman was set up and priced. In general, these budgets were for a single woman living away from home; employers argued that such a budget should be for a woman living at home. On the other hand, the U.S. women's bureau argued that allowance should be made for dependents.

Place to Place Differences.—Comparison in the cost of living between two places is simple if one budget represents the same level of consumption in the two places, but this condition seldom occurs. There may be differences in climate that affect need, in market prices that affect the relative quantity of various purchased goods and in the combination of adults and children in the consuming units that affect economy of consumption. All of these factors make it difficult to prepare budgets to represent comparable levels of consumption. The city worker's budget of 1948 varied the quantity weights for the clothing and housing in order to take account of the difference in climate among the cities in which it was priced.

Attempts were made to compare the cost of living of farm and urban families. One such measure was made by Nathan Koffsky. Two budgets were used and priced in both markets. City prices as relatives of farm prices using farm expenditure weights were found to be 30% higher, whereas farm prices as relatives of city prices using city expenditure weights were 12% lower. If two budgets could be developed to provide equivalent welfare, each could be priced in its own market and a single measure of cost of living secured. Suitable methods for this type of measurement had not yet been developed in the early 1960s. (*See* also BUDGET, FAMILY.) (M. G. R.)

SOME COMMONWEALTH COUNTRIES AND IRELAND

United Kingdom.—From 1914 to June 1947 the ministry of labour calculated a cost-of-living index at monthly intervals with 1914 as base year. The "weights" of the index were based on the average expenditure of 1,944 urban working-class family budgets collected by the board of trade in 1904. It was assumed that the proportions of total expenditure devoted to different goods and services remained unaltered until 1914. The average weekly expenditure of these families in 1904 was 36*s.* 10*d.*, of which 22*s.* 6*d.* was spent on food. The weights allotted to the different groups of

items were 60% for food, 16% for rent, rates, etc., 12% for clothing, 8% for fuel and light and 4% for other items.

In 1937–38 the ministry of labour carried out a household budget inquiry to gather data for a review of the basis of the cost-of-living index (see *Methods of Measurement*, above). Most of the households were those of persons insured against unemployment but some of the uninsured workers in the same class were also included; *e.g.*, domestic servants, police, etc. The scope of the inquiry covered agricultural workers and workers in industrial, commercial and clerical occupations. The average weekly expenditure of the industrial households was 85*s.* and of the agricultural households 57*s.* 4*d.* (*Ministry of Labour Gazette*, Dec. 1940 and Jan. 1941).

The outbreak of World War II prevented any immediate action but in March 1947 the Cost of Living Advisory committee, which had been appointed in 1946, issued its report (Cmd. 7077, 1947). The committee recommended the institution of a temporary index based on the pattern of expenditure disclosed by the 1937–38 working-class budgets. Meanwhile, study of the problems of collecting a regular series of budget studies was to go on so that the form of a permanent index could be decided. Accordingly, an "interim index of retail prices" was calculated and was published at monthly intervals from June 1947. The groups of this index were eight in number and their weights were 34.8% for food, 8.8% for rent and rates, 9.7% for clothing, 6.5% for fuel and light, 7.1% for household durable goods, 3.5% for miscellaneous goods, 7.9% for services and 21.7% for drink and tobacco. In the 1937–38 budgets it had been shown that items attracting 22% of total expenditure were not covered by the old cost-of-living index.

The course of the old cost-of-living index during and after World War II may be compared with that of an index calculated by R. G. D. Allen using the weights of the interim index (*London and Cambridge Economic Service Bulletin*, Feb. 1949). Both indexes were computed on the basis 1938 = 100.

Table III clearly shows the effect of government policy of subsidizing those articles of consumption that entered the old cost-of-living index.

TABLE III.—*Comparison of Cost-of-Living Indexes*

Year	Cost-of-living index	Allen's index
1939	101	102
1940	118	119
1941	127	130
1942	128	139
1943	127	143
1944	129	146
1945	130	148
1946	130	150
1947	130	160
1948	—	173

Dudley Seers attempted to calculate the increase in the cost of living of the middle classes during World War II (*Bulletin of the Oxford Institute of Statistics*, Aug. 1948). He defined the middle classes as those with salaries of more than £250 per year in 1938, proprietors of business and those living on investment income (other than retired members of the working classes) together with their dependents. He further distinguished the lower middle classes from the upper middle classes by considering those with salaries of between £250 and £500 a year and those whose professional earnings or profits from farming, shopkeeping, etc., or investment income were less than £500 a year in 1938 as being the lower middle classes. Seers estimated that whereas the working-class cost of living had risen 61.2% between 1938 and 1947, for the middle classes as a whole it had risen 77.8%. Further, the middle classes were divided, the rise between 1938 and 1947 amounted to 66% for the lower middle class and 85% for the upper middle class. These estimates are somewhat hazardous because of the method used to estimate the weights for the middle class indexes.

In June 1951 the Cost of Living Advisory committee recommended that a new full-scale budget inquiry should be held as soon as possible since conditions of spending appeared to be sufficiently stable. In March 1952 the committee reported on its investigation into the working of the interim index and suggested modifications in the weighting structure of this index, to be based on the 1950 pattern of consumption as revealed by national income estimates, until such time as the new inquiry could be completed. The new index took Jan. 1952 as 100 but the all-items index was also linked to the interim index. The weights used for combining the proportionate changes in prices after Jan. 1952 were: food 39.9%; rent and rates 7.2%; clothing 9.8%; fuel and light 6.6%; household durable goods 6.2%; miscellaneous goods 4.4%; services 9.1%; alcoholic drink 7.8%; tobacco 9.0%.

The committee reported again in March 1956 when the results of the budget inquiry held between Jan. 1953 and Jan. 1954 had been analyzed. The new index was based on Jan. 1956 as 100 but as before the all-items index was linked to the interim index. The weights, as of Jan. 1956, for the new index were: food 35.0%; alcoholic drinks 7.1%; tobacco 8.0%; housing 8.7%; fuel and light 5.5%; durable household goods 6.6%; clothing and footwear 10.6%; transport and vehicles 6.8%; miscellaneous goods 5.9%; services 5.8%.

Particular attention was paid to the problem of obtaining adequate information about changes in rent, both of local authority houses and privately owned houses. After the Rent act, 1957, the sample of dwellings was increased from 2,200 to about 6,000. Quotations for food prices and for a number of other goods were obtained from retailers in 200 representative towns, while for furniture and various household appliances information was provided by agents who visited retailers in about 23 large urban areas. The ten groups of the index were divided into 91 separate sections, for each of which a number of items were priced monthly with a total of nearly 350 items.

In the annual government publication *National Income and Expenditure*, indexes are published of the market prices of groups of commodities based on the current pattern of expenditure of consumers of all classes. The recent course of the index referring to consumers' expenditure in the United Kingdom is given below:

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Index	83	91	97	98	100	103	108	111	114	114	115

Further details about the interim and new indexes may be obtained from *Interim Index of Retail Prices* (H.M.S.O., 1952), *Report on the Working of the Interim Index of Retail Prices*, Cmd. 8481 (H.M.S.O., 1952), *Report on Proposals for a New Index of Retail Prices*, Cmd. 9710 (H.M.S.O., 1956) and *Method of Construction* and *Calculation of the Index of Retail Prices* (H.M.S.O., 1959).

Republic of Ireland.—In Nov. 1953 a consumer price index replaced the interim cost-of-living index (essential items), which had been published since Aug. 1947. The index covered all non-agricultural households and its weights were based on a family living study conducted in 1951–52. In this study 3,000 households reported their expenditure over a period of one week in each quarter of the year. Investigation showed that different types of families had reasonably consistent expenditure patterns.

The prices of 191 items were collected once every quarter in 118 towns and villages. Over 30,000 individual price quotations were used for each calculation of the index. A special rent inquiry was conducted annually in mid-November to obtain information about the rents and rates paid for rented dwellings, both local authority and privately owned. Allowance was made for the rates paid and the maintenance costs incurred by owner-occupiers. The prices of milk, eggs and potatoes were adjusted for season by correction factors based on the average seasonal movement over the preceding five years. The new index was linked to the old interim index but no official backward revision of the earlier index was made. The weights of the groups were as follows: food 40.8%; clothing 12.7%; fuel and light 7.0%; rent 6.2%; and miscellaneous 33.3%.

Australia.—The index used from 1953 was not based on a budget study but on national consumption data for the years 1950–53 as derived from consumption estimates using official production and trade figures, the census of retail establishments and general census data. Prices were collected for 245 items in each of six state capital cities. For commodities, prices were obtained generally from not fewer than ten retail outlets in each city. Information about rents was derived from a 5%–15% sample survey of four- and five-room brick or wood dwellings. A

TABLE IV.—*Movements of Cost-of-Living Indexes in Various Countries, 1937–38 and 1952–60**
(1953 = 100)

Year	Australia	Belgium†	Burma (Rangoon)	Canada	Chile (Santiago)	France (Paris)	India	Ireland	Netherlands	New Zealand	Portugal (Lisbon)	South Africa	Sweden	Switzerland	Turkey (Istanbul)	United Kingdom	United States
1937	38	24	27†	55	9	. . .	. . .	43	38	52	. . .	50	49	59	. . .	43‡	54
1938	39	25	26†	55	9	4‡	. . .	44	38	54	. . .	52	50	59	26	43‡	53
1952	96§	100	103§	101	80	101	97	95§	100§	96	99	97	99	101	97	97	99
1953	100	100	100	100	100	100	100	100§	100	100	100	100	100	100	100	100	100
1954	101	101	95	101	172	100	95	100	104	105	99	102	101	101	110	102	100
1955	103	101	99	101	302	101	90	103	106	107‡	99	105	104	102	119	106	100
1956	109	104	106	102	471	103	99	107	108	111	102	107	109	103	136	112	102
1957	112	107	112	106	627	106§	104	112	115	113	104	110	113	105	152	116	105
1958	113	108	108	108	752§	121	109	116	117	118	105	114	119	107	171	119	108
1959	116	110	96	110	1,043	129	114	116	119	123	107	115	120	106	216	120	109
1960	120	110	108	111	1,164	134	116	117	121	124	109	117	124	108	228	121	111

*The greatest caution should be used in making comparisons between two countries, since the coverage and basis of the indexes vary widely. †Excludes rent. ‡Estimate.
§New series linked to former series.
Sources: *Yearbook of Labour Statistics* (Geneva); *U.N. Monthly Bulletin of Statistics*.

six-city index of each item was obtained by weighting each city price-relative (the current price of an item as a percentage of its price in some base year) by its population. In the base period of July 1952 to June 1953 the weights allotted to each commodity group were: food 37.1%; clothing and drapery 26.8%; rent 9.0%; fuel and light 4.6%; miscellaneous 22.5%.

Canada.—A budget study was conducted in the year ending Aug. 31, 1948, in which records of expenditure for 3,600 families were obtained. The families represented all sectors of Canadian nonfarm population. For the compilation of the index 1,517 budgets were used belonging to families (1) who lived in cities with a population of over 30,000; (2) whose size ranged from two adults only to two adults and four children; and (3) whose income in the survey year was between $1,650 and $4,050. In fact, 45% had incomes between $2,000 and $3,000.

The year 1949 was chosen as the base period and the index included 224 items, 40% more than the previous index. Price quotations which could be collected by mail were obtained from 33 cities, while for articles which might be subject to quality changes the quotations were collected by full-time agents in eight cities. For each item individual price quotations were weighted by the volume of sales of the retail outlet concerned to derive the average price for a given city. The city average prices were then combined according to the relative importance of the article's sales in each city. Varying monthly weights were used for items the consumption of which fluctuates seasonally, such as fresh and canned fruits and vegetables, fats, eggs and meat. Expenditures such as property insurance and prepaid medical care were included in the index, but life insurance premiums were excluded.

New Zealand.—From 1956 the index was based on the postwar urban expenditure pattern, with the period Jan.–March 1948 as base. A total of 306 items were included in the index and prices of commodities were collected from 503 retail stores in from 10 to 21 towns with a 1948 population of 6,000 or more. Rent data covered 10,200 private houses, 25,800 state houses and 5,400 flats.

The weights for each commodity group in the base period were: food 32.3%; housing 15.4%; household operation 10.6%; clothing and footwear 15.4%; transportation 8.7%; miscellaneous 17.6%.

Table IV gives the movements of the cost-of-living or retail price indexes in various countries before World War II and from 1952–60. (A. D. R.)

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COSTS, in law, denotes the expenses involved in bringing or defending either a civil lawsuit or criminal proceedings. In England, taxable or chargeable costs may include all the litigant's expenses in preparing and presenting his case and a reasonable fee for his counsel, as allowed by a taxing master (*see* PRACTICE AND PROCEDURE: *England; Civil Procedure*). There the court has a broad discretion to refuse costs to a successful party and even to assess them against him if he has improperly increased his opponent's expenses or the action is vexatiously or unnecessarily brought. In the United States, only fees paid to officers of the court, with at most a purely nominal counsel fee, are taxable. Occasional statutes or rules, however, authorize the award of counsel fees to a successful litigant in particular types of actions and give the court power, rarely exercised, to assess full costs against a delaying or dilatory litigant. The striking contrast between English and U.S. cost awards suggests that the leniency of the latter may actually stimulate litigation while the harshness of the former may burden it unduly. (C. E. CL.)

COSTUME: *see* DRESS.

COSTUME DESIGN, THEATRICAL. The purpose of theatre costume is to separate actors from audience and to distinguish each actor from his fellows while they enact whatever it is the spectators have come to see. The actors' garments may be accurate versions of the clothing of some period; they may exaggerate or distort it; they may be primarily symbolic; or they may furnish an animal disguise.

WESTERN COSTUMES

PREMEDIEVAL AND MEDIEVAL

Premedieval Origins.—Among primitive peoples the forerunners of true theatre are religious dances and other ceremonials; hence the earliest theatre costumes are religious. When a people's welfare is dependent upon the caprices of nature, interpreted as the granting or withholding of favours by the gods, ceremonies of propitiation take on various forms: imitative movements such as a rain dance, acts of commemoration that repeat some important happening of the past or impersonations in which the actor becomes for the time being an animal, a tribal hero, a god. The individuals chosen to enact these ceremonies renounce their own personalities temporarily and don garments appropriate to their roles. From such pretheatre beginnings of costumed action developed the great drama of Greece, but in many parts of the world the theatre still has not taken the final step into drama.

American Indian.—In the United States the Pueblo Indians,

Knights in the chorus of an early Greek comedy riding on men disguised as horses. Detail from a black-figured vase; 6th century B.C. Staatliche Museen, Berlin, Germany

Greek actor wearing the full-length, long-sleeved tunic of tragic drama in the title role of Euripides' *Andromeda*. Detail from a vase painting; 5th century B.C. Staatliche Museen, Berlin, Germany

Sketch of Zuni Pueblo Indian ceremonial dancer wearing the Shalako mask that represents a spirit or god whom the wearer personifies

Tragic actor holding his mask. He wears a long-sleeved, short tunic and high boots (cothurni). Fragment of a vase from Tarentum, a Greek city in southern Italy; late 4th century B.C. Martin von Wagner museum, Würzburg, Germany

PREMEDIEVAL THEATRE COSTUMES

Scene from a burlesque with actors wearing the short tunic and tubular pants of Greek Old Comedy. Detail from a mixing bowl of Assteas of Paestum, Italy; late 4th century B.C. Ehemals Staatliche Museen, Berlin, Germany

Scene from a New Comedy of the Hellenistic period in Rome. The actors are masked and wear long tunics and draperies (pallia). Marble relief from Pompeii, Italy. National museum, Naples, Italy

Y COURTESY OF (TOP LEFT, TOP CENTRE) STAATLICHE MUSEEN ZU BERLIN, (TOP RIGHT) VIRIGINIA MORE ROEDIGER, (BOTTOM LEFT) EHEMALS STAATLICHE MUSEEN, BERLIN; PHOTOGRAPHS, CENTRE LEFT) HIRMER FOTOARCHIVE—PUBLIX, (BOTTOM RIGHT) ALINARI

COSTUME DESIGN

Men and women wearing both furry garments and fashionable clothes, the costume of 15th-century French court *bals sauvages*. Detail from a tapestry in the church of Notre Dame of Nantilly, Saumur, France

"Buste de Femme," mask and costume designed by Rosso Fiorentino for a 16th-century spectacle. Engraving by René Boyvin. Metropolitan Museum of Art

"Warrior Riding on a Swan" by Francesco Primaticcio; 16th century. The actor, dressed as a warrior on top, stands inside the swan; the bent leg is false. National museum, Stockholm, Sweden

Pastoral costume design by Leonardo da Vinci for the "Festival of Paradise," an Italian court pageant; 16th century. Royal library, Windsor castle, England

King Henry III of France dressed in an "antique" costume of a warrior for a court masquerade. Detail from the "Quintain," one of the Valois tapestries; dated about 1580. Uffizi gallery, Florence, Italy

15TH- AND 16TH-CENTURY COSTUMES

BY COURTESY OF (TOP CENTRE) THE METROPOLITAN MUSEUM OF ART, DICK FUND, 1928, (CENTRE RIGHT) THE NATIONAL MUSEUM, STOCKHOLM, PHOTOGRAPHS, (TOP LEFT) ARCHIVES PHOTOGRAPHIQUES, (BOTTOM LEFT) ROYAL LIBRARY, WINDSOR CASTLE, BY GRACIOUS PERMISSION OF HER MAJESTY THE QUEEN, COPYRIGHT RESERVED, (BOTTOM RIGHT) SOPRINTENDENZA ALLE GALLERIE FLORENCE

Costume design by Daniel Rabel (1578–1637) for a *ballet de cour* at the court of Louis XIII of France; dated about 1626. The Louvre, Paris

Costumes for a hero and a devil in a street show of the early 17th century. Detail from a painting by Denis van Alsloot. Victoria and Albert museum, London

Left and below, baroque costume designs by Jean Bérain (1637–1711) for ballets performed at the court of Louis XIV of France; 17th century. Archives de l'Opéra, Paris

Costume design by Inigo Jones (1573–1652) for Iris in *Hymenaei*, a court masque by Ben Jonson for James I of England; 1606. Devonshire collection, Chatsworth, England

COSTUMES OF THE 17TH CENTURY

BY COURTESY OF (TOP LEFT) THE LOUVRE, (TOP RIGHT) THE VICTORIA AND ALBERT MUSEUM, (CENTRE AND BOTTOM LEFT) ARCHIVES DE L'OPÉRA, PARIS; PHOTOGRAPHS, (TOP RIGHT) C. G CANNINGS FOR ENCYCLOPÆDIA BRITANNICA, INC., (BOTTOM RIGHT) DEVONSHIRE COLLECTION, CHATSWORTH, REPRODUCED BY PERMISSION OF THE TRUSTEES OF THE CHATSWORTH SETTLEMENT

COSTUME DESIGN

THEATRE COSTUMES OF THE 18TH AND 19TH CENTURIES

Pastoral costume design for a French peasant girl by Jean Baptiste Martin (1659–1735); dated early to mid-18th century. Bibliothèque de l'Arsenal, Paris

Ballet costumes in the rococo style of the 18th century designed by (left) François Boucher (1703–70) and (right) Louis Boquet (1717–1814), court painters to Louis XV of France. Archives de l'Opéra, Paris

Neoclassic costumes designed by Jean Simon Berthélémy (1743–1811) for *Proserpine;* late 18th century. Archives de l'Opéra, Paris

Costume for an Indian queen in a play for the English Toy theatre; 19th century. Harvard Theatre collection

Costume design by James Robinson Planché (1796–1880) for the king in the Charles Kemble production of *King John* by William Shakespeare; 1823. The British museum, London

BY COURTESY OF (TOP CENTRE AND RIGHT, CENTRE RIGHT) ARCHIVES DE L'OPERA, PARIS (CENTRE LEFT) BIBLIOTHEQUE DE L ARSENAL, PARIS, (BOTTOM LEFT) HARVARD THEATRE COLLECTION (BOTTOM RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM. PHOTOGRAPH (BOTTOM RIGHT) JOHN R FREEMAN & CO. FOR ENCYCLOPÆDIA BRITANNICA, INC

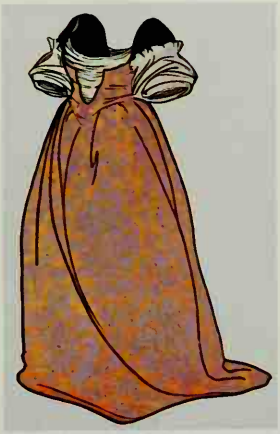
ostume design by Norman Bel Geddes (1893–1958) for a bridesmaid in
ie Max Reinhardt production of *The Miracle;* 1924. Bel Geddes col-
ction

Costume design by Léon Bakst (1866–1924) for Électre in *Hélène de Sparte*; 1912. Art Institute of Chicago

A costume design by Eugène Berman for Mozart's *Don Giovanni;* 1958

COSTUME DESIGNS OF THE 20TH CENTURY

ostume design by Raymond Sovey for Lucio in
illiam Shakespeare's *Measure for Measure;*
argaret Webster production, 1964



Costume design by Robert Edmond Jones (1887–1954) for the extra lady in *The Merchant of Venice* by Shakespeare; about 1913

Costume design by Caley Summers for Lady Anne in Shakespeare's *Richard III;* Colorado Shakespeare festival, 1963

COURTESY OF (TOP LEFT) HOBLITZELLE THEATRE ARTS LIBRARY, THE UNIVERSITY OF TEXAS. (TOP RIGHT) THE ART INSTITUTE OF CHICAGO, SIDNEY A. KENT FUND. (CENTRE RIGHT, BOTTOM CENTRE) ROBERT L. B. TOBIN. (BOTTOM LEFT) RAYMOND SOVEY. (BOTTOM RIGHT) CALEY SUMMERS. PHOTOGRAPH, (BOTTOM LEFT) CREATIVE PHOTOGRAPHERS

COSTUME DESIGN

TRADITIONAL THEATRE COSTUMES OF THE EAST

Chinese actress wearing the costume of the heroine of *The Peony Pavilion*, a 16th-century opera by T'ang-Sien-Tsu in the *k'un-ch'ü* style

Chinese actor wearing an ancient national costume of a warrior in *The Retreat of Kisi-Ting*. The flags on his back signify that he is on horseback

Japanese actor wearing a late 18th-century nō robe in his portrayal of a female role

Kabuki actor wearing the costume of a leading character in *The Subscription List*, a classic Kabuki play dating from 1840

Dancer actor in a traditional costume of Javanese ritualistic theatre said to have derived from shadow plays

PAINTED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA, INC. BY CALEY SUMMERS. PAINTINGS FROM (TOP LEFT) A PHOTOGRAPH IN KALVODOVÁ SÍS-VANÍS, "CHINESE THEATRE," SPRING BOOKS LONDON. (TOP RIGHT) A DRAWING IN "THE CHINESE THEATRE" BY CHU-CHIA-CHIEN. THE BODLEY HEAD LTD. LONDON. (BOTTOM LEFT) A PHOTOGRAPH BY WILLIAM E. RUSSELL. (CENTRE) AN ORIGINAL COSTUME IN THE COLLECTION OF THE METROPOLITAN MUSEUM OF ART. PURCHASE 1932. JOSEPH PULITZER BEQUEST

of the southwest are a case in point. Their unique culture was arrested by the coming of the Spanish in the 16th century, but these people steadfastly preserved their symbolic ceremonial dances with the traditional costumes in the face of an alien and conquering religion. These costumes include garments of the style worn before the conquest: for men a wrap-around or kilt woven of heavy cotton, for women a drapery equally simple but more enveloping. (Such reverence for and symbolic use of garments formerly worn by all is a persistent characteristic of theatrical costume everywhere.) These particular costumes are decorated with highly abstract, symbolic designs. Along with the basic dress or sometimes instead of it may be worn ornaments and accessories that suggest an animal to be honoured or propitiated.

The eagle dance costume of the Hopi tribe includes wings with which the dancer imitates the swooping motions of the eagle and a headdress that symbolizes that bird. The Hopi eagle dancer wears a mask-headdress of more than human size, of highly unrealistic design, symbolic not imitative—actually a sacred symbol.

In the same category is the Shalako mask, which in the Zuni tribal ceremonial represents an ancestral spirit with "god-like potency." For, as Virginia Roediger explains, "As soon as the impersonator dons the mask of the supernatural he is believed to become that spirit. As a consequence he *is* supernatural and must not be approached or touched during the ceremonies and must be uncharmed before he again becomes mortal." Body paint also has magic power: it too renders the wearer untouchable and must be washed off ceremonially before he again becomes as other men.

Outsiders unaware of the important ritual meanings in the Pueblo ceremonial are stirred by the aesthetic appeal of the costumes: their vibrant colours, ingenious construction, abstract designs pleasingly applied and such ornaments as sashes, fringes, tassels and rattling shells that combine in a syncopated accompaniment to the basic rhythm of the measured steps.

Egyptian.—From such dances and other primitive religious embryo dramas, scholars infer that similar conventions developed in prehistoric civilizations. The rather sketchy information available about Egyptian theatre in historic times points the same way. Scripts of a few Egyptian religious plays do exist but there is no indication of the costuming. However, many Egyptian figures in stone, in fresco and on papyrus have the look of theatre costume designs: hawk-headed men in loincloths and round beaded collars; female figures wearing headdresses representing the folded wings of birds, their bodies wrapped in feather-painted skirts, and many others, beautiful now as pure design, once charged with symbolic beauty as well. Those animal heads could well be the masks of priests impersonating gods. Certain to be identified as elements of priestly costume concerned with ritual are the false ceremonial beard (also reserved to the Pharaoh) and the exotic leopard skin drapery so alien to the ordinary dress of a tropical people. Here consideration of Egyptian theatrical costume must rest until more evidence comes to light.

Greek.—Egypt was one of the contributors to the religious thought of Greece. Another was Thrace, whence the god Dionysus came rioting down. With the worship of Dionysus began Greek drama, lusty with satyrs and dancing women. The satyr impersonators, who formed the first choruses, imitated nature creatures with hairy legs, bushy tails and animal-like masks. Long after the form of the ritual song-dance had been subordinated to developed drama with choruses of various sorts, the satyr play lingered on, as though men were loath to give up the opportunity to identify themselves with the wild things by means of masks and tails. The mask, then, is the first important item of Greek theatrical dress. Also associated with Dionysus is the non-Hellenic tunic, the distinctive garment of the dramatic hero who emerged in the time of Aeschylus. This tunic was characterized by its length (to the feet); sometimes by a train called the *syrma,* which was added occasionally for special emphasis; its slight shaping to the form; its long, snug-fitting sleeves; and its lavish ornamentation. This garment, of Thracian or possibly Persian origin, is an early example of the ever-recurrent tendency in theatrical costume design to turn to the exotic, the foreign. No costume could have been further removed from the ordinary dress of the Greeks, whose principal garment was then the chiton, which in its pure form is never shaped to the body; it is a rectangle of wool draped upon the wearer and secured by pins and cords. It is never caught to enclose the arms snugly and often leaves them entirely bare. Men wore the chiton short, women wore it long.

The tragic actor's tunic was long probably because of the tradition that Dionysus himself wore a long dress. He also traditionally wore the cothurnus, a soft boot laced to mid-calf; this also became a part of the actor's costume. Aeschylus is said to have caused the boot (it was originally feminine footwear) to be modified with a hard sole that added to the wearer's height. Evidently this sole was thickened progressively, but when and by how much and to what ultimate thickness are matters of controversy. Early written testimony is ambiguous. Pictorial evidence for really high soles is scanty and late, dating from the early centuries of the Christian era and the decline of tragedy. From the beginning, however, the principal actors did wear masks, which almost immediately were accompanied by the headdress, or *onkos.* Together they served to identify and characterize the wearer, and in time both became more and more stylized and exaggerated. Mask, *onkos,* instep-length robe with long sleeves and lavish decoration, high boots with hard soles—by these distinctive details was the tragic actor set apart.

By contrast, the chorus appears to have worn chitons and these were made of the richest material and ornamentation the *chorēgos* could afford. The *chorēgos* was some wealthy Athenian who, since he had been accorded the honour of dressing these singers and dancers, would strive to live up to it by extravagant expenditure. When both chorus and principal actors needed to augment their costumes they put on the chlamys, a moderate-sized scarf, or the himation, a great enveloping length of fabric that served both men and women as an outside wrap.

Concerning colour symbolism on the tragic stage of the 5th century B.C., evidence is far from definite. In the works of art that yield information about Greek dress, including theatrical, virtually no colour remains. Passages quoted are generally from Pollux, who wrote 500 years later. Contemporary writing pays tribute to the "rich colours" worn by the actors and to the "sumptuousness" of the chorus. It states that gold threads were woven into purple cloth for royalty; red, ranging from purple-red to flame colour, was a hue for heroes; the drabs and black stood for poverty and grief. But decorative design and its motifs fared better: there still exists in vase painting a clear recording of the actor's patterned robes with their horizontal stripes, pointed rays, palmettes, spirals, heads of sphinxes, horses, human figures and the familiar wave.

Comedy, which also derived from the worship of Dionysus, followed the spirit of the funmakers rather than that of the more reverent worshipers. The costume of Old Comedy is far removed from that of tragedy. It was gross and clownish and sometimes inspired extra mirth by satirizing the dignity of tragic heroes and gods. The masks were exaggerated and ludicrous; when the wearer represented some contemporary poet or politician his face was recognized as easily as the faces in present-day cartoons. Masks survived into the later, realistic New Comedy of Menander; by that time they were no longer caricatures but merely types. Whereas tragic theatre dress was longer than ordinary, that of comedy was shorter; the tunic, whether sleeved or not, reached just to the buttocks. Ankle-length tubular pants covered the legs. Feet, though sometimes bare, were often dressed in the soft sock shoes or *soccus* that came to be identified with comedy as the cothurnus was with tragedy. The pants were wrinkled, sloppy laugh-getters. The whole figure of the comic actor was a grossly undignified contrast to the stately body of the tragic hero; he had shoulder humps, bumpy biceps and calves (or stringy arms and legs), and a huge belly balanced by great fat buttocks; and he always wore the phallus, stylized, greatly exaggerated, but recognizable. A leftover from the primitive once serious fertility rites, this appendage had come down via the satyrs. It eventually disappeared from the sophisticated and realistic New Comedy but was retained by performers in the rustic Dorian Phlyakes. New

Comedy, dressing its actors in ordinary clothes, clung to the mask, which still set the actor apart from his fellow Greeks.

Roman.—When republican Rome took over Greek drama, few alterations were made in costume except in the direction of lavishness; these changes were neither as important nor as extensive as the changes in staging. There existed, however, a native drama in republican Rome that was in the style of realistic Greek New Comedy, but with Roman plots; this drama had costume characteristics so distinctive that the name of the garment was given to each type of play. The dramas based on Roman history and its heroes were called *fabulae togatae,* which meant that its characters were Roman citizens entitled to wear the toga; the *fabulae praetextatae* concerned magistrates and senators, whose togas had a purple border, the *praetexta,* as a distinguishing ornament. These honourable persons also wore the high boot (cothurnus), possibly with the sole elevated a few inches. The realistic comedies dealt with characters of all sorts, few of them entitled to the toga. They wore the pallium (an upper garment resembling the Greek himation), and therefore these plays were called *fabulae palliatae.* Actors in the comedies of both Plautus and Terence were costumed in ordinary clothes and used the pallium, not the toga. The actors in these comedies wore—if they did not go barefoot—the low, soft sock shoe (*soccus*) or the *solea,* a sandal for women, slaves, freedmen and foreigners.

Some scholars, notably W. Beare, are convinced that from the time of Plautus (3rd century B.C.) the actors in these original Roman plays wore masks, but this contention is vehemently denied by others, including Margarete Bieber, who holds that only facial paint and wigs proclaimed the actor's character. She concedes, however, that possibly in the 2nd century B.C. masks were used in the plays of Terence. All agree that Quintus Roscius, the accomplished actor of both tragedy and comedy in the time of Cicero, inaugurated the regular use in Rome of masks that, as in the Greek tradition, identified characters as old, young, master, slave, courtesan and so on. In imperial Rome both the mask and the *onkos,* worn in Greek-derived tragedies, were exaggerated to the point of exciting derision. It is from the viewpoint of this latter time that Pollux compiled his oft-quoted list of masks worn, he says, in Greek New Comedy.

Masks continued to be the one indispensable article of theatrical costume throughout the sordid history of the theatre in imperial Rome and Constantinople. The mimes who unfolded their story by means of speech as well as gesture wore the old-style masks with open mouths. Evidence suggests that sometimes facial paint was substituted, which would allow more freedom in expression. Regarding the rest of the costume little is recorded except that it became increasingly spectacular—and probably, like the plays, increasingly indecent. The pantomimists, who danced without words but with agile and expressive body gestures, wore a new kind of mask with closed mouth. About their costumes there can only be conjecture based on audience reaction recorded as approving (of rich fabrics and jewels) or disapproving (of lascivious design).

As to colour in the Roman plays, there would of necessity be the white of ordinary togas with, when called for, the purple of a *praetexta* border. Written testimony as to other colours comes from Pollux and from Aelius Donatus (they do not always agree). Purple is associated with royalty, of course, and also with the military; poor folk are allotted dull red; pimps (frequent characters in the comedies) are distinguished by "variegated colors"; and prostitutes by yellow, signifying greediness. Slaves wear red wigs. White is for old men but also for "a young man" and for "a cheerful person." Those frescoes and mosaics of the 1st century A.D. that represent scenes from plays show costumes in a variety of bright colours that did not, apparently, follow any symbolic conventions.

Alongside the Roman-Byzantine shows continued the *Atellanae,* the farces that had originated in the south of Italy as descendants of the Greek Phlyakes. The players of Atella developed a technique of improvised comedy in which the actors always were identified with certain typed characters in varied situations. Here are the prototypes of certain *commedia dell'arte* characters: Maccus the fool, Pappus the old man and particularly humpbacked, hooked-nosed Manducus, who became Pulcinella and finally Punch, the rascally hero of the puppet show and the jolly reprobate on the cover of the English periodical.

The country improvisers held on, even after the vast metropolitan spectacles had died out under the disapproval of the church and the dwindling Byzantine power. Acrobats, jugglers and tightrope artists scattered through western Europe, bringing their masks, foolscaps and even the shaggy skins inherited from ancient satyrs. They became well known at village fairs and showed up at castles, too. A few became domiciled as household jesters, complete with foolscap and sometimes bells. Such relics of the entertainer's arts preserved traces of theatrical dress. More important theatre costume then came into being along with the Christian drama as once again religion became the root of theatre.

Early Christian Drama.—The central ritual of the early church was the eucharistic feast, a shared commemorative partaking of bread and wine. The ritual, an ordered sequence, was led by the priest, who thus became the protagonist, the leading actor in a sacred drama. Out of reverence, he wore from the beginning his best alba, a long, sleeved, generally white garment commonly worn in Rome during the empire. This is the ancestor of the alb, still a principal church vestment. To it were soon added other dignified Roman garments. Set apart by their use, the Roman vestments were retained after their secular origin had been forgotten (another instance of the persistent archaic element in theatrical costume). Roman civilian dress thus became the costume of the Christian ritual drama. Hence when the first dramatic episode was interpolated in the Easter service, the actors found costumes at hand. The characters were the angel at the sepulchre and the three women who came to anoint the body of their crucified Lord. At a given moment a young man came from the choir and took his place at the tomb. He was already clad in his long white alb, suitable vesture for an angel. Now came the two Marys and the third woman, three more young men from the choir, also in albs. To complete their woman's costume they had only to lift the amice (large neck scarf) and put it over the head to become women. The playlet over, they returned to their places and their own personalities. From this simple beginning religious drama developed into a whole epic of mankind from creation to last judgment, but even after it had moved out of the church, priestly vestments were resorted to on occasion. For instance, the clergy of one cathedral gave permission to the townspeople to use a cope (rich cape) for God the Father, "on condition that the play does not become dissolute."

Medieval Developments.—The medieval theatre, regardless of how faithfully its subject matter was taken from Holy Writ, was by no means only religious. Just as Greece had its satyrs and misshapen clowns, the middle ages had its devils. Some recall the old satyrs with shaggy goat legs, cloven hooves and horns; some developed new drolleries with bat wings and scorpion tails; some were embellished with ornaments on the knees, elbows and bellies as well as grotesque masks on the face. These devils were black, red or blue from head to foot. Herod, who ranked next to Lucifer-Satan as the archvillain, was likewise fitted with grotesqueries, including a great turban-crown and a mask with hooked nose and fanged mouth. Terrifying as these creatures were intended to be, they were also objects of mirth, as were other characters including Noah's wife and sometimes the shepherds. Usually the actors needed only face paint to emphasize natural endowments; but when superhuman majesty was wanted, as for the Transfiguration, craftsmen devised an awe-inspiring mask and gilded it. The European craft guilds and the societies dedicated to producing the sacred dramas, as well as the leaders of the Italian city-states, strove to present their plays as factually and as sumptuously as possible. Surviving records—stage directions, expense accounts and chronicles—testify to expenditures for rich fabrics and gold leaf, and to the ingenuity of designers and craftsmen. No construction problems baffled them. They produced instantaneous transformations, talking beasts and practicable wings for angels as needed. The stage costumes were not only rich but also exotic. The costumer drew upon the past, especially antiquity, and upon the foreign, especially the tales of infide-

Saracen and Turk, constructing rich and strange costumes from these partly understood sources. Throughout the later middle ges the costume parade included tyrants outfitted in papier-nâché heads, with scarlet wigs and beards, and crowns, turbans nd robes that glittered with jewels; demons whose huge grotesque nasks and lashing tails struck fearful pleasure to the hearts of he beholders; angels with shining garments and gilded limbs; nd deity, towering above the restless crowd, immovably benign n a golden mask.

Renaissance to Modern

Renaissance.—In the 15th century, northern Europe was still nedieval, although by then the Renaissance was well launched in taly; by the early 16th century both France and England were ollowing the new ideas, at least in court circles. In the meantime, s morality plays began to supersede the drama based on religious tories, costumes became allegorical for Justice, Peace, Truth and he like. Such abstract figures began to assume an "antique" ppearance as the classical Renaissance took firmer hold, and it vas not long before the slightly classic robes of the Christian irtues were followed by similar robes for Jupiter, Mars and even 'enus.

Except for the rural comedies and the somewhat literary farces layed mostly in the universities, theatre in the 16th century ound its outlet in the expensive show-off spectacles of munici-ality or court. First came the processional shows, called in Eng-nd "progresses," in France *entrées* and in Italy *triomfi*. (The talians wanted to believe that they were reviving the triumphs of ncient Rome, in which a victorious general paraded the streets n a golden chariot, clad in purple and gold, crowned, preceded nd followed by his royal captives in chains, his soldiers and is wagons of loot.) Actually the Italian street show, like *en-rées*, celebrated the entry into a city of some important person nd included that person, his entourage, the city greats and float fter float of allegorical figures. The medieval combats at arms eveloped into shows that had rudimentary plots. These stage onflicts were grim contests in which costume pageantry was fur-ished by distinguishing colours, crests, plumes, shields and other araphernalia of heraldry; they served as the excuse for dressing pposing horsemen in magnificent costumes of Turks, Crusaders, mazons or "wild Scotsmen." Other outdoor spectacles furnished he opportunity for dressing actors in magnificent mythological, ylvan, pastoral and marine costumes. Top-grade artists designed hese costumes as well as the scenic effects; among the designers n France were Rosso Fiorentino and Francesco Primaticcio, Ital-ans who brought Renaissance art to the north. In Italy itself ll the artists were called upon to design costumes, from such lorentines as Giorgio Vasari, Jacopo da Pontormo, Bernardo uontalenti to the great Leonardo da Vinci himself.

Outdoor spectacles made free use of masks, almost a necessity hen men had to impersonate women. At court balls both men nd women wore masks—not for magic or for character identifica-on but for concealment. Presently the spectacle and the fancy-ress ball merged, women joined the performers, ladies and gentle-ien learned to step through figure dances and the court ballet, the *allet de cour*, was born. The Italians believed that in these usical spectacles they were reviving the Greek heroic drama. rom court ballet developed opera, which has seldom lost sight of he original spectacular features, including costume. To be sure, he first opera ballets can most logically be better compared with he musical of modern times, particularly in the matter of highly pectacular costumes. The *Ballet comique de la reine* at the rench court in 1581 is the example most often quoted, probably ecause there are a number of copies of the book, which records the roduction and includes costume pictures by the designer, Jacques atin. These costumes, called "antique" like others of the time, re in reality very much in the current mode, with additions that iggest classical draperies. A nymph will not have abandoned er tight bodice and great puffed sleeves, but she will have added billowing overskirt, gauzy oversleeves and a fanciful headdress om which floats (invariably) a chiffon veil. The male actor-ero, probably cast as a warrior, will be clad in a version of Roman style cuirass (body armour) over a doublet with the fashionable great sleeves, a classical helmet with impressive plumes (the panache) and Roman "labels" over his breeches and long hose. These labels were originally metal-tipped leather tabs that hung from the cuirass to cover the thighs. The Renaissance developed this useful accessory into a greatly exaggerated and ornately mounted skirt and named it the *tonnelet*.

While amateurs at European courts strutted and sang through ballet operas in costumes created at a cost beyond the reach of even a 20th-century Broadway musical, bands of professional actors in tradition-perfected costumes were making their way from Italy to other European cities and courts. The *commedia dell'arte*, grown in skill and sophistication far beyond the rustic improvisations of the *Atellanae*, clothed their well-defined characters in the distinguishing garments that they were to retain through succeeding centuries, subject only to the dictates of changing taste. These are ideal theatrical costumes: they identify the characters, allow complete freedom for acrobatic dancing, exaggerate tellingly and delight the eye with bright colours and amusing patterns. Most *commedia* actors (except the lovers) wore half masks that emphasized the character.

There is little direct evidence that shows how the characters in the great plays written by Shakespeare and his fellow playwrights were dressed. Students of the theatre conclude that costumes at the Globe, for instance, were as handsome as the cash-box allowed; that they were often in the contemporary mode; that period such as Roman was indicated by classical and exotic details —togas, turbans, oriental-looking robes; and that when it came to fairies and such imaginary creatures, the wardrobe supervisor did his best to imitate the sort of "antique" creations that were being designed by Inigo Jones for Ben Jonson's masques at court. Jones had received his art education in Italy. His costume designs have a close affinity to those of Vasari. Fortunately, many designs by both Jones and Vasari are preserved along with written descriptions, so that costume plates for specific productions can be assigned to specific artists. These men of the late 16th and early 17th centuries had artistic stature. Their designs reflect the last stages of Renaissance classicism and form a transition to costumes of the baroque theatre.

Baroque.—The 17th century was a period of theatricality. Architects of palaces, chateaux and churches joined with sculptors and ornamentalists in producing effects boldly emotional, with sharp contrasts of light and shadow, the whole enriched by a profusion of C-curves, vines, flowers and human forms. The time was propitious for truly theatrical design, and the men for it were at hand. All the skills of stagecraft, including that of costuming, reached a high peak in the 17th century. From Italy came the Bibiena family, with their marvelous scenic illusions, and Giacomo Torelli, whose stage effects caused astonished Parisians to accuse him of practising black magic. Amid all this grandeur and complementing the painted backgrounds moved stately figures in rich, stiff fabrics hung with gold tassels and fringe and encrusted with gold and jeweled ornaments. Jacques Callot recorded these costumes as well as those of the *commedia*, whose types were thus set for later generations.

Heroic tragedy had its own costume conventions; these were established with the performances first of Corneille's classic dramas and then those of Racine. Actresses modified the current fashions with external touches of antiquity and enhanced their impressiveness with towering plumes. The tragic hero in his cuirasslike doublet still recalled the Roman warrior, but his headpiece was more frequently a plume-laden hat worn over a periwig than it was a helmet, and his *tonnelet* had widened into a heavily ornamented petticoat.

Molière devised brilliant shows for performance at the new royal residence of Versailles, his witty texts combining perfectly with the music of Jean Baptiste Lully and the décor of Jean Bérain. Courtiers acted in these shows along with professionals, and occasionally the king himself, Louis XIV, danced a ballet, dressed in a costume designed by Bérain. A great many of Bérain's designs have been preserved; all of them are supremely theatrical, supremely baroque. Inspired by visions of the past and

of foreign lands, he designed costumes to be danced in, with swaying skirts, floating veils, flying ribbons, dangling tassels; costumes to spring in, with snug breeches, close caps and free-moving sleeves. He designed fairies and antique goddesses and savage chiefs of the Americas. Yet even his most fantastic designs are chic with the particular ornamental stiffness of fashion plates by Pierre Bonnard, his contemporary.

The actors in Molière's comedies, such as *Tartufe*, played in contemporary dress, as did those in the English Restoration comedies. Drama had not yet retreated behind a proscenium arch; the actors playing on the apron were visible from three sides and were close to the audience, so that their clothes had to stand scrutiny. It was worthwhile to embroider intricate designs. The motifs, if bold, were no bolder than current taste allowed in the gowns of their cosmopolitan audiences.

Rococo.—Early in the 18th century, Louis XV, in his turn, danced his ballet for the admiration of his subjects. His costumes and those of the ensemble were designed by the court decorative painters, such as François Boucher, Nicolas Lancret, Jean Marc Nattier and Louis Boquet—the last-named less important as a painter but a most delightful designer of costumes. Antoine Watteau, rather than designing *for* the theatre, painted the actors *of* the theatre—both the Italian troupe and the French comedians. He also painted imaginary actors dressed in costumes fancifully nostalgic and shown in amorous scenes, courtly or pastoral.

In theatre designs of the 18th century the pastoral influence often intrudes. In other eras countryfolk had been represented realistically on the stage as often as poetically, but in the rococo period they were all pretty, very very clean, clad in delicate silks, garlanded with flowers and carrying beribboned crooks. Two other influences on stage costume and interior decoration were the familiar antique and the Chinese, the latter enthusiastically discovered in the late 17th century and adopted into the essence of rococo. As for the antique, its real influence upon stage costume awaited the French Revolution.

Operatic costumes followed the mode into lighter fabrics and more delicate motifs, except that the *tonnelet* became larger and more ornate. A leading tenor depicted on the stage with his singing partner had his *tonnelet* looped and draped in silken swags as wide as her panniers, but knee-length instead of to the instep like hers. His wig is the fashionable close-curled tiewig; his hat a flourishing tricorne, plumed.

Ballet dress as a special, functional stage costume was introduced early in the 18th century when the solo feminine dancer, who now performed light and intricate steps, had need of a shorter, lighter dress. Marie Camargo, as pictured by Lancret, wears skirts well above the ankle; here was the introduction of the distinctive ballerina costume that would be perfected in the 19th century.

Empire.—The French Revolution, with its wholesale imitation of the styles of republican Rome, exerted an influence on stage costume that was as profound as its influence upon women's dress. By the end of the 18th century actresses, along with the ladies in the audience, had discarded their impressive but cumbersome trappings such as panniers and high wigs and were playing neoclassic roles in neoclassic robes. Jacques Louis David, a painter deeply imbued with admiration for the classic, having managed to hold on from monarchy to directory to empire, set out to reform the male actor's attire, which had never relinquished the traditional *tonnelet* and other trappings. He persuaded the great actor François Talma to appear in one of his classical roles in a Roman-style *tunica* minus *tonnelet* and stockings. Now the men of the new era, who had not followed their womenfolk in adopting Roman dress, were coated, high-collared and pantalooned to the ankle. Consequently neither men nor women in the audience took kindly to bare shanks on the stage. Throughout the rest of the 19th century and even into the 20th Romans in reasonably authentic tunics and togas continued to step out in snug tights, not always flesh-coloured.

19th Century.—The antique as a fashion did not last long in the 19th century; in the succeeding romantic period stage costumes followed the current mode: drop-shouldered décolletage, snug bodice, bell skirt. The early part of the century also brought something new to the costuming of any period play—a conscientious obligation to revive the dress of the period portrayed. In England the pioneer in this attempt at historical integrity was James Robinson Planché. Although the libretti he wrote and staged for Mme Vestris, the dancer, were feeble imitations of rococo, he established his place in theatre history by writing one of the first and most reliable histories of costume and, even more, by dressing King John for Charles Kemble in 10th-century garb based on manuscript pictures and sculpture contemporary with that chronicle play. That was a milestone in theatre history truly exciting in its own time. The 19th century witnessed a growing interest in archaeology of all kinds. Out of it came, for one thing, the publication in England, France and Germany of other scholarly histories that still form the basis of a costume designer's library.

But time has proved that historicity is not enough to ensure the success of a theatre costume, mainly because the time element always stands between the present and the past. No costume designer, costume maker or actor can escape it. For instance, from the earliest years of Victoria's reign to the death of Edward VII the fashionable female figure of the entire urban world was amply boned, padded and petticoated; the male counterpart was encased just as completely if not so tightly constricted. The result for all branches of the theatre except ballet was that bodies were corseted in the Victorian mode as a foundation for such varied period costumes as those of Calpurnia in *Julius Caesar*, Norma in the druidical opera, Francesca da Rimini in the popular play by Bokar and Beatrice in *Much Ado About Nothing*. No amount of authentic ornamentation or accessories could transform the wearer into a figure from the past. No wonder later generations found the accurate reproductions from Victoria's reign stuffy, overelaborate, unimaginative, boring. Later, in the 20th century, when modern art had changed even philistine ideals of beauty, the once-admired archaeological approach to costuming the classics was thrown out along with the old-fashioned corsets. Even such epoch-making costumes as those designed for the spectacular Wagnerian operas seemed in retrospect far less pre-Romanesque than mid-19th century German. Nevertheless, some costume rental establishments continued for years to stock and send out to amateur groups those sturdily constructed relics of the past that can best be labeled costumer period.

Meanwhile professionals in the lighter forms of entertainment dressed as always in costumes that met the time-tested essentials of theatre: construction that permits free movement, eye appeal through exaggerated motifs, striking colours, sequins, plumes, trains and display of as much of the feminine figure as is countenanced by the local mores; and somehow through it all large concession to the contemporary mode. The improvised comedy, which had dwindled to insignificance as a dramatic form, bequeathed to the popular theatre certain characters and their costumes. Pierrot, once an unimportant member of the *commedia* troupe as a stupid, hayseed type, was transformed by the French pantomimist Jean Gaspard Deburau into the pathetic lover, white-faced, black-capped, in droopy white garments, eternally mooning over Columbine. She herself developed from a second-class soubrette to a leading dancer in the short, fluffy skirt of ballet. Harlequin, always clever, became the leading figure of English light entertainment. Many versatile actors were famous for their dancing Harlequins. Under a variety of names and embellishments he was always fundamentally a lithe, sleek figure in diamond-patterned tights and a neat black half mask. He brought along the bat that he had inherited from the forgotten *Atellanae*, the same bat that medieval devils had flourished in the old guild plays. Other descendants of ancient buffoonery are the whole tribe of clowns familiar in the English pantomime, the circus and vaudeville. However varied the clown costume, from comic elf to hobo, the constant feature is grotesque make-up. A mask of paint, rather than the inflexible mask of the ancients, often recalls the old comic masks with their great noses, huge eye sockets and enormous, wide-lipped mouths. A unique American contribution to the ancient line of clown masks is the burnt-cork minstrel show face, a stylized exaggeration of African Negro features.

Most important in the 19th-century theatre was the evolution of the classical ballet, which developed a costume of its own that was both functional and aesthetically satisfying. When the dancer went up on *pointes* (the toes), she seemed to scorn the ground, each of her technical tours de force contributing to that illusion. Her costume always enhanced this denial of gravity, from the calf-length tarlatans of Carlotta Grisi in 1804 to the thigh-short tutu of Anna Pavlova. Perfectly adapted to its function, the tutu with its accompanying sleek bodice epitomizes the flight from reality to the dream world existence of classical ballet. Under its spell the 19th-century moderns painted the art of ballet, for Renoir, Seurat and the rest were not so much interested in designing ballet costumes as in painting girls in them. (To be sure, Pablo Picasso was still a modern in the 20th century; at that time he did make costume designs for a number of ballet-operas, and so did his younger contemporaries.)

Famous throughout Europe from about 1875 to 1890 were the productions of the repertory company organized by George II, the duke of Saxe-Meiningen. He designed costumes for his own productions that set a new standard of meticulous authenticity and excellent craftsmanship. Fastidious good taste was equally the mark of Sir Squire Bancroft's London company that played popular drawing-room comedies in smart contemporary dress. Everywhere the standard of theatrical production went up. The conservative leading artists of the late 19th century in England included among their activities the designing of both scenery and costumes. They brought to the task erudition and the techniques of painting, though not always theatrical sense. Impressive certainly were the costumes designed and constructed for the spectacular productions of such actor-producers as Sir Henry Irving and Sir Herbert Beerbohm Tree.

Modern.—As the 19th century approached its close and all visual arts stirred in rebellion against the long-established post-Renaissance representational ideal, the theatre began to be bored with established production methods. As always at the beginning of any revolutionary movement the ordinary theatregoer was slow to notice the new trends, but even before World War I enthusiasm had begun to spread from a few young students of the theatre to a wider public. Perhaps the biggest jolt to conventional minds was the Russian ballet with its costumes (and of course décor) designed by Leon Bakst. In contrast to the older designers and their polite but tired palettes, he threw upon the stage explosive and barbaric colours, piling colour upon colour, motif upon motif in oriental profusion. His drawings leaped from the paper just as the dancers whom he dressed leaped about the stage. Starting with folk costume or historic dress he exaggerated, intensified and distorted to express the meaning of the dance dramas. Even timid young theatre workers caught fire from him and dared to combine orange and watermelon pink.

Other influences tended to counterbalance the Russian frenzy. Edward Gordon Craig revealed the virtues of lofty and uncluttered surfaces, long grave lines and heavy fabrics; Adolphe Appia showed the way to creative lighting, and from him and his followers costume designers learned how to cope with light and take advantage of it. Max Reinhardt in Germany and the U.S. revived the splendours of the middle ages and the Renaissance. In his vast productions of *Jedermann* (*Everyman*) and *The Miracle* he drew upon modern techniques, the exaggerations of the Russians and the vast scale of Craig to recreate religious drama in terms acceptable to modern taste. In one version of *A Midsummer Night's Dream* he revived the baroque splendors of Vasari and Jones.

The new theatre artists were competent to create costumes of vastly different sorts to meet the demands of widely different plays. A designer might create in the baroque spirit for one play or in purest classical simplicity for the next, in each case dictated so only by his sensitivity to the needs of the play, his knowledge of art history and his feeling for design. Theatre, which had been in the 18th century the actor's province and in the 19th a ground shared by actor and playwright, bade fair in the early 20th to become chiefly a field of artistic expression for the designers of scenery and costumes.

After World War I, new developments in art were inevitably reflected in the theatre, primarily in a sophistication of colour and an extremely acute selectivity of line and mass. After achieving fame in other pictorial media artists might try their hand at stage décor and costuming. That boldest experimenter in new art forms, Picasso, created for *The Three-Cornered Hat* a set of costume designs as practical as they were stunning. Various artists well trained in the ateliers of Europe and New York adjusted their skills to the demands of the stage, as had their remote predecessors in the Renaissance. In general, costume designers succeeded in proportion to their experience in total theatre.

If any one artistic viewpoint proved more congenial than others in the first half of the 20th century, it was the baroque, as expressed in costume designs for romantic plays from or portraying the rococo 18th century, all periods of the 19th and the early 20th; all these designs, called respectively empire, early Victorian and Edwardian, were nostalgic stylizations of decorative elements that were admired in the world of yesterday. Such neobaroque designing found its richest opportunity in the newer music theatre, which was developing the haphazard song-and-dance musical comedy into a well-plotted drama with integrated music and dance.

One theatre might house a sumptuous musical; the next, an experiment with classics in modern dress—an economical style of costuming that proved there is emotional significance in anything worn on the stage. Perhaps it was via modern-dress Shakespeare that the earlier revolt against a strictly archaeological approach to period plays reached the popular theatre of Europe and New York. If modern dress succeeded, then why not any period deemed suitable, or a mixture of periods? Eventually audiences saw characters in *Measure for Measure* dressed like those in *Lady Windermere's Fan* and actors in *The Taming of the Shrew* wearing the ten-gallon hats and leather chaps of pioneering Texas. As a rule the ephemeral appeal of novelty was backed by the solid worth of good design, for costumers after mid-century generally were well-trained, creative and knowledgeable.

EASTERN COSTUMES

Throughout the thousands of years during which occidental theatrical costumes developed, fell into disuse and were revived in other forms, the costumes of the eastern theatre showed very little change. Drama itself was a more conservative art in the east, leaning to formalism in acting and staging and therefore in costuming. To western eyes the eastern costume never seems realistic, not even in the popular dramas with domestic plots. It is always primarily theatrical.

China.—In China the theatre is of extremely ancient origin and as elsewhere has its roots in religious ritual. It has been a popular art for centuries, and the conventions of its staging, acting and costumes have been well understood by the average playgoer. Headdresses, for instance, indicate clearly not only social caste but even the character's place in the plot. Thus costumes besides being ornate, are also functional and highly important in communicating the story to the audience. In some plays and for some characters masks are worn; *e.g.*, to portray the supernatural or some part that requires extra emphasis. Generally, however, character make-up is achieved by using symbolic colours and lines, with the addition of appropriate wigs and beards. Female impersonators in the all male cast rely entirely on exquisite make-up and a body trained in the quintessence of feminine grace essential to wearing their lady robes.

Japan.—In Japan masked temple dancers preceded the nō drama, which itself was so intensely aristocratic that it was performed only under imperial auspices. Nō costumes, derived from ancient ritual and court ceremonial dress of the era corresponding to the western 14th and 15th centuries, are constructed of the most sumptuous materials and in their gravely beautiful lines perfectly express the ritual quality of these highly symbolic poetic dramas. Nō masks are among the most skilfully made and possibly are the most beautiful in the world. The popular theatre is the Kabuki, derived from the esoteric ritual drama but far removed from it in spirit and prestige. The Kabuki's costumes are handsome and as remote from the ordinary dress of the audience as its gesturing is

from everyday movement. The Kabuki actor dresses carefully in layers of traditional garments and transforms his natural appearance with wonderfully constructed wigs and with stylized make-up in conventionalized symbols of line and colour. Japanese acting traditions have broken down to some extent under the impact of western theatre and especially western motion pictures. Nevertheless much of tradition remains in the pantomimic dance dramas.

Java.—Javanese theatre has preserved its ritual character and the costumes that express so well the symbolic movements of its highly trained dancer actors. This form is said to have derived from the shadow plays that used not men but marionettes in the form of cutouts; it has preserved in its costumes something of the rigidity and strange beauty of these prototypes. Masks play an important part.

Burma.—In Burma with its ancient Hindu culture the costumes are sumptuous and reflect almost literally the dress represented on ancient temple sculpture. They are cleverly constructed for their functions in the dance drama.

The theatre costume of the east is primarily theatrical. It may be distinguished by those elements that set theatre costumes apart from ordinary clothes in all parts of the world; these elements include: exaggerations or distortions of the familiar; holdovers from the past that take on symbolic meaning as they become obsolete and exotics deliberately introduced from distant lands or legendary epochs.

MODERN DESIGN AND CONSTRUCTION

An Integral Part of the Play.—Throughout the long history of theatre costuming, designs have been adopted for a variety of reasons: their wearability, their usefulness as identification, their dignity, their symbolic meaning, their magic potency, their flattery of the wearer's ego, their advertisement of the producer's wealth and importance. Modern designers of theatre costumes still have to take into account all these factors—even magic—but the approach is somewhat different. It is now expected of the costume designer as of the scenic artist that he will fully understand the aim of the production as a whole, the meaning of the play and the nature of the characters he is to dress. For this reason he must subordinate his own creative artistry to the demands of the play as it is to be presented. He is only one partner in a cooperative enterprise of author, director, designers and actors.

To express the dramatic idea clearly in terms of costume requires constant vigilance to include only essentials; in other words, the designer must eliminate whatever does not serve to identify a character or interpret him. The designer thinks in terms not of single costumes but of the whole stageful. He subordinates minor characters in order that he may focus attention on the protagonists. With his costumes he helps to compose a scene, balancing colour with colour, line with line, texture with texture. Above all, mindful not only of the characterizations that his costumes are to help but also of what their wearers are called upon to do physically, he designs clothes that can be worn without discomfort or without hampering the actor. On this score, costumes for the dance are the greatest challenge to the designer, who must constantly curb the exuberance of his imagination to leave the dancer free. A dance costume design must satisfy the choreographer, who knows what the performer has to do in it. The dancer's body is his major tool of expression and creates its own design. Too easily is this design obscured by irrelevancies in drapery or ornament. On the other hand, it may be accentuated by colour, flat decoration and texture. The fabric itself, clinging, floating or trailing, contributes materially to the rhythm of the dance. The successful designer of dance costumes has learned the value of simplification. He will not disregard the lesson when he thinks in terms of drama, opera or musical.

The designer for the modern stage must take into account not only the scenery against which his costumes will appear but also the lights under which they will be seen. His knowledge of fabrics must therefore include an acquaintance with the effect of coloured lights on coloured textiles. Because he is aware of the transformations that take place on the lighted stage, he chooses his palette in close co-operation with the scenic artist. This done, a busy designer for the commercial theatre may call upon assistants to sample-shop for him; many prefer to shop for themselves. His costume plates will be accompanied by swatches of the materials selected, including trimmings. He may add enlarged-to-scale drawings of the ornamentation.

How Costumes Are Made.—After costumes are designed, the workshop takes over. The commercial theatre is served by costume makers whose shops employ specialists in every branch of construction. The shop is headed by a costumier upon whose understanding and experience depends the successful realization of the artist's design. (In theatres in colleges and civic organizations in many parts of the world the artist himself supervises the execution of his designs.) Costume making calls for many skills besides dressmaking and tailoring—dyeing, for instance. Although the larger yardages may be handed over to a professional dyer, there will be times when a craftsman must work with dye for special effects, such as shading from one value to another, tie-dyeing and ornamenting with stencil, batik or freehand brushwork. There must be wigs—not only hair wigs that require great skill and much time to construct but also others, often not realistic and made from such materials as rayon, horsehair, nylon, raveled rope, string and felt. There must be millinery of all imaginable sorts. There must be footwear, from sandals to boots. Skilled shoemakers specialize in theatrical footwear, but again sometimes even boots are made in the workshop. Armour is not considered beyond the scope of the workshop, for armour appropriate and theatrically truthful can be made from a variety of materials: papier mâché, leather, felt, all of these metallized and possibly augmented with real metal; brass, steel, copper or aluminum in the form of scales, rings, disks or thin strips. Jewelry of every variety is produced from the same sort of materials as well as from balsa wood and cork.

Costumes are often made from fabrics not generally used by dressmakers or tailors, since for theatre costumes the right material may be located in unorthodox places: in the upholstery department, the houseware section, even the hardware store. Costumes have been made successfully from canvas, Osnaburg, felt, leatherette, carpeting, sheet rubber and all the synthetics including plastics. To the imaginative costumier the material that will look right on the actor on stage is the proper material, however unorthodox such a use may seem. Of course the modern costumier has at his command the natural fabrics that his predecessors used —cotton, wool, silk; often he still finds one of them the ideal material. But he also has at his disposal the range of man-made fabrics and stiffeners. Particularly valuable are the nylon nets, especially for use as ruffs and standing collars and tutus.

The construction of a costume starts with the underpinning. Padding of all kinds, corsets and such supports as farthingales, panniers and hoop skirts should be acquired or constructed with extreme care, for on them depends the basic integrity of the exterior. Over such foundations and adequate petticoats a muslin lining is tried on the actor; alterations are made in it to ensure becomingness as well as fit. At this point the cutter and draper take over; upon their sensitivity to the grain of the material depends the ultimate success of the costume. Next it goes to seamstresses, whose sewing must be accurate and above all dependable, because on stage a ripped seam or loose fastening may mean catastrophe. Thus all these craftsmen become inevitably co-creators with the costume designer, who should never forget that his design is not the handsome picture he submitted to the director but the finished garment on the actor upon the stage before an audience.

See also STAGE DESIGN; BALLET; MASK; COMMEDIA DELL'ARTE.

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sance Stage (1938); Virginia More Roediger, *Ceremonial Costumes of the Pueblo Indians* (1941); Lilian Wilson, *The Clothing of the Ancient Romans* (1938). (Lu. B.)

COSWAY, RICHARD (*c.* 1742–1821), English miniaturist, was born in Devon and baptized in Nov. 1742. Before he was 12 he was sent to London and apprenticed to Thomas Hudson, under whom he learned oil painting. He exhibited at the Royal Academy from 1770 to 1806 and was elected associate in 1770 and full academician in 1771, the rapidity of these elections being the more surprising in that he was principally a portrait miniaturist, then not a very highly regarded art. He used transparent water colours on ivory, allowing the tone of the ivory to shine through, a practice quite different from the solid painting of the 16th- and 17th-century masters.

Vain, superstitious and foppish, he was fortunate in securing the patronage of the prince of Wales, although the rumours connected with the parties held in his house were not to his credit. In 1781 he married Maria Hadfield (*c.* 1760–1838), who was also a miniaturist and painter in oils. He died at Edgware, Middlesex, on July 21, 1821.

Cosway's miniatures are well represented in London (Victoria and Albert museum, Wallace collection), in the royal collection and at Cambridge. *See* Miniature Painting.

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COTABATO, a province of Mindanao Island, Republic of the Philippines. Area 8,868 sq.mi. Pop. (1960) 1,152,474. It has upland margins, and the Liguasan marsh and Lake Buluan are in the central lowland. The area is drained by the Rio Grande de Mindanao. Buluan, near the lake, and Koronadal, near the south coast, are new centres of settlement. Formerly inhabited by Muslim Moros, the province is being settled by Catholic Visayans. The capital is Cotabato (pop. [1960] 37,320), at the mouth of the Rio Grande. It is an important commercial centre and an interisland port shipping rice, maize, abacá and ramie. (J. E. Sr.)

COTARELO Y MORI, EMILIO (1857–1936), Spanish literary scholar, who became secretary of the Academia Española and conducted much of his research on its behalf, was born at Vega de Ribadeo, Asturias, Spain, on May 1, 1857, and died at Madrid on Jan. 27, 1936. His investigations were varied, his method more scientific than that of the better-known Menéndez y Pelayo; his documentary results were monumental. Notable are his researches on dramatic history: on the 18th-century stage and histrionic art; on the prolific dramatist Ramón de la Cruz; on the problematic Tirso de Molina; and on the origins of opera. The most famous of his publications is *Iriarte y su época* (1897), a detailed survey of 18th-century literary society. (I. L. McC.)

CÔTE-D'OR, a *département* of east central France, formed in 1790 from the northern part of Burgundy (*q.v.*) and bounded north by Aube, northeast by Haute-Marne, east by Haute-Saône and Jura, south by Saône-et-Loire and west by Nièvre and Yonne. Pop. (1954) 356,839. Area 8,788 sq.km. (3,393 sq.mi.).

The limestone plateau of Langres crosses the *département* from northeast to southwest and forms the watershed between drainage to the Seine and that to the Saône. Southwest of Dijon its southeast-facing escarpment is the Côte-d'Or, the crest of which exceeds 2,000 ft. The Langres plateau slopes northwest, as the rocks dip toward the centre of the Paris basin, and in the extreme north of the *département* a groove of well-farmed clay country, known as La Vallée in contradistinction to La Montagne of the Langres plateau, runs northeast-southwest in front of a broken, wooded escarpment of Corallian limestone. The high, exposed Langres plateau, with only thin soils on its porous, stony surface, is extensively wooded and thinly settled. Spurs from the granitic highland of the Morvan extend into the west of the *département*. Between these hills and the backslope of the Côte-d'Or, in the upper basin of the Armançon, the undulating Lias clay country of Auxois provides rich cattle-fattening pastures. The lower alluvial terraces of the Saône plain are richly cultivated, wheat and maize being especially important, but there are also sandy tracts that carry extensive forests, such as that of Cîteaux. Along the foot and lower slopes of the Côte-d'Or is the great wine-producing district of Burgundy, its vineyards comprising the two main groups of Beaune and Nuits. Farther northeast, the continuation of the escarpment in the Dijon district is another important area, though orchards have encroached here upon former vineyards.

The main line of the Sud-Est region railway (formerly the Paris-Lyon-Méditerranée) traverses the *département* on its way from Paris to Dijon and the south, and important trunk roads also converge upon Dijon. The Burgundy canal, connecting the Saône with the Armançon headstream of the Seine, also passes through Dijon, and the Marne-Saône canal crosses the extreme east of the *département*. Dijon (*q.v.*) is the capital of the *département*, the seat of a bishopric, an *académie* (educational division) and a court of appeal. It is a great commercial as well as an administrative and cultural centre and has a variety of important industries, including food preparation and engineering. Little medieval building remains at the famous Cistercian abbey of Cîteaux, home of St. Bernard, but Fontenay is the best preserved of the great Cistercian houses. Montbard has the remains of a castle of the dukes of Burgundy that was later the home of the 18th-century naturalist Buffon. (Ar. E. S.)

CÔTES-DU-NORD, a maritime *département* of northwestern France formed in 1790 from the northern part of the old province of Brittany (*q.v.*), is bounded north by the English channel, west by the *département* of Finistère, south by that of Morbihan and east by that of Ille-et-Vilaine. Pop. (1954) 503,178. Area 7,218 sq.km. (2,787 sq.mi.).

Côtes-du-Nord consists of much denuded folds of ancient sedimentary rocks, with extensive intrusions of granite masses. Inland the Landes du Méné, the highest parts of which exceed 1,000 ft., form the watershed between the southward drainage to the Bay of Biscay and the Rance, Arguenon, Gouessan, Gouet and Tréguier rivers, which with other small streams flow north toward the Channel in winding, steep-sided valleys that cut transversely across the grain of the country. The coast is extremely rocky and indented, with discontinuous patches of more level land between the promontories. Market gardening is extensively practised there on smallholdings, advantage being taken of the special mildness of the coastal climate, the availability of seaweed fertilizer and the accessibility of the British market. Onions are an especially important crop around Saint-Brieuc. The interior, humid and windswept and with poor acid soils, is used chiefly for pasture. Some of the formerly extensive tracts of heath remain, though much reduced by modern enclosure. Rye, oats and buckwheat, formerly the chief crops, have tended to make way for pasture as farming has become increasingly specialized upon livestock. Cattle and pigs are important, but there are comparatively few sheep.

Longshore fishing, especially for mackerel, is an important activity of the numerous small ports, and trawlers from Paimpol operate in Icelandic and Newfoundland waters. The picturesque coastal scenery, sheltered coves and quaint fishing villages attract increasing numbers of visitors, and the tourist industry is thriving. In the east of the *département* the Côte d'Emeraude around Dinard (*q.v.*) is especially popular, and the rugged granite coast of Trégorrois in the west also deserves mention. Like other parts of Brittany, Côtes-du-Nord is rich in prehistoric remains and there are many interesting churches. The cathedral at Tréguier and the ruins of the 15th-century castle of Tonquédec, 7 km. (4 mi.) S.E. of Lannion, are noteworthy buildings.

Côtes-du-Nord is divided into the *arrondissements* of Saint-Brieuc, Dinan, Guingamp and Lannion. Saint-Brieuc, the capital, is also the seat of a bishop. The *département* comes under the archbishopric, court of appeal and *académie* (educational division) of Rennes (*q.v.*). (Ar. E. S.)

COTMAN, JOHN SELL (1782–1842), English watercolourist and etcher, and the greatest member of the Norwich school, was born in Norwich on May 16, 1782, and was sent to London to study about 1798. Through Thomas Monro he met both J. M. W. Turner and Thomas Girtin. From 1800 to 1806 he exhibited water colours at the Royal Academy, and some of his

works of this period, with their grand simplicity and geometrical composition, are now reckoned as among the finest English landscape paintings. In 1807 Cotman left London and returned to Norwich, where he worked as a drawing master and exhibited regularly with the Norwich Society of Artists, of which he was a leading member. In 1812 he moved to Yarmouth and began a long period of work as an archaeological draftsman in collaboration with the antiquary Dawson Turner. He visited Normandy in 1817, 1818 and 1820. In 1823 he returned to Norwich and in 1834 to London, where he died on July 28, 1842. In his last years his style changed completely and he started using rice paste mixed with his water colours to get a richer and more impasted effect, like oil painting. His sons, Miles Edmund (1810–58) and Joseph John (1814–78), were also painters. Cotman is well represented in the Victoria and Albert and British museums, London, and in Norwich.

See S. D. Kitson, *The Life of John Sell Cotman* (1937); V. G. R. Rienaecker, *John Sell Cotman* (1953). (P. J. My.)

COTONEASTER, a genus of the rose family (Rosaceae; *q.v.*), containing about 50 species, mostly evergreen or deciduous shrubs, from temperate regions of Europe and Asia. The abundant small flowers are white. Each has five petals. The berrylike fruits are red or black and resemble diminutive apples—evidence of close kinship to the latter. About 40 species and many hybrids are grown for ornament in temperate and subtropical gardens of the world. The kinds vary in form from low dense prostrate shrubs to small, diffusely branching trees. (G. H. M. L.)

COTONOU, the chief port and economic centre of the Republic of Dahomey in west Africa, lies on the coast of the Gulf of Guinea about 65 mi. W. of Lagos, Nigeria. Pop. (1955 est.) 28,064. It is built on a narrow sandy spit which lies between the open sea and the navigable lagoon of Lake Nokoué, the older part of the town being on the western side of the lagoon entrance. The port and commercial area give place farther west to an administrative quarter and then to a residential area of villas set in gardens fronting the sea. Inland is a poorer built-up area.

Metre-gauge railways and motor roads connect Cotonou with the hinterland, and from its airport (20 mi. inland) there are regular services to Paris, Marseilles and the chief towns of west Africa. Construction of a new deepwater port began in 1959. Cotonou is the headquarters in Dahomey of a number of business and banking firms and in the late 1950s its port handled about 250,000 tons of cargo annually. The place was ceded to the French in 1868 and occupied by them ten years later, but its development dates from the period 1936–40 and continued after World War II. (J. D.)

COTOPAXI, a province (formerly called León) in highland Ecuador, bounded west by Los Ríos, north by Pichincha, east by El Oriente and south by Tungurahua and Bolívar. Pop. (1960 est.) 213,600. Area 1,781 sq.mi. On its northeast border is the active volcano of the same name. The chief concentration of people is in the basin of Latacunga, drained by the Río Patate, a headwater of the Pastaza. The capital is Latacunga. The crops include wheat, barley, potatoes, maize, vegetables and fibre plants. Much land is used to pasture dairy cattle, and the higher mountain grasslands are used for sheep. The province is served by the railroad that connects Guayaquil with Quito, and by the Pan-American highway, both of which pass through Latacunga. (P. E. J.)

COTOPAXI, a mountain in the Andes of Ecuador in South America, probably the world's highest active volcano. It is located 30 mi. S. of Quito, at latitude 0° 40′ S., and longitude 78° 26′ W. It rises to a height 19,498 ft. above sea level. Cotopaxi looms above the Eastern Cordillera of the Andes on which it stands, with an almost perfectly symmetrical cone, interrupted only by one minor cone—the *Cabeza del Inca,* or Inca's Head. It has a long record of violent eruption and the country about its base has many times been devastated by earthquakes or buried in pumice and ash blown out of the crater. The mountain itself is built up of alternating flows of dark-coloured trachytic lava and falls of lighter-coloured ash. Porous ash from this and other Ecuadorean volcanoes covers the basins between the Andean ranges to great depths. The crater at the top is 2,300 ft. in diameter from north to south, and 1,650 ft. from east to west. Its depth is 1,200 ft.

Much of the time the beautifully symmetrical cone of Cotopaxi is hidden by clouds that are lighted up at night by the fires in the crater. The base of the volcano stands on open paramos, or mountain grassland; but the whole upper part of the mountain is covered with permanent snow. The snow line on the drier western side is about 15,500 ft. above sea level, but on the wetter eastern side it is about 1,000 ft. lower. Sometimes the mountain is crowned by a huge cumulus cloud in which the mountaintop is hidden; at other times the base of the volcano is hidden by a cloud sheet and the top stands majestically against the dark blue of the sky. The prevailing wind at the summit is from the northwest, causing the plume of volcanic smoke to drift toward the southeast.

The first European to attempt an ascent of Cotopaxi was Alexander von Humboldt in 1802. He failed to reach the top and pronounced the mountain unclimbable. Other failures in 1831 and 1858 seemed to confirm this verdict. But in 1872 Wilhelm Reiss succeeded in reaching the top on Nov. 28, and in May of the following year A. Stübel was also successful. Other famous ascents were made by T. Wolf in 1877, M. von Thielmann in 1878, and Edward Whymper in 1880. (P. E. J.)

COTSWOLDS, a range of hills in the western midlands of England. The greater part lies in Gloucestershire, but they also extend into Somersetshire, Wiltshire, Oxfordshire, Worcestershire and Warwickshire. The range forms part of the Jurassic escarpments which cross the country from Dorset to north Yorkshire. The northwestern scarp face rises abruptly from the clayey Triassic and Liassic beds flooring the valleys of the lower Severn and the Warwickshire Avon and slopes gradually down to the east. The limestones forming the steeper slopes are mainly of Great Oolite age near Bath, but of Inferior Oolite age behind Cheltenham. The rock is generally of a rich cream colour, in places long quarried as a building stone because it hardens and mellows with exposure. The range extends for 60 mi. from the Bristol Avon to the Cherwell, widening from about 6 mi. in the south to nearly 30 in the north. Heights average from 600 to 700 ft., reaching a maximum at 1,083 ft. in Cleeve Cloud which overlooks Cheltenham. The Thames-Severn watershed is near the western edge except where the Frome tributary of the Severn cuts deep into the hills near Stroud. The region is noted for its picturesque countryside. From the 10th to the 18th century the Cotswolds were famous as open sheep pastures and gave their name to a large long-wooled breed (*see* SHEEP). The wealth obtained from sales of wool is evident in the buildings of its many villages and small towns, such as Burford, Chipping Campden, Cirencester, Malmesbury and Northleach, and especially in their fine churches. The enclosure of the sheepwalks led to a gradual change to mixed farming; the fields are often divided by dry-stone walls. Some minor cloth manufactures are still carried on; *e.g.,* at Witney and Stroud. In the Cotswolds are many prehistoric long barrows. (T. HER.)

COTTA, the name of a family of German publishers, the most notable of whom is celebrated for his connection with Goethe and other writers of the period.

JOHANN GEORG COTTA (1631–92) was the founder of the publishing house. He settled in Württemberg and in 1659 acquired by marriage the bookseller's business of Philipp Brunn at Tübingen thereby establishing the J. G. Cotta'sche Buchhandlung. On his death the firm passed to his son Johann Georg (2) and after him to his eldest son Johann Georg (3).

JOHANN FRIEDRICH COTTA (1701–79) was the second son of Johann Georg (2). In 1733 he became professor of philosophy at Tübingen, and subsequently professor of theology at Göttingen (1735) and Tübingen (1739). He was a well-known theological writer in his day.

CHRISTOPH FRIEDRICH COTTA (1730–1807), son of Johann Georg (3), established a printing house to the court at Stuttgart. It was Christoph Friedrich's son, Johann Friedrich, who restored the fortunes of the family firm, then in decline.

JOHANN FRIEDRICH COTTA, FREIHERR VON COTTENDORF (1764–1832), was born at Stuttgart on April 27, 1764. He studied at Tübingen, spent some time in Paris and qualified as a barrister,

However, learning that the family business at Tübingen was to be sold, he took upon himself the task of restoration. At that time he was 23 and totally inexperienced in the business. In 1794 he planned with Schiller the *Horen,* a periodical which, although it only ran until 1797, has a place in the history of German literature. Through Schiller, Cotta met Goethe, and his connection with other literary men increased. He became in time publisher not only to Goethe but also to Herder, Wieland, A. W. Schlegel, Tieck, Jean Paul, Kleist, Hölderlin, Uhland and others. He also published for the brothers Humboldt and for such philosophers as Fichte, Hegel and Schelling. In 1798 he began to publish the *Allgemeine Zeitung.* Censorship difficulties caused the editorial office of the newspaper to be transferred from Tübingen to Stuttgart, in 1803 to Ulm, in 1810 to Augsburg and in 1882 to Munich. It ceased publication in its traditional form in 1912.) In 1811 the firm moved to Stuttgart, and in 1823 Cotta started a branch in Augsburg and in 1827 one in Munich. By that time he had made his publishing house one of the first in Germany. He developed his political interests, going on several official missions to Paris. He attended the Vienna congress to make, among other commissions, a plea for freedom of the press on behalf of German booksellers. He also had scientific interests. He was a progressive farmer and in 1824 he introduced the first steam printing presses in Bavaria into his Augsburg branch. In 1820 the title of von Cottendorf was conferred on him by Württemberg, and in 1822 he was created hereditary Freiherr by the king of Bavaria. He died in Stuttgart on Dec. 29, 1832.

His son JOHANN GEORG COTTA (4), FREIHERR VON COTTENDORF (1796–1863) extended the firm by buying in 1839 the business of J. J. Göschen in Leipzig and in 1845 that of Vogel in Landshut. In the same year Bible branches were started at Stuttgart and Munich.

Johann Georg (4) was succeeded by his son Karl and by his nephew Hermann Albert von Reischach. They preserved the Stuttgart branch and the *Allgemeine Zeitung* office in Augsburg but the other branches gradually broke away. In 1889 the firm was bought by Adolf and Paul Kröner. The buildings were badly damaged in World War II but the firm was subsequently reestablished.

COTTBUS, a town of Germany which after partition of the nation following World War II became headquarters of a *Bezirk* (district) of the German Democratic Republic, lies chiefly on the left (western) bank of the Spree river about 110 km. (68 mi.) S.E. of Berlin and about 20 km. (12 mi.) from the Polish border. Pop. (1959 est.) 66,099. Cottbus was founded in the 12th century, becoming part of Brandenburg in 1445 and of the kingdom of Saxony in 1807–13. It has 14th- and 15th-century churches and the Spremberg tower is a remnant of the old fortifications. The town is a railway junction and an industrial centre with manufactures of textiles, leather, tobacco, machinery and soap. Cottbus district had a population (1959) of 807,840 and an area of 3,169 sq.mi.; the neighbourhood was one of the last in which the Wendish language survived.

COTTENHAM, CHARLES CHRISTOPHER PEPYS, 1ST EARL OF (1781–1851), lord chancellor of Great Britain, whose important contribution to the statute-book was the Judgments Act (1838), which amended the law for relieving insolvent debtors, was born in London on April 29, 1781. Descended from John Pepys, of Cottenham, Cambridgeshire, a great-uncle of the diarist Samuel Pepys, he was educated at Harrow and Trinity college, Cambridge, and after being called to the bar by Lincoln's Inn in 1804 and practising at the chancery bar, he became a king's counsel in 1826. In 1831 he entered parliament, and in 1834 became solicitor general and was knighted. Later the same year he was appointed master of the rolls. Next year he was one of the commissioners of the Great Seal, and in Jan. 1836 he became lord chancellor and Baron Cottenham under Lord Melbourne. He lost office with his party in 1841, but in 1846 under Lord John Russell he was again chancellor. In 1850 he retired and was created Viscount Crowhurst and Earl of Cottenham, and on his birthday in 1851 he died at Pietrasanta, near Lucca, Italy.

Although not profoundly learned, he was a good equity lawyer. He was direct and straightforward, and despite being somewhat rigid and overtenacious of first impressions, and latterly increasingly slow and testy, he was an excellent judge.

See E. Manson, *The Builders of Our Law* (1904); J. B. Atlay, *The Victorian Chancellors* (1906). (R. E. My.)

COTTII REGNUM, a district of ancient Liguria, Italy, commanding the important route into Gaul over the pass (6,083 ft.) of Montgenevre. In 58 B.C. Caesar established friendly relations with the king of the district, Donnus, whose son Cottius was confirmed in his position by Augustus. Under Nero, after the death of the last Cottius, the district was annexed, becoming the procuratorial province of Alpes Cottiae. A triumphal arch in honour of Augustus can be seen at the ancient capital Segusio (the modern Susa). (J. B. W.-P.)

COTTINGTON, FRANCIS COTTINGTON, BARON (*c.* 1579–1652), English lord treasurer and ambassador, was a supporter of Roman Catholicism and of Spain during the political struggles preceding the Civil War. He was appointed English agent in Spain from 1609 to 1611. In 1612 he became consul at Seville. Returning to England, he became a clerk of the council in 1613 and in 1616 ambassador to Spain. In 1622 he became Prince Charles's secretary and the next year accompanied Charles and the duke of Buckingham to Madrid. On their return he fell into disgrace as a result of Buckingham's enmity, but after the duke's assassination he regained his position, being made a privy councilor in 1628. Next year he became chancellor of the exchequer and was again sent as ambassador to Spain. He concluded the treaty of peace with that country and in 1631 was created Baron Cottington of Hanworth, Middlesex. Archbishop William Laud's opposition prevented him from becoming lord treasurer in 1635–36, but his prominence in Charles's council, his exactions as master of the court of wards, his Roman Catholic and Spanish leanings and his declaration that for the Scottish War the king might levy money without parliament made him unpopular when the Long parliament met. He gave up the court of wards in 1641 and the chancellorship of the exchequer in 1642. He joined the king in 1643, took part in the proceedings of the Oxford parliament and was made lord treasurer in October. He signed the surrender of Oxford in 1646 and, being excepted from the indemnity, joined Prince Charles at The Hague in 1648. Next year he accompanied Edward Hyde (afterward earl of Clarendon) to Spain to obtain help for the royal cause but, receiving no response, settled there and died at Valladolid on June 19, 1652. (R. B. Wm.)

COTTOLENGO, SAINT GIUSEPPE (1786–1842), founder of the Cottolengo charitable institute and of 14 religious congregations, was born at Bra near Turin, Italy, on May 3, 1786. He was a canon in Turin when in 1827 he was summoned to a woman dying in squalor for want of a hospital to receive her. This painful experience began an extensive and successful series of charitable enterprises. He first hired two rooms to receive the sick, but this venture soon grew into a hospital situated at Valdocco, then on the outskirts of Turin, called the Little House (Piccola Casa) of Divine Providence. He founded the Brothers and Sisters of St. Vincent de Paul to nurse in the hospital, the Sisters of Thais to care for a refuge for penitent women, and a congregation of priests called after the Trinity to minister to homes he established for epileptics, deaf and dumb, orphans, the aged, the mad, etc. In all he founded 14 congregations, both active and contemplative, all affiliated to the Piccola Casa and assisting in its activities. For Cottolengo the active and contemplative lives were interwoven, the latter being the soul of the former. His achievement was based on prayer; he kept no accounts and invested no funds but never ran short of the means for continuing his work. He died on April 30, 1842, at Chieri, near Turin, and was canonized in 1934. His feast day is April 29.

See H. L. Hughes, *St. Joseph Cottolengo* (1934), and the biography by P. P. Gastaldi, 2 vol. (1892). (E. I. W.)

COTTON, SIR ARTHUR THOMAS (1803–1899), English engineer, who was responsible for much irrigation work in India, was born on May 15, 1803. He entered the Madras engineers in 1820, served in the first Burmese war (1824–26), and began his life work on the irrigation works of southern India in

1828. He constructed works on the Cauvery, Coleroon, Godavari and Krishna rivers, making anicuts (dams) on the Coleroon (1836) for the irrigation of the Tanjore, Trichinopoly (now Tiruchirapalli) and South Arcot districts, and on the Godavari (1847–52) for the irrigation of the Godavari district. He also projected the anicut on the Kistna. Before the beginning of his work Tanjore and the adjoining districts were threatened with ruin from lack of water; on its completion they became the richest part of Madras, and Tanjore returned the largest revenue of any district in India. Cotton was the founder of the school of Indian hydraulic engineering. He was knighted in 1861. After retiring from government service in 1862, he was employed from time to time in investigating and reporting upon various irrigation projects. He retired from the army with the rank of general in 1877, and died at Dorking, Surrey, on July 14, 1899.

See Lady Hope, *General Sir Arthur Cotton* (1900). (A. McD.)

COTTON, CHARLES (1630–1687), English poet, man of letters and country squire, chiefly remembered for his share in Izaak Walton's *Compleat Angler,* was born on April 28, 1630, at Beresford, Staffordshire, where he lived all his life. His father, also Charles Cotton, was the friend of Ben Jonson, John Donne, Sir Henry Wotton, John Fletcher, Robert Herrick, Sir William Davenant, Richard Lovelace and Izaak Walton. His mother was daughter to the Lady Stanhope for whom Michael Drayton wrote an elegy. Cotton married his cousin, Isabella Hutchinson, half sister of the Puritan colonel John Hutchinson; she died in 1669 and in 1675 he married the dowager countess of Ardglass. He died during a visit to London and was buried in St. James's church, Piccadilly, on Feb. 16, 1687.

Cotton's father had an excellent library and to this, rather than to a visit to France in 1655, he owed his knowledge of French literature. He made a number of translations, including, in 1685, the often reprinted *Essays of Michel de Montaigne* (which is much closer to the original than Giovanni Florio's more famous version), Corneille's *Horace* (1671) and several historical and philosophical works. He followed French fashion also in *Scarronides* (1664, 1665) a coarse burlesque of the *Aeneid,* books I and IV, and in the *Burlesque upon Burlesque . . . being some of Lucian's Dialogue newly put into English Fustian* (1675).

Cotton described himself as "an old-fashioned country squire," meaning one who played his full part in the life of his county, as farmer, sportsman, magistrate and host. From this life he drew the inspiration for all his original writings: *The Compleat Gamester* (1674), *The Planter's Manual* (1675) and the second part, on fly-fishing, which he added, at Walton's suggestion, to the 5th edition of *The Compleat Angler* (1676). (For their pleasure in 1675 Cotton built the fishing house beside the river Dove, with their initials twisted together in monogram above the door.) *The Wonders of the Peak* (1681), a long topographical poem, popular throughout the 18th century, and his other poetry, published in the posthumous and unauthorized *Poems on Several Occasions* (1689), reflect his enjoyment of life.

Although Cotton's fame rests chiefly on his connection with *The Compleat Angler,* the qualities which make it memorable—his delighted observation of the country scene, his friendly charm of manner, the vigour and purity of his style—are all to be found in his poetry, which was much admired by Wordsworth, Coleridge and Lamb.

See John Buxton (ed.), *Poems* of Charles Cotton (1958), a selection which corrects the faulty text of 1689 from a contemporary manuscript. (E. J. M. Bn.)

COTTON, GEORGE EDWARD LYNCH (1813–1866), English bishop of Calcutta and, earlier, a distinguished schoolmaster, was born at Chester on Oct. 29, 1813. He was educated at Westminster school and at Trinity college, Cambridge. He became an assistant master at Rugby, where he worked devotedly for 15 years, inspired by the headmaster, Thomas Arnold, and heartily entering into his plans and methods. Cotton is the "model young master" who intervenes at the end of part one of Thomas Hughes's *Tom Brown's Schooldays* (1867). Cotton became master of Marlborough college in 1852, and in his six years of rule raised it to a high position. In 1858 he became bishop of Calcutta, where he established schools for British and Eurasian children, did much to improve the position of the chaplains and was unwearied in missionary visitation. On Oct. 6, 1866, he was drowned at Kushtia on the Ganges. A memoir of Cotton, edited by his widow, was published in 1871.

COTTON, JOHN (1585–1652), English-American Puritan minister, sometimes called the "patriarch of New England," was born in Derby, Eng., on Dec. 4, 1585. He was educated at Trinity college, Cambridge, and became a fellow of Emmanuel college, Cambridge, then a stronghold of Puritanism. In June 1612 he became vicar of the parish church of St. Botolph in Boston, Lincolnshire, where he remained for 21 years. Becoming more and more a Puritan in spirit, he ceased, about 1615, to observe certain ceremonies prescribed by the legally authorized ritual, and in 1632 action was begun against him in the high commission court. He thereupon escaped, disguised, to London, lay in concealment for several months, and eluding the watch set for him at the various English ports, in July 1633 emigrated to the colony of Massachusetts Bay, arriving at Boston early in September. On Oct. 10 he was chosen "teacher" of the First Church of Boston, of which John Wilson (1588–1667) was pastor, and there he remained until his death on Dec. 23, 1652. In the newer as in the older Boston his popularity was almost unbounded, and his influence, both in ecclesiastical and in civil affairs, was probably greater than that of any other minister in theocratic New England.

He was a man of great learning and was a prolific writer. His writings include: *The Keyes to the Kingdom of Heaven and the Power thereof* (1644), *The Way of the Churches of Christ in New England* (1645), and *The Way of Congregational Churches Cleared* (1648), these works constituting an invaluable exposition of New England Congregationalism; and *Milk for Babes, Drawn out of the Breasts of Both Testaments, Chiefly for the Spirituall Nourishment of Boston Babes in either England, but may be of like Use for any Children* (1646), widely used for many years, in New England, for the religious instruction of children.

See the quaint sketch by Cotton Mather, John Cotton's grandson, in *Magnalia* (1702), and a sketch by Cotton's contemporary and friend, Rev. Samuel Whiting, printed in Alexander Young's *Chronicles of the First Planters of the Colony of Massachusetts Bay from 1623 to 1636* (1846); also A. W. McClure's *The Life of John Cotton* (1846), a chapter in Arthur B. Ellis's *History of the First Church in Boston* (1881), and a chapter in Williston Walker's *Ten New England Leaders* (1901). (W. W.)

COTTON, SIR ROBERT BRUCE, Bart. (1571–1631), English antiquary, the founder of the Cottonian library, was born at Denton, Huntingdonshire, on Jan. 22, 1571. He was a descendant, as he delighted to boast, of Robert Bruce. He was educated at Westminster school under William Camden (*q.v.*), the antiquary, and at Jesus college, Cambridge, where he graduated in 1585. He took a house near Old Palace yard, Westminster, and there began to assemble a collection of manuscripts, books and coins, which he supplemented steadily throughout his life. It became a meeting place for scholars, who were allowed to use the library freely. In 1614 Arthur Agarde (*q.v.*) left Cotton his papers, and Camden's manuscripts came to him on Camden's death in 1623. His connection with Camden had been renewed when he joined (*c.* 1590) the Society of Antiquaries: in 1600 they toured the north of England in search of Pictish and Roman monuments and inscriptions. Cotton assisted in the preparation of the 5th edition of Camden's *Britannia* and was regarded as the compiler of his *History of Elizabeth.* He certainly revised it after Camden's death and had probably supervised it, especially with regard to its treatment of Mary, Queen of Scots. He also helped John Speed to compile his *History of England* (1611).

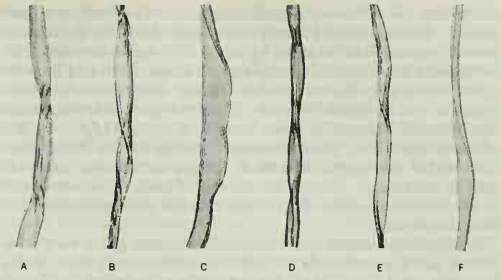
Cotton's pride in his Scottish ancestry attracted the favour of James I, and he was knighted on the king's accession. In 1608 he wrote a *Memorial on Abuses in the Navy,* and attended the privy council at which the matter was discussed. In 1611 he presented to the king a historical *Inquiry into the Crown Revenues,* in which he supported the creation of the order of baronets as a means of raising money. In the same year he himself received the title.

After this, however, Cotton's favour at court began to decline. His acquisition of so many public documents had aroused misgivings, and in 1615 he was involved in the disgrace of his patron, the earl of Somerset (*see* SOMERSET, ROBERT CARR), and was arrested. He confessed to having acted as intermediary between Somerset and the Spanish ambassador, and to having altered dates in correspondence to substantiate Somerset's plea of innocence of the murder of Sir Thomas Overbury. Cotton received no formal trial, and was pardoned eight months later, but he never regained his standing at court. Moreover, his antiquarian studies caused him increasingly to lend the weight of his learning to the opponents of Stuart methods of taxation. In the *Inquiry into the Crown Revenues* he had argued that tonnage and poundage should be levied in wartime only, and the circulation in the house of commons of his notes during the debate on supply in 1625 materially contributed to the decision to grant Charles I that tax for one year only. In 1626 he successfully protested on behalf of the London merchants against a proposal to debase the coinage. His *The Reign of Henry III* was published in 1627 in the face of a government threat to prosecute the printers, and in 1628 the opposition leaders, Sir John Eliot, John Pym and Sir Simonds D'Ewes, used his house as their headquarters. Cotton himself had entered parliament in 1601 as member for Newtown: in 1604 he sat for Huntingdon; in 1624 for Old Sarum; in 1625 for Thetford; and in 1628 for Castle Rising, Norfolk.

Finally, the publication of his political tract, entitled *The Danger wherein the Kingdome now standeth and the Remedie* (1628), and the circulation of another, a *Proposition to Bridle Parliament*, the original of which was found in Cotton's library, caused his imprisonment in 1629 and the sealing up of his library. His trial fortunately coincided with the birth of the future Charles II and he was released in honour of the event, but his library was not restored and his zest for life was destroyed. He died, probably in London, on May 6, 1631. His son, Sir Thomas (1594–1662), regained possession of the library and added considerably to it. Sir John, the 4th baronet, presented it to the nation in 1700. It was moved from Cotton house, first to Essex house in the Strand and then to Ashburnham house, Westminster, where in 1731 it was severely damaged by fire. In 1753, when the British museum was founded, it formed the basis of the manuscript collection, and many of the partially burned manuscripts were restored. In the old library at Cotton house, the books and manuscripts had been kept in 14 tall cupboards, on 12 of which stood busts of the Roman emperors, with busts of Cleopatra and Faustina on the remaining two, and catalogues of the library (1696, 1732 and 1802) continued to group manuscripts under the names of the emperors in whose cupboard they were originally kept.

See *Cottoni Posthuma*, collected by J. Howell (1651; ed. by E. Oldsmid, 1884–88); E. Edwards, *Libraries and Founders of Libraries* (1865).

COTTON, while supplying a dominant supply of the world's clothing needs, also provides human food and livestock feed. Extensive use of the seed and of the products derived from it is a recent development; the use of the fibre, a mass of unicellular hairs which grow attached to the seed on all types of cotton plants, has been traced as far back as 3000 B.C. through spun cotton yarns found in the ruins of Mohenjo-Daro, a city in the Indus valley. Cotton was mentioned in a Hindu Rigveda hymn 15 centuries before Christ and Herodotus (*c.* 450 B.C.) tells how the patient hands of women of India plucked lint from seed, carded it and spun yarn for weaving on their crude hand looms. It was grown and spun by the Egyptians, probably in A.D. 600–700. It was the subject of legend and myth during the middle ages, and it was for an additional supply of the fibre that many of the great explorations of the 15th and 16th centuries were undertaken. Cotton has been found in prehistoric pueblo ruins in Arizona, and cotton grave cloths from pre-Inca Peru are still in existence. The spinning of cotton for nets and fishing lines apparently antedated weaving of cloth in Peru and the Caribbean, but when Christopher Columbus landed in the West Indies in 1492 the natives brought skeins of cotton yarn to his ship for barter; Yucatán natives presented cotton garments to Hernán Cortés, and Mexicans were clad in cotton when Cortés established Veracruz. When Vasco da Gama sailed around the African continent to Calicut (Kozhikode) in 1498 he found that, centuries before, Arab traders had taught the natives of Africa to cultivate and spin cotton. From Calicut he brought back to Lisbon *pintados*, or calicoes.



BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

FIG. I.—LONGITUDINAL SECTION OF COTTON FIBRES: (A), (B), (C) COARSE FIBRES; (D), (E), (F) FINE FIBRES

An examination of one of the earliest-known fragments of cotton textiles reveals an analogous persistence of fibre structure. Breeding has produced longer, finer and stronger cotton, but the fibres from bits of cloth and yarn found in the Indus valley, like the fibres in today's cottons, are flattened, twisted tubes, the walls of which are composed of fibrils of cellulose built up in a number of concentric layers; the textile character known to scientists and the trade as cottonlike is the result of this persistent fibrous structure. The length of a single cotton fibre is from 1,000 to 3,000 times its diameter. The various species of cotton govern the diameter and number of twists the respective fibres have—the more twists, the better the spinning qualities. The spirality of a cotton fibre distinguishes it from all other fibres and gives it elasticity and superior value for spinning. No other natural fibre has this feature.

Despite the increase in production of man-made fibres, cotton continues to be one of the most important of the world's money crops. It is a tropical plant, adapted to temperate zones, thriving best with high temperatures, considerable sunshine, abundant but not excessive moisture and high soil fertility. More than 60 countries within the zone of latitude 47° N. and 35° S. produce cotton for commercial purposes. A trend toward increased cotton production was in evidence in all cotton-producing countries, especially following World War II, when world production reached approximately 40,000,000 bales, compared with a pre-World War II average of 31,600,000 bales. World cotton production was about five times that of both wool and rayon.

In the years following 1940 remarkable advances were made in agronomy. Increased production of desirable-quality cottons and per-acre profit to the farmer became dual dominating factors in the raw-cotton industry. New varieties and strains of cotton were developed to meet the demands of agricultural mechanization, to respond to chemical controls in cultivation and to resist diseases.

BOTANY

The development of an engineering approach to the design and utilization of textile fibres resulted in a new evaluation of the botanical study of cotton, placing emphasis upon the selection of varieties which will maintain the economic potentials and market stability of the world's most important nonfood agricultural commodity.

Taxonomy.—Wild and cultivated species of cotton have been placed in the genus *Gossypium*. Authorities have disagreed on the family and tribe but have agreed in placing the genus in the order Malvales. The seeds of all species of *Gossypium* produce hairs, and the seeds are produced inside capsules (bolls). Four species have been cultivated for the production of lint. *G. herbaceum* and *G. arboreum*, commonly known as Asiatic species, have a haploid chromosome number of 13 and produce short ($\frac{1}{8}$ to $\frac{3}{4}$ in.)

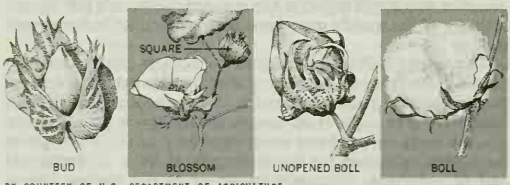
coarse lint. *G. hirsutum* is commonly known as American upland cotton. It has a haploid chromosome number of 26 and produces lint of intermediate length ($1\frac{3}{16}$ to $1\frac{1}{4}$ in.) and coarseness. *G. barbadense* has a haploid chromosome number of 26 and includes types commonly known as Sea Island, Egyptian, American-Egyptian and Peruvian Tanguis. These commercial types, except for Peruvian Tanguis, produce extra long staple ($1\frac{7}{16}$ to $2\frac{1}{2}$ in.) which is very fine. Most commercial cotton of the above types falls within the lengths indicated; longer and shorter extremes exist in each type. Botanical varieties of both *G. hirsutum* and *G. barbadense* that occur both in the wild and cultivated state have been described.

Wild species include one with 26 chromosome pairs, *G. tomentosum*, and approximately 20 with 13 chromosome pairs. These latter so-called diploid species occur in the subcontinent of India, Australia, Africa and Arabia and in the Americas from Arizona to Peru. Botanists and geneticists have accumulated evidence indicating that the cultivated tetraploid species (those with 26 chromosome pairs) arose from a hybrid of an Asiatic species or a fairly close relative and a wild American species.

Fibre.—Cotton fibres are single plant cells which develop as elongations of the outer layer of cells of the cotton seed. Each fibre consists of an outer or primary cell wall and an inner layer of cellulose comprising the secondary wall. Microscopic examination of the cross section of a fibre reveals the existence of daily growth rings which form a series of concentric circles. During development the inside of each fibre (lumen) contains the living protoplasm of the cell. When mature and exposed to the air, the fibre dries, and the drying is accompanied by flattening and twisting. This process is emphasized because the convolutions in the fibre make it easily spinnable. All cultivated species of cotton are distinguished from wild species by their convoluted lint (seed hairs).

Seed fuzz begins to develop from epidermal cells during the period from 5 to 11 days after opening of the cotton flower, in contrast to the lint development which is initiated on the day of flowering. Commercial types of upland cotton have relatively uniform fuzz over the entire seed; Sea Island, Egyptian and Tanguis have only a portion of the seed covered with fuzz. Seed fuzz from upland cotton is a by-product of the oil-milling industry known as linters and is used primarily as a source of cellulose. (*See* also COTTONSEED.)

While all lint has in common the convoluted characteristic important to spinning, wide ranges exist in length, coarseness and strength. Differences in these properties exist within the produce of a single variety, and species and varieties within species are quite different in mean values for these properties. In addition to inherent differences, the influence of environmental conditions under which the crop is grown is important. Specialized instruments have been developed for measuring specific properties, including an electronic device for scanning a sample of lint and recording graphically the frequency of fibres of various lengths; strength testers that measure the tensile strength of a flat bundle of fibres, which is reported as strength in relation to the actual weight of the fibres in the sample; and air-flow instruments that estimate relative fineness and coarseness of fibres in a sample by relating rate of flow of air to specific surface of fibres in the sample. Performance of each of these instruments has been related to results obtained by more tedious laboratory methods, and the combined lint properties have been related to the performance of individual lots of cotton in the manufacturing process. Thickness of the secondary wall of individual fibres is related to measurements of relative fineness, and modifications of the air-flow instruments have been developed to estimate this relative thickness. Unusually thin walls in a given type of cotton often result from adverse environmental conditions, and such thin-walled fibres are called immature. Other immaturity tests include microscopic examination and differential dye tests.



BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

FIG. 2.—STAGES IN THE DEVELOPMENT OF A COTTON BOLL

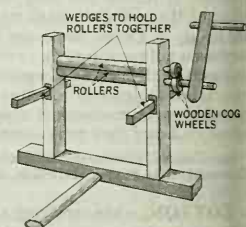
CULTURE

Most of the cotton produced in the world has been produced by comparatively primitive methods. Into the second half of the 20th century most cotton-producing areas still relied upon animal power for preparing the soil, and the crop was planted, cultivated and harvested by hand. In the United States, which became a major producer of cotton after the invention of the Whitney-Holmes saw-type gin in 1796, mechanization of cotton production lagged behind mechanization in the production of corn, wheat and other crops. The use of tractor power for cultivation developed in the 1920s but did not spread until the 1930s, when additional implements were developed for seed-bed preparation and cultivation. Mechanical pickers and strippers for harvesting the crop had been developed for commercial use by the 1940s, but by 1949 only 6% of the U.S. crop was mechanically harvested; during the 1950s the percentage increased to about 30% but by 1958, in southwestern United States, the most mechanized cotton-producing area in the world, some hand labour was still utilized in weeding and less than $\frac{1}{4}$ of the crop was harvested mechanically. The degree of mechanization became progressively less from west to east in the cotton belt of the United States, partly as a result of farm size, field size, slope and competition for labour. In areas of Mexico contiguous to the United States the degree of mechanization approached that in the U.S. more closely than in other cotton-producing areas of the world.

See also FARM MACHINERY; HARVESTING MACHINERY: *Mechanical Cotton Harvesters.*

GINNING

The earliest record of a mechanical device for separating lint from seed comes from India, which is the country in which utilization of cotton is believed to have developed first. The primitive "churcka" gin consisted of two rollers through which lint could pass but seed could not. From this hand-operated model, power-driven roller gins were developed which continue in use for ginning extra-long staple Sea Island and Egyptian types as well as shorter staple types in India and China, all of which are smooth seeded or sparsely fuzzy. While naked seed occurs as a genetic aberrant in the medium-staple American-upland type, most upland varieties have the dense coat of short fuzz known as linters, and in this type the longer lint hairs are attached more securely to the seed coat.



FROM H. B. BROWN AND J. O. WARE, "COTTON," 1958; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 3.—PRIMITIVE HAND-DRIVEN CHURCKA COTTON GIN, DEVELOPED IN INDIA CENTURIES AGO, EMPLOYING ROLLER PRINCIPLE OF MODERN ROLLER GINS

Hand separation of lint and seed was replaced rapidly by use of saw-type gins in the United States after the inventions of Eli Whitney in 1794 and of Hogden Holmes in 1796. Whitney's gin was improved upon by Holmes who substituted toothed saws for the hooked cylinder and flat metal ribs for the slotted bar used by Whitney. The saws, metal ribs and doffing brush in these early models persist in modern gins, with no basic change in ginning principle having been made, although some modern gins substitute an air blast for the doffing brushes.

Additional gin machinery has been developed to keep pace with changes in harvesting practices which have resulted in a trend from careful hand picking to rougher hand and machine harvesting. These developments include seed-cotton driers, seed-cotton clean-

ers, burr extractors, green-boll traps and magnetic devices for removing metal. Lint cleaners, designed to remove trash from lint after it had been removed from the seed, were added to modern gins in the late 1940s and 1950s. Improvement in grade, which resulted in a higher price for the lint, was, in some cases, offset by the loss in weight. Gin installations include presses for baling the lint and equipment for moving the seed away from the gin stands. While some of the seed is saved for planting purposes, most of it moves directly to an oil mill for processing. Because whole cottonseed is somewhat toxic when ingested, its utilization commercially had to await the development of oil-extracting equipment, and not all countries producing cotton fully utilize the seed produced (*see* also FEEDS, ANIMAL).

PESTS AND DISEASES

Insect Pests.—More than 500 species of insects attack cotton, among them being some of the most destructive known to agriculture. With its lush, succulent foliage, large flowers all with nectaries and its extended fruiting period, cotton is an excellent host for many insects. Included in the insects visiting cotton are those with beneficial effects and some with apparently neutral effects on the plant, in addition to the harmful species. A few of the most harmful are the boll weevil, pink bollworm, bollworm, cotton leafworm, cotton aphid, cotton fleahopper, rapid plant bug, conchuela, southern green stink bug, spider mites (red spiders), grasshoppers, thrips and tarnished plant bugs.

The earliest cotton production, utilizing perennials, was ideal for the development of insect populations. The development and use of annual types made possible some insect control through timing of planting and other cultural methods, including sanitation measures such as clean culture and disposal of crop residues at the end of the season. Such methods continue to be important, and modification of varieties by breeding has provided means of escaping most serious damage by insects in some cases and has provided degrees of resistance in others. Chemical control, research in which was started in the early 1900s, has become of great importance. Losses caused by insects have been high in all cotton-producing countries, the annual loss in the United States averaging more than $243,000,000 since 1929, with an all-time high of over $900,000,000 in 1950. To the losses caused by insects must be added the cost of control measures, and these have been estimated at $58,000,000 to $95,000,000 annually in the U.S.

The pink bollworm (*Pectinophora gossypiella*), first reported in India in 1842, has become generally established in eight of the nine countries that produce nine-tenths of the world's cotton. It has caused an average annual loss of 15% to 25% in India and Egypt; in China it has caused more damage than all other cotton insects together. Losses in Russia have been severe, and in Brazil the average annual loss is 20% to 25%. The pink bollworm appeared in Mexico in 1911 and by 1960 had spread throughout a six-state area in the United States. Control has been attempted through heating or fumigating of cottonseed, burning of gin trash, rolling lint to crush larvae and enforcing destruction of crop residues by specified dates at the end of the season to destroy insects and food supply. Strict quarantines have been enforced on the movement of untreated cotton to help prevent spread of the insect. In a few relatively small areas where sufficiently strict control has been possible the pink bollworm has been eradicated. *See* also PLANT QUARANTINE.)

The boll weevil (*Anthonomus grandis*) is believed to be a native of Mexico or Central America and it is restricted to the northern hemisphere of the Americas. Another closely related species occurs in South America. After entering the United States in 1892 and spreading throughout the cotton belt by 1922, the boll weevil became the most serious cotton insect pest. Natural control factors—including about 60% mortality in hibernating weevils, death of emerging adults before cotton produces squares in which eggs may be deposited, and deterrents to rapid multiplication such as heat, dry weather, insect parasites and predators, and birds—make it possible to produce cotton when the weevil is present. Cultural methods of control for the weevil include preparation of a good seedbed, early planting, a relatively early variety, soil improvement and fertilization, proper cultivation, cleanup of favourable hibernation quarters and early destruction of cotton stalks. Direct control by poisoning adult weevils is used when the population of weevils in the field is high enough to warrant it. Continued applications at intervals of four to five days are required because the immature stages of the weevil develop inside the flower buds and young bolls where poison does not affect them, and the continued growth of the plant and chemical breakdown and disappearance of poison from the older parts of the plants prevent a lasting killing effect. Calcium arsenate was used as the sole weevil poison from discovery of its effectiveness in 1916 until about 1948, when organic insecticides became available. Chlorinated hydrocarbons and organic phosphates were used extensively during the 1950s, and late in that decade the appearance of weevils resistant to the chlorinated hydrocarbons were recorded. Certain of the chemicals available effectively controlled other cotton insects and chemical control spread to many cotton-growing areas of the world. (*See* also BOLL WEEVIL.)

Another major insect is the bollworm (*Heliothis zea*). Unlike the pink bollworm, which has a limited host range, and the boll weevil, which attacks only cotton, the bollworm feeds on many wild and cultivated plants including corn (maize), grain sorghums, tomatoes, peas, alfalfa, lespedeza, beans, soybeans, flax and peanuts. In many areas it moves to cotton from corn, on which it is known as the corn-ear worm. Natural enemies sometimes prevent bollworm infestation, but when bollworms appear the application of insecticides is the best means of control. Poison must be applied when the worms are small, for after they enter the bolls poison will not reach them.

Insects which feed on the leaves and buds, including the cotton leafworm, which is a chewing insect, and the sucking insects including fleahoppers, leafhoppers and aphids, do considerable damage to cotton crops throughout the world. Damage caused by such insects is often difficult to assess because it is not always spectacular, and when sap-sucking insects attack they often cause shedding of very young buds, too small to attract attention. Chemical control is an important adjunct to natural factors affecting the insects. In Africa and Asia damage caused by leafhoppers has been reduced through incorporation of plant hairiness in the commercial varieties. In some areas of Africa the tarnished plant bug is the most serious insect pest.

A stalk borer called broca is a serious pest in parts of South America. The larva enters the stalk at the soil surface as a rule, and it can be controlled either by application of chemicals to the soil surface or seed treatment with systemic insecticides.

Diseases.—Cotton is subject to attack by pathogenic fungi, bacteria and virus, and damage caused by nematodes and physiological disturbances are usually called diseases. Descriptions of many of the diseases were published in 1892, although the occurrence of virus diseases was not noted until the late 1950s. Losses caused by disease have been estimated as high as 50% in some countries of Africa and in Brazil. In India losses have ranged from 7% to 20%, and in the United States annual losses as high as 15% have been reported.

A complex of disease organisms attacking young seedlings, with the predominant organism differing with locality and conditions within localities, is probably the most widespread disease problem. In many cotton areas seeds are treated with chemicals before planting to reduce disease injury to seedlings. The second most widespread problem is a bacterial disease known either as angular leaf spot or black arm, depending upon which symptom of the disease is predominant in the area. In African countries outside of Egypt this is considered the most serious disease, and considerable progress in breeding resistant varieties has been made. It is not a problem in areas of little or no summer rainfall like Egypt and California where cotton production depends on irrigation. Considerable attention has been given to the development of resistant varieties in some areas of the United States.

Fungus diseases attacking growing plants include fusarium and verticillium wilt and Texas root rot. The latter is limited in distribution by soil type, soil reaction and climate primarily to areas of Mexico, Texas, New Mexico and Arizona. Fusarium wilt is

somewhat restricted to sandy and mixed soils, usually occurring in combination with nematodes in areas with 40 or more inches of annual rainfall. It is an important disease in the United States and is the major disease in Egypt. Soil fumigation is effective in control, but the development of resistant varieties has provided the best means of control. Verticillium wilt is most serious in heavy soils and is more serious with heavy irrigation and high levels of soil nitrogen. Losses in the irrigated southwest of the United States were reduced through the use of tolerant varieties and modified cultural practices. It has been reported in other countries in both the northern and southern hemispheres, and its distribution may be in doubt because of the similarity of its symptoms to those of fusarium wilt. Both cause chlorosis, or blanching of the green parts, leaf drop and ultimate death of the plant.

Boll rots can cause severe damage to the crop. The bacterium causing angular leaf spot also attacks green bolls, and the lesions formed permit the entry of secondary invaders. Partially open and open bolls are attacked by several fungi, both pathogenic and saprophytic, and the lush foliage of the plant provides ideal conditions for the development of such organisms on the lower bolls, particularly in areas of high humidity at the time the crop matures.

Nematodes are widespread, and the damage they cause both in combination with fusarium wilt and alone has most likely been underestimated. Soil fumigation and varietal resistance both provide control.

PRODUCTION AND MARKETING

World production statistics as compiled in the United States are for actual bales of U.S. cotton (these bales average 490 lb. net weight) and for equivalent bales of 478 lb. net for non-U.S. cotton. The approximate world crop of 48,000,000 bales is the combined output of over 60 countries including the United States (15,000,000 bales), Brazil (1,800,000), China and Manchuria (7,500,000), Egypt (2,000,000), India (4,500,000), Pakistan (1,300,000), the U.S.S.R. (7,000,000) and Mexico (2,000,000).

World Production.—The United States, the world's largest producer, accounted for 60% of the total in 1929–30, 41% in 1939–40 and 50% in 1949–50, but by the mid-1950s produced only about 39% of the total. In 1933 acreage control and price supports were established in the United States in order to aid farmers during a period of economic distress. Continued control and price support, except during World War II and certain years of predicted short supply, have been a factor in a shift in world production. Price supports in the U.S. have encouraged the production of cotton by other countries by enabling them to compete in the world market and have also encouraged the production of synthetics, which have been able to compete with cotton at the level of supported prices.

Among the countries which consume a high percentage of the cotton they produce are the U.S., the U.S.S.R., China, Korea, India, Brazil and Argentina. Among those exporting most of their production are Egypt, Turkey, Mexico, Peru, Republic of Sudan, Uganda and Republic of the (former Belgian) Congo. Chief among the importers of cotton are Japan and countries of the European Common Market.

Quality of cotton is commonly measured in terms of length and coarseness or fineness of the lint. Other factors, including amount of trash in the bale and discoloration of the lint, also determine price (see *Classing and Marketing*, below) but may or may not be directly related to the spinning quality of the cotton. Roughly 70% to 75% of world production is in the range of length from $\frac{7}{8}$ to $1\frac{1}{8}$ in. About 12% to 15% is in the range from $\frac{3}{4}$ to $\frac{7}{8}$ in. About 9% ranges from $1\frac{1}{8}$ to $1\frac{1}{2}$ in. and 1% is $1\frac{1}{2}$ in. and longer.

About 95% of the cotton produced in the United States is $\frac{7}{8}$ to $1\frac{1}{8}$ in., the remainder consisting of long staple upland and American-Egyptian and a very small percentage below $\frac{7}{8}$ in. produced in areas with adverse seasonal conditions. Roughly 5% of the Indian crop is 1 to $1\frac{1}{16}$ in., 30% to 35% is $\frac{7}{8}$ to $\frac{31}{32}$ in. and 60% to 65% less than $\frac{7}{8}$ in. There is a continuing trend in India to produce more of the longer (1 in.) cotton in place of the shorter types by replacing the Asiatic species with adapted varieties of American upland. Practically all Egyptian cotton is $1\frac{1}{8}$ in. or longer, with the longer group coming from adapted *G. barbadense* varieties producing lint up to $1\frac{31}{32}$ in. Brazil produces 95% $\frac{29}{32}$ to 1 in. cotton and about 5% $1\frac{3}{16}$ in. China produces short cotton primarily, $\frac{7}{8}$ in. and shorter. Since much of this is used in the home, it has little influence on cotton in world trade. Russian cotton is mostly $\frac{7}{8}$ to $1\frac{1}{32}$ in. Increased production in Russia has therefore been in direct competition with many other countries, even though Russia exports only negligible amounts. Long staple types are imported by Russia, primarily from Egypt.

Of the remaining cotton-producing countries, most produce lengths in the range $\frac{7}{8}$ to $1\frac{1}{8}$ in. Peru is a notable exception, where 85% is about $1\frac{3}{16}$ in., 7% is $1\frac{1}{2}$ in. and the remainder is $1\frac{1}{4}$ to $1\frac{3}{16}$ in.

Classing and Marketing.—The market value of cotton is determined by length of the fibre, colour, preparation and foreign-matter content. These characteristics are used in determining grade and staple; additional measurements on fibre fineness, strength and maturity came into use on an extensive basis during the 1950s in some phases of marketing. Classing systems vary throughout the cotton-producing and -consuming areas of the world; a brief description of the United States system will serve as an example. All bales are sampled individually, approximately three to six ounces of lint from each of two sides of the bale, at the gin. Unless sold directly to a mill, the bales will be sampled again after periods of storage or when the bales are offered to a subsequent buyer.

Grade standards in use in the U.S. for white cotton, ranged from best to poorest, are: good middling, strict middling, middling, strict low middling, low middling, strict good ordinary and good ordinary. Coloured cottons include spotted, tinged, yellow-stained and gray, and within each of these colours no grades of ordinary exist. Cotton not fitting the description of any of the established grades is called below grade. The grade of each sample is determined by matching it with a sample in the official box of standard samples as prepared and distributed by the U.S. department of agriculture. The above standards apply to upland cotton up to $1\frac{1}{8}$ in. in length and, with special consideration given to preparation (ropy, matted or otherwise undesirable condition of the lint in the bale), to upland over $1\frac{1}{8}$ in. Sea Island is classed in grades one to six, with half grades for description, and American-Egyptian cotton in grades one to nine.

Classing is done by men employed by the department of agriculture as a free service to sellers and buyers, and each bale submitted is given an official grade. Many buyers prefer to do their own classing, however, and much of the cotton in trade is bought and sold on grade and staple determined by the buyer or his classer.

Local markets are maintained where cotton is ginned, and the local buyer may be the ginner, an independent buyer or a merchant or banker to whom the cotton grower is indebted. Buyers for mills are especially active at gins near the spinning mills and they sometimes buy in local markets in areas remote from the mills, especially in areas producing sizeable volumes or where cotton with special qualities is produced. Co-operative marketing agencies also have buyers in the local markets. Much of the U.S. cotton has gone into the government loan program since it was established in 1933 and such cotton is not purchased by a local buyer but is transferred from the gin to approved warehouses after which the grower obtains a loan on the negotiable warehouse receipt. Central markets are located in larger cities and merchants and shippers operating in these markets buy from local markets and sell to mills, both domestic and foreign. These merchants do not engage in the physical handling of cotton but trade in negotiable warehouse receipts and are therefore dependent upon the warehouses for storage and handling of the cotton. Each central market serves its members in providing market information and in handling purchases and sales on the futures market.

Central markets determine the basis, which is the relation of spot-market price to futures-contract price. The base price in the U.S. is the price of middling one-inch cotton, and the basis sheet lists premiums and discounts for other lengths and grades of upland cotton that may be delivered in place of middling inch. Premiums and discounts are related to the supply of the various

kinds of cotton and the basis varies throughout the season.

Manufacturers' markets are not assembled markets but exist in the spinning-mill area in the person of mill buyers. Some of these are professional buyers; others, officers of the mills. Purchases are made from central markets as a rule, usually for forward delivery at a price agreed upon when the purchase is made. A survey after World War II showed that about 20% of the cotton used by U.S. mills was purchased through mill buyers, agents or other subsidiaries; 64% was obtained through central markets; 10% through ginners and other local first buyers; 4% through the Commodity Credit corporation (a government loan agency); 1% through co-operatives; and 1% direct from growers.

All of the physical markets described above utilize the futures market for lowering their risk in handling a commodity subject to price change (*see* FUTURES). Cotton merchants hedge their purchases of cotton bought at fixed prices which they have not sold at fixed prices by selling cotton contracts on the futures market to the extent that such sales offset in quantity actual cotton bought. In order to hedge sales of actual cotton which was sold at fixed prices but which was not bought at fixed prices, merchants purchase sufficient contracts on the futures exchanges to offset in quantity the actual cotton sold.

See also references under "Cotton" in the Index volume.

BIBLIOGRAPHY.—H. B. Brown and J. O. Ware, *Cotton* (1958), contains comprehensive bibliography; Frank D. Barlow, *Cotton in South America* (1952); *Yearbook of the New York Cotton Exchange* (annually); *Cotton Year Book* (annually). *See* also Read P. Dunn, Jr., series on foreign trade in cotton, published by the National Cotton Council of America.

Current production statistics are summarized annually in *Britannica Book of the Year*. (J. M. GR.)

COTTON BELT, a name traditionally applied to the cotton-growing part of the old south in the United States. As a crop term it was extended in the 1930s to include western irrigated areas.

There are four major areas of cotton production in the United States. The southeastern area extends from the Carolinas to the Mississippi delta and includes parts of Virginia and Florida. This was the original zone of cotton production in the south. In the 19th century up to one-fourth of the cropland was in cotton; by the second half of the 20th century only 1 crop acre in 11 was in cotton, and the area had one-sixth of the national crop. Yields per acre were moderate (350–400 lb.), and staple length typically $1\frac{1}{32}$ in. The small farms and hilly landscape are not suitable for mechanization, and farm abandonment and consolidations have been widespread; beef cattle, dairying, broiler production, peanuts and soybeans became of increasing importance. The crop remained significant on the inner coastal plains and the Piedmont of the Carolinas and Georgia and in north Alabama, but few farms had as much as 20 cotton acres each.

The Mississippi lowland or delta includes the cotton areas in Missouri, Arkansas, Tennessee, Mississippi and Louisiana, plus a few acres in Illinois and Kentucky. Cotton remains "king" on the flat and very fertile alluvial soils. In the early 1930s cotton was planted on more than 40% of the crop acres; although by the 1960s cotton acreage was only half as much, production increased slightly, to 25%–30% of the national crop. Many farms had over 100 cotton acres and were almost fully mechanized. Per acre yields were about one bale (500 lb.) and staple length $1\frac{1}{16}$ in. Corn, soybeans, rice and beef pastures increased in acreage.

In the southwest (Texas and Oklahoma), cotton long has been important. In the Blackland prairie and Corpus Christi areas it is raised with the aid of natural rain much as in the southeast, but farms are larger, many with more than 100 cotton acres. The cotton raised in the flat to rolling lands of southwest Oklahoma and nearby parts of Texas is also a rainfall crop, but irrigation is necessary in the lower Rio Grande valley and in the Lubbock basin of the West Texas high plains. On irrigated farms cotton acreages are large and production is mechanized. Yields per acre average about 300 lb., and the staple length is $\frac{7}{8}$ to $1\frac{3}{16}$ in. The southwest had more than two-fifths of the national cotton acreage in the early 1960s and nearly one-third of the production.

The western and newest part of the cotton belt is in the irrigated lands of New Mexico, Arizona and especially California. Cotton experiments began in Kern county, Calif., in 1916, but the major acreage expansion came in the 1940s. By the 1950s this area, with less than one-tenth of the national acreage, had nearly one-fifth of the production. Up to 2 bales per acre were raised, with staple lengths of $1\frac{1}{16}$ in. and over. Cultivation is highly mechanized. This area also raises the small U.S. crop of American-Egyptian cotton, with yields of a bale per acre and staple lengths averaging over $1\frac{7}{16}$ in. *See* also COTTON.

See Ladd Haystead and Gilbert C. Fite, *The Agricultural Regions of the U.S.* (1955); U.S. Department of Agriculture, "Land," *1958 Yearbook of Agriculture* (1958). (J. A. TR.)

COTTON FAMINE (1861–65), which devastated the Lancashire cotton industry, was the result of the American Civil War, when the supply of U.S. cotton, which then formed 85% of Lancashire's total consumption of raw material, was almost entirely cut off. The years 1859 and 1860 had been a period of great activity in the cotton trade: large stocks of cotton had been imported, and the stocks of yarns and manufactured goods were unusually large. Had there been no war it is probable that the trade would have been compelled to face a reaction involving a severe spell of depression and short time. It was not therefore till well into the autumn of 1861 (the blockade of the southern ports was established in July of that year) that the pinch first began to be felt in Lancashire. The rise in the price of cotton, which had been the first effect of the war, had enabled the spinners and manufacturers to dispose of large stocks of goods, and it was probably the cessation of demand rather than the lack of supplies of the raw material which first began to produce stagnation in the trade. In the opening weeks of 1862 trouble became acute. Widespread appeals for contributions were sent out with very satisfactory results. In all nearly £1,750,000 was distributed by various relief committees, not including contributions in kind (which were estimated at about £112,000 in value) and relief granted by the boards of guardians. In three years the latter spent just under £2,000,000. The total loss incurred by the whole trade in wages, profits, etc., is incalculable, but must have exceeded £10,000,000. By the time the large prefamine stocks had disappeared (some cotton was actually reshipped to the northern states) other supplies, especially from India, were coming into England, though in comparatively small quantities. The quality of this cotton proved exceedingly unsatisfactory. And although the cotton from Egypt, where quantity was comparatively small, proved better in quality even than U.S. (except Sea Island), at best, however, the total supplies were never more than enough to keep the industry running about half-time. Even after the conclusion of peace in April 1865 it was a long time before supplies reached anything like normal.

See R. A. Arnold, *History of the Cotton Famine* (1864). (A. BRI.)

COTTON GRASS or COTTON SEDGE is the name applied to species of *Eriophorum*, a genus of the sedge family, Cyperaceae (*q.v.*). There are about 15 species, about 10 being North American. They are generally found on wet and boggy moors, and are sometimes planted in the bog garden. The flowers are massed together into heads and each has four or more hairlike bristles at the base. After fertilization these grow out into long, conspicuous, cottony hairs which serve to distribute the seed which is contained in a small dry achene. The alpine cotton grass (*E. alpinum*) and the slender cotton grass (*E. gracile*) occur both in Great Britain and in North America. The Virginia cotton grass (*E. virginicum*), with dingy brown, rarely white, hairs, grows from Newfoundland to Manitoba and

COTTON GRASS (ERIOPHORUM POLYSTACHION), ABOUT ONE-THIRD NATURAL SIZE, SHOWING MATURE FLOWER CLUSTERS CLOTHED WITH WHITE COTTONY HAIRS

southward to Florida and Nebraska. The sheathed cotton grass (*E. callithrix*), found from Newfoundland to Pennsylvania and Wisconsin and northward to the arctic, and also in Asia, forms in Alaska the summer food of reindeer.

COTTON MANUFACTURE. Raw cotton has few uses; processed, or manufactured, cotton has many. This article tells how raw cotton fibres, which are about as fine as human hair and from ½ in. to 2 in. long, are changed into useful products. The main sections of this article are as follows:

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I. MANUFACTURING PROCESSES

The vast bulk of the world's cotton is spun into yarn, which is marketed as such, especially as sewing cotton, or is made into fabrics by weaving, knitting, lacemaking or braiding. Some yarns, and most fabrics, are rendered more attractive and useful by a variety of converting processes, which include bleaching, dyeing and printing, and a wide range of finishing processes, both mechanical (*e.g.*, calendering, stiffening, glazing and raising) and chemical (such as mercerizing, parchmentizing, making crease resistant, waterproofing and rotproofing). The description below outlines the manufacturing processes; for further details *see* SPINNING; WEAVING; YARN.

A. PRODUCTION OF YARNS

1. Preparation for Spinning.—In some countries cotton is grown so near the mills that it can be ginned and carried to the spinner loose in farm wagons, but the usual practice is to deliver ginned cotton in highly compressed bales (*see* COTTON). The raw cotton contains 1%–2% of impurities such as soil, dust particles and bits of leaf and seed husk. A special type of impurity is caused by fibres that have failed to grow properly on the seed and are said to be immature or even dead. They have very thin walls and tend to form tangles that may enclose bits of leaf. These tangles are known as neps and are regarded as a major nuisance by spinners.

Once the cotton is received in the mill the following preparatory and spinning processes take place: (1) the highly compressed cotton is reduced to the greatest possible state of division, and impurities are removed; (2) the fibres are formed into a rope, or sliver; (3) the slivers are drawn between rollers to attenuate them and are sometimes combed to arrange the fibres in parallel rows and to increase the regularity of the material; (4) sufficient twist is inserted into the attenuated slivers, by now called roving, to make a firm thread; (5) where required, two or more threads are combined into a folded yarn; and (6) the yarn is "finished" and prepared for shipment.

The principal machines used in spinning preparation and spinning are: bale breakers, openers, pickers (U.S.) or scutchers (Great Britain), for cleaning and blending the cotton; carding engines, draw frames and, for high-quality yarns, combers, which remove further impurities and form the fibres into a sliver; flyer frames for drawing and twisting; either ring frames or mules, for spinning, and, where folded or ply yarns are produced, winders and doublers, or twisters; cleaning and gassing (singeing) frames; and reels and bundling presses.

The Bale Breaker.—The raw material, in the form of hard compressed slabs from the bale, is fed by hand into a hopper, from where it passes to a system of spiked and latticed conveyor belts. These belts carry the cotton under a spiked roller and then return most of the material to the hopper so that the tearing process can be repeated. As a result of the repeated passes between the two sets of spikes the cotton is reduced to a fairly fluffy state. Besides breaking down the raw material, which has been chosen from bales of different grades so as to give the desired quality of yarn, the bale breaker also mixes the raw cotton. In most cases mixing is completed satisfactorily by the machinery through which the cotton subsequently passes; sometimes, however, in mills that spin fine yarns, mixing is assisted by building up a stack of cotton from the breaker in horizontal layers and, after leaving it for two or three days to become aerated, pulling it down in vertical layers. From the bale breaker the material goes to the opener.

The opening and cleaning range employs various combinations of machines that have several features in common. Their function is to loosen, or open, the tufts of cotton as delivered by the bale breaker and mixing machines, and to separate more of the dirt and trash from the clean cotton. Spiked and other endless lattices are used to lift and convey the mass of cotton over short distances from one part of a machine to another. Beaters break up the tufts, and rotary cages sift the dirt and trash. The beater is a rotary shaft from which protrude blunt spikes or flat-ended blades that strike the cotton as it passes round them. It was once considered sufficient to clean and fluff up the cotton. By the 1950s, however, blending had become equally important because of the advent of high-speed spinning machinery and the more precise methods of measuring and specifying the qualities required of the fibres and yarns. More use came to be made of hoppers for storing and feeding loosened masses of cotton, of automatic devices for weighing and feeding so that blends can be made in exact proportions, and of air currents for conveying loose cotton through lengths of trunking.

The picker (*scutcher*) is the last machine in the opening and cleaning line and, besides picking, has the additional function of forming the loose cotton into a sheet (the lap) nearly an inch thick and rolling it up into a package weighing 40–50 lb. The regularity of this lap is important for the success of subsequent processes, and a device known as an evener motion is used to control the rate at which cotton reaches the lap-forming mechanism so that across and along the length of the lap there is, as near as possible, the same weight of cotton per inch.

The Carding Engine or Card.—Here the elimination of impurities, including neps, is completed. The picker lap is reduced for a brief moment to gossamer fineness and then rolled into a soft rope called a sliver. Trash and short, broken and immature fibres are jettisoned but the machine must be carefully set and supervised so that it does not create more neps than it removes.

At the start of the carding operation, the picker lap is unwound by a small roller and presented to a taker-in roller, or licker-in. This consists of a series of fine-toothed circular saws mounted together on a shaft. The teeth move at a speed of about 1,000 ft. a minute and tear away small bunches of fibre from the lap. These are stripped from the licker-in by a cylinder, about 40 in. in diameter, that is covered with closely set steel wire teeth and revolves at about 2,000 ft. a minute. Above part of this cylinder are narrow bars, called flats, that are carried by an endless belt and are covered with wire teeth similar to those on the cylinder but pointed in the opposite direction. The cotton passes between the cylinder and the flats; the distance between them is set to about seven one-thousandths of an inch. Since the flats move in the same direction as the cylinder but only at two to three inches a minute they have a retarding and combing action and pick up the trash, short fibres and neps. This material is removed

from the flats by a comb and a rotary brush and is deposited n a waste receptacle. The good cotton is held between the wire eeth on the main cylinder, from which it is doffed by a smaller ylinder. This doffer also has wire points, facing into those of he main cylinder, but travels at only about $\frac{1}{25}$th of the speed. A rapidly rocking comb takes the cotton fibres from the doffer n a continuous sheet nearly as fine as a spider's web. The web s immediately formed into a sliver by a pair of rollers that pull t through a trumpet- or funnel-shaped hole and pass it on to a mechanism that coils it into a tall can.

Formerly, the carding operation created a very dusty atmosphere in its part of a cotton mill and the dust gave rise to byssinosis, a form of pneumonoconiosis (*q.v.*). As a result of research work, the carding engine was modified so that no dust can escape into the atmosphere and it has become possible to have an atmosphere in the card room that is cleaner than the outside atmosphere.

The Draw Frame.—It is only necessary to attenuate and twist he card sliver to produce a yarn. The initial processing at this tage is carried out on the draw frame. Steps are taken to make he sliver more regular and to arrange the constituent fibres in pproximately parallel order. Four, six or eight card slivers are blended into one on the probability that a thick place in one sliver will balance out a thin place in another. To prevent the combined liver from becoming thick, the blending is accompanied by attenuation, or drafting, as a result of which the product becomes our, six or eight times as long as but no thicker than one of the ard slivers. The draw frame has four pairs of smooth, leather-overed rollers arranged fairly close together in four rows. The airs are driven so that the speed of rotation increases from row o row until the front pair is moving four, six or eight times as ast as the back pair, depending on the number of card slivers eing fed into the machine. Because of the increasing roller peed, the individual fibres slip forward as they pass between the airs of rollers and are also pulled straight. The increasing amount f parallelism of the fibres becomes apparent in the increased ustre of the draw-frame sliver, which is quite silky. The process ay be repeated two or three times on the assumption that the egularity of the sliver is improved every time the sliver passes hrough the draw frame. Spinners now realize, however, that the epetition can be overdone.

The Comber.—For high-quality and fine (*i.e.*, thin) yarns, it is sual to remove 5%–15% or even 20% of the shorter fibres as his enhances the "spinnability" of the remainder. To remove the bres the slivers are recombined into small rolled-up laps that re fed to the comber. At regular intervals a lap is advanced so o present a fringe to a set of combs that pass through the inge and take out the loose, short fibres. These are detached om the combs and reserved for use in spinning a coarser yarn. he combed fringe is then pushed forward and combined with ie tail of the previous fringe. The machine usually has six mbing units, and the six combed laps are combined and drafted to one combed sliver, which may then be passed through the raw frame again.

Drafting Machines.—To complete the attenuation of the sliver ie same principle of drafting by means of rollers is exploited a series of machines known collectively as speed frames and ndividually as slubbing, intermediate, roving and fine jack frames. ne machine drafts (*i.e.*, reduces the bulk and weight per unit f length) the sliver about six times; the thinner product, known s roving, is passed to the next machine, where it is drafted nother six times and so on down the line of frames. During the peration, the opportunity is taken to make the products more egular by blending, two slivers or rovings being fed together to ie rollers. The drafted product, at each stage, must be wound to a package that is convenient to handle and set up on the ext machine. It must also be twisted enough to make it stand ntle pulls during the winding and unwinding but not enough to nder drafting. The twisting is performed on flyer spindles. The ckage, called a bobbin, is built up on a wooden support, also lled a bobbin, that fits loosely on a vertical spindle to whose p is fixed a hollow, inverted U-shaped device, the flyer. The roving passes through the flyer to the bobbin, which it drags round; because of the high speed of rotation of the spindle and flyer, twist is inserted in the roving as it passes from the flyer to the bobbin. The bobbin rests on a frame through which the spindle protrudes; the frame rises and falls so that the coils of roving are laid down in regular succession over the major part of the length of the bobbin.

The limit to which the traditional roller drafting (invented by Lewis Paul in 1738) can be carried in one stage depends on the staple length of the cotton and the distance between nips of the roller pairs; the maximum attenuation possible with traditional drafting machines is a draft of about six. If the pairs of rollers are too close together many fibres will be ruptured. If they are too far apart many fibres will be floating loose between them, with a risk that the product will build up unevenly. This risk has led machine makers to avoid relying on two pairs of rollers to effect the desired draft and to divide the draft between three or four pairs, each pair revolving faster than the pair behind it. These three- or four-line roller systems are the rule, especially on the spinning frames proper. At the turn of the 20th century it was realized that if the floating fibres could be controlled much longer or higher drafts would be feasible; many long or high drafting systems are available. In some, the space between the pairs of drafting rollers is filled out by inserting thin rollers that support the product as it is being drafted. In others a pair of endless traveling belts (called aprons) is used as support; small trumpet-like supports are also used. These systems of fibre control are usually fitted to the spinning machine and have rendered some of the traditional speed frames redundant. Drafts of 30 or more, instead are 6, are currently attained in spinning, without detriment to yarn quality. Indeed, experimental and testing machines are in use that spin directly from card sliver with a draft of 900 and more.

2. Spinning.—Spinning machines continue the blending and drafting begun on the speed frames, but they also insert twist in the desired direction and to the desired extent and wind the yarn into packages—known as cops, or bobbins—that vary in size according to the purpose for which the yarn is intended. Two types of machine are used: the mule, which was invented by Samuel Crompton in 1779 and is a cross between J. Hargreaves' spinning jenny (1764) and R. Arkwright's water frame (1769); and the ring frame, which was invented by John Thorp in the U.S. in 1828 and which by the early 1960s had almost entirely replaced the mule.

Mule Spinning.—In the early 1960s mule spinning was obsolete in the United States and declining rapidly in England and other parts of the world (see *Economic Development of the Cotton Industry: Machinery,* below). However, many British spinners claim that, for some purposes, the mule produces a better yarn than the ring frame and it is still used for spinning the finest yarns in numbers above about 200.

In the mule the action is intermittent, twisting and winding being separate operations. The roving from a creel of bobbins is passed in the usual way through a roller drafting system to a bare spindle mounted on a carriage that runs on rails. The carriage may accommodate as many as 1,200 spindles in two groups on either side of the driving mechanism. Spinning begins with the carriage close to the drafting rollers. As the drafted roving is delivered to the spindle the carriage moves away and the rapidly revolving spindle inserts twist. The carriage moves a distance (known as the draw or stretch) of 54–66 in. and then stops an instant while the spindles continue to revolve. It then moves back toward the rollers and during this inward run the stretch of twisted yarn on the spindle is wound into a cop of the desired shape.

Ring Spinning.—In this process the drafted roving is twisted into yarn and wound onto a bobbin simultaneously and continuously as in the flyer frames except that on the ring frame the flyer is replaced by a smooth ring with a flanged upper edge over which is sprung a small C-shaped piece of steel wire or plastic known as a traveler. The spindle, carrying a wood, paper or metal support for the bobbin (itself known as an empty bobbin), projects vertically through the horizontal ring. The drafted roving runs

from the drafting system to the traveler a few inches away and then to the bobbin; as the latter revolves with the spindle the yarn drags the traveler round the ring and the twist is thus inserted. The ring is mounted on a rail that moves up and down so that the yarn is laid down as a close succession of coils on the bobbin. The size of the bobbin and the degree to which the yarn is twisted are governed by the diameter of the ring and weight of the traveler.

A fundamental difference between the ring and mule methods of spinning is that the length of the element of yarn that receives twist at a given moment is only a few inches on the ring frame but is 54–66 in. on the mule. This may account for some of the alleged differences in yarn quality.

3. Doubling.—For many purposes two or more single spun yarns are twisted together (doubled), usually by ring and traveler or flyer mechanism but, as attenuation is not required, the drafting system is replaced by feed rollers. The singles may be run through a trough of water. Wet doubling produces a firm and smooth yarn, but dry doubling gives a softer product.

Further processes include the production of cords; for example, by twisting together three doubled yarns. The variety of yarns that can be produced depends on the direction and degree of the twist inserted in the component "singles" and in the various folding, or plying, operations that follow. An endless range of novelty or fancy yarns can be produced by plying together different types or colours of single yarns, by feeding one yarn to the twisting device much faster than the other so that it corkscrews around it, or by feeding one yarn alternately fast and slowly so that the product is uneven in thickness (see *Varieties of Cotton Products*, below).

4. Finishing and Making-Up.—When lustre and smoothness are desired, the yarn is passed several times through a gas flame or red-hot tube at such a speed that the fibres projecting from the surface are burned off without damaging the rest of the yarn. This process is known as gassing, or singeing. Such yarns may also be polished by repeated calenderings between a pair of heavily loaded rollers.

B. Production of Fabrics

Weaving is the process by which longitudinal yarns, known as the warp, are interlaced at right angles with transverse yarns, called the filling or weft, by means of a loom. The discussion below deals with the principal processes that take place during the weaving of cotton goods.

1. Preparation for Weaving.—Yarn from the spinning room must be specially wound for the weaving machinery, and its preparation depends on whether it is to be the warp or the weft.

The filling yarn (weft) is sometimes sent to the weave room on the bobbins on which it left the spinning frame, but in the modern process much yarn is rewound onto cones and then into the packages (called cops, quills or pirns) demanded by modern automatic looms. The second part of the rewinding process is carried out by automatic quill winders that tightly wind nearly double the amount of yarn that can otherwise be wound on a quill. Rewinding also provides an opportunity to break out weak places and join up the good yarn; to facilitate this, the operative usually wears on the back of his thumb a little device for tying uniform knots.

Warp yarn needs more preparation for the loom and is usually spooled, warped and slashed (sized).

2. Spooling.—The function of the spooler is to unwind the yarn from the bobbins onto which it was spun and to rewind it on a large package called a cheese, which weighs as much as ten pounds. The machine consists of a long frame that supports a row of bobbins in a vertical position on either side and, above them, a row of cheeses arranged on either side of a horizontal drum. A knot-tying device, called a traveler, circles a track on top of the frame at preset intervals (usually about three minutes). When it has attached the yarn from the full bobbins to the cheeses, the arms that hold the cheeses press them against the drum, which is revolving at high speed. This drives the cheeses by friction and makes winding possible at speeds of 900–1,200 yd. a minute. When the bobbin runs out, the yarn breaks or the cheese fills up, the cheese arm lifts the cheese free of the drum. Empty bobbins are dropped on a conveyor belt and new ones fall into place from a reserve.

3. Warping.—The purpose of warping is to run 200–400 equally long threads side by side onto a single beam. The sheet thus formed is then finally prepared for weaving in the slasher.

The full cheeses of yarn are doffed from the spooler and taken to the warper. There they are put into the warp creel, a framework of vertical metal bars, each of which holds 9–12 cheeses. Two creel sections are placed in the form of a V with the cheeses on the outside and the junction pointing toward the horizontal beam onto which the yarn is to be wound. Because of the frailty of the yarn, the motor driving this take-up beam starts slowly; it also stops automatically if the yarn breaks. In the high-speed warper both sides of the creel are fitted with spring cores to hold the cheeses, and operatives place cheeses on the inside while the winding is taking place. As soon as the outside cheeses are exhausted the position of the creels is reversed.

4. Slashing.—In the slasher (known as a tape frame in England) several beams of yarn from the warper are combined on one loom beam to give the number of warp yarns (several thousand) necessary for the loom; they are then coated with size (mostly starch) to prevent chafing during weaving.

The warper beams are mounted horizontally across the back frame of the slasher and are brought together in a single sheet at a condenser comb, or bar. The sheet is then treated with size solution, usually by running it between rollers below the surface of the size in the size box. It is important that the warp yarn should pick up a correct and constant quantity of size, about 7%–10% for good weaving, and so the viscosity and concentration of the solution must be watched carefully. As a result of research work conducted in the 1950s, many tape frames in England were fitted with automatic controls. The basic ingredients of the size, chosen for its cheapness, is usually cornstarch in the U.S. and potato starch, flour or sago in the U.K. Other ingredients—for example, softeners, lubricants, emulsifiers and materials to prevent the growth of mildew—are usually present in small quantities. A typical formula for gingham is 80 lb. of starch, 5 lb. of softener and 100 gal. of water, which makes 125 gal. of size.

After leaving the size box the sheet goes to the drier, which, in the U.S., usually consists of two or three steam-heated metal-surface cylinders. The aim in drying is to leave the yarn with a moisture content of about 8%–10%; complete dryness is avoided. When the sheet emerges, the yarns are stuck together with the hardened size solution and have to be split apart by rods and combs; the sheet is then wound on a loom beam and stored until needed for weaving.

In the 1960s homogenizers were replacing the kettles in which the size previously had been cooked. These render the material homogeneous without cooking and make it possible to use pearl starch, which is cheap, instead of the more expensive thin-boiling starch. In some mills hot-air driers are used instead of steam cans. Although this procedure is somewhat more expensive, it has two advantages over the older method: the sheet can be separated into individual yarns while still wet, thus avoiding the ragged edges caused by separating them when they are dry, and the dried yarn is perfectly round, whereas if it is pressed against a metal cylinder it emerges flat on one side.

5. Action on the Loom.—The warp is brought to the back of the loom on a beam that carries the number of ends needed to give the desired width and density (ends per inch) to the woven fabric. Each end is threaded through an eye in a set of heddles, or healds, and between the teeth of a fine comb, known as a reed, before being secured at the front of the loom, usually to the ends of a previous warp. A heddle is a string or wire with an eye at its midpoint; a large number of heddles are stretched across a wooden or metal frame that is as wide as the loom, and several of these frames, or shafts, are suspended one in front of another at the back of the loom. Mechanism is provided for alternately lifting and lowering the frames so that a lozenge-shaped gap, called the warp shed, can be created between warp threads that are up and those that are down.

The filling (weft) is brought to the loom as a tightly wound package inserted in a shuttle; the shuttle is struck by the picking device and made to pass on the smooth track (race board) of the sley. The sley is an apparatus that extends across the loom and rocks to and fro, being pivoted to a shaft in the lower part of the loom. It carries the reed and, just below this, the race board.

The picking device is usually a strong stick, faced at its striking end with buffalo hide or other wear-resistant material. The other end is mounted in the loom mechanism, from which, by means of a cam, it is made to give a powerful blow to the end of the shuttle. For a long time engineers have considered this traditional picking to be quite inefficient. The aim is to carry across the loom a short length of yarn—say 30–120 in.—whose weight is negligible, but a filling package weighing several ounces is put into a much heavier shuttle and picked hundreds of times before it is used up. The force required to insert filling at a given speed increases proportionately with the cube of the weight of the filling package, so the traditional method wastes an enormous amount of power. It is not surprising, therefore, that in the mid-20th century other methods of inserting filling were made available. In some, packages of filling yarn are mounted at both sides of the loom and the traditional shuttle is reduced to a bulletlike gripper, about the size of a man's small finger, that engages the end of the filling as it flies across the loom and releases it at the opposite side. In other new types of loom, puffs of air are employed to carry the filling.

As soon as the shuttle passes through the warp shed, the heddles reverse and the shuttle is picked back again, this time riding over the warp ends that it passed under on the forward journey. At each pick, the length of weft that has escaped through the eye of the shuttle is pushed up tightly against the fell of the woven cloth by the reed. This is known as beating up. The cloth is wound tightly on a roller and, meanwhile, the warp beam is turned slightly to let off more warp to replace that already made into cloth. All these operations—the letting off of warp, the forming of the shed, the picking of weft, the beat up and the take-up of the cloth—must work in harmony and at speeds up to 200 or more picks a minute for cloth about one yard wide. The adjustment of a loom is aptly called tuning.

The simplest weave is a "one over, one under" interlacing of warp and weft. The effect of diagonal lines, known as twill, is introduced into a fabric by making the weft go over two or three and under one end in the first pick, and over a different set of two or three ends in the second pick, and so on. Patterns can be woven by arranging groups of coloured ends on the warp beam —this being the best way to produce stripes—or by using two or more shuttles with wefts of different colours. Colour-bordered tablecloths and cloths with coloured squares are produced in this way. By means of a dobby, a mechanism that can manipulate about 25 heddle frames to effect more complex shedding arrangements, an almost endless variety of geometrical patterns can be woven—checks, diagonals and so forth. Even more elaborate is the Jacquard mechanism, which is used to control the shedding of individual warps rather than regularly deployed sets of them; this makes it possible to weave floral and other nongeometrical patterns. Another method of weaving uses two warp beams, one of which lets off its yarn faster than the other so that at the beat up the longer pieces of yarn form into loops between the short pieces. Fabrics such as turkish toweling are made in this way. All these methods are used all over the world; some of the many fabrics manufactured are listed below under *Varieties of Cotton Products: Varieties of Cotton Fabrics* or are described in separate articles.

6. Other Types of Production.—*Knitting.*—Much cotton yarn was formerly knitted into cheap stockings and socks, but by the mid-20th century the man-made fibres were providing more attractive products. However, cotton continued to be used largely for comfortable underwear that was either fashioned from knitted fabrics or knitted as entire garments. (*See* KNITTING.)

Lacemaking.—Some of the finest cotton yarn is manufactured into lace, ranging from curtains to trimmings.

Braiding.—Other trimmings and articles like shoestrings are made by braiding, in which yarns are interlaced at an angle less than 90°. Sometimes this is done about a core, a very familiar example being the braided insulation of electrical wire (flex). The operation of braiding recalls the old-time maypole dance, the separate packages of yarn corresponding to the dancers and the central core to the pole.

C. Converting of Cotton Goods

Only a small percentage of woven cloth is sold to the consumer in the condition in which it leaves the weave shed; *i.e.*, in the loom state or the gray. Much of it is bleached, dyed or printed and subjected to various finishing treatments, the procedure chosen depending on the construction of the fabric and the use for which it is intended. A brief outline of some of the more important operations follows.

Usually the gray goods are received from the weaver in lengths of 120 yd. or 240 yd. The pieces are inspected for imperfections, marked with a lot number for identification purposes and sewn end to end to permit processing in continuous lengths. They are then passed over a gas or electric singeing machine, where the short fibres protruding from the surface of the cloth are burned off. The goods may next go to a desizing machine, where the starch that was employed in sizing the warp yarns before weaving is removed. For this purpose enzymes that digest starch are often used.

1. Scouring and Bleaching.—Before cotton piece goods are bleached they usually are boiled for several hours with dilute caustic soda (sodium hydroxide) solution in a closed vessel, called a kier, to remove the natural oils, waxes and other impurities. Next they are rinsed, soured in a dilute solution of sulfuric or hydrochloric acid, rinsed, chemicked by being passed through a solution of sodium hypochlorite, piled in bins to permit the bleaching action to take place, rinsed, passed through a solution of sulfurous acid or other antichlor to remove the last traces of chlorine, again rinsed, passed through a water mangle to squeeze out excess water and dried on a set of revolving steam-heated cylinders, or cans. Bleaching can also be carried out in the kier by means of an alkaline solution of hydrogen peroxide, after which the cloth is rinsed and dried. Sodium chlorite won favour as a bleaching agent because it is easier to control and the cotton is not overbleached and weakened (tendered) in the process. Many bleachworks practise continuous bleaching, the gray cloth passing in succession through a series of scouring, washing and bleaching units. (*See* BLEACHING.)

2. Dyeing and Printing.—Dyeing is often carried out in machines in which a batch of the cloth, stitched end to end, is carried through tanks of hot dye liquor. In some machines a pair of rollers are submerged in the liquor; the cloth travels between them and is padded with the dye. Continuous machines are also used. They consist of long tanks with a set of rollers at the top alternating with another set near the bottom. The cloth runs alternately over a top roller and under a bottom roller and so travels from one end of the tank to the other. Fabrics that are to be dyed in light or medium shades are bleached before dyeing. Bleaching is frequently omitted if the fabrics are to be dyed in dark shades. Printing is usually carried out on roller printing machines, although some fabrics are screen printed (*see* TEXTILE PRINTING). After being printed, the fabric is frequently passed through a steam chest, called an ager, and then through a continuous washer before being dried. The choice of dyestuff depends on its cost and the purpose for which the fabric is intended. Dyes that provide the highest degree of fastness to washing are used in articles such as handkerchiefs and children's frocks; those that provide fastness to light (*i.e.*, resistance to fading) are used in sun blinds and curtains; and those that provide fastness to perspiration are used in coloured garments worn next to the skin. (*See* DYES.)

3. Finishing.—The white, dyed or printed goods are dried on steam-heated drums or in hot-air chambers and then finished. Finishing may be a mechanical process, assisted by starches, dextrins, gums, china clay and other agents designed to smooth, stiffen

and in other ways improve the feel (handle) of the cloth, or it may be a chemical process.

In mechanical finishing the two types of equipment used for applying the finishing agents are starch mangles and backfilling machines, the latter being designed to apply the finish to one side of the cloth only. After the finishing agents have been applied the cloth is partially dried, then passed over a stenter, or tenter, where drying is completed and the fabric is stretched to the desired width and straightened. On this machine the fabric is held taut by pins or clips as it passes through a drying chamber. The pins or clips are attached to endless belts and the distance between the belts gradually increases so that the fabric is stretched widthways. Various types of calenders are employed to give smooth, lustrous or embossed effects. These machines consist essentially of metal, paper or fibre rolls between which the cloth is passed under considerable pressure. A linenlike appearance is obtained by use of a beetle—a machine that drops heavy wooden posts on the cloth as it travels over a steel roll.

Controlled-shrinking machines of various types are employed to counteract the stretching effect of the preceding operations and thus to prevent the fabric from shrinking upon laundering. Certain fabrics, such as cotton blankets and flannelette, are run over a raising machine to produce a nap.

Chemical finishing is commonly applied to cotton goods before they are given a mechanical finishing. Chemical finishing consists of using certain chemicals to obtain specific effects, which are of great importance to the cotton industry since they make cotton a fashionable, rather than a purely utilitarian, material. The first truly chemical finish to be employed was mercerizing (*q.v.*), named after John Mercer, an English dyeworks chemist. In 1844 he discovered that when cotton is steeped in sodium hydroxide (especially of 18% strength) the fibres shrink in length, swell and become round in outline, and dye to a deeper shade. With this process he produced fabrics with dark, puckered spots on a paler ground; some types of modern seersucker fabrics are their descendants. Later (1889–90), Horace Lowe, a bleachworks chemist working near Stockport, Eng., discovered that if the cotton (yarn or fabric) is held in the caustic soda so that it cannot shrink, or is stretched to its full length while still in the alkali, it acquires a silky lustre. This is the really valuable effect of mercerization and the process is commonly applied to high-quality cotton fabrics such as poplins.

Strong sulfuric acid has a parchmentizing effect on cotton; for instance, it is used to give the swiss-organdy finish in which the cotton fabric becomes stiff and semitransparent. Other chemicals are used as proofing agents. Cotton fabrics are made waterproof or water repellent by depositing an alum soap within and between the fibres, or by the surface action of one of the silicones. A variety of efficient antiseptics is available for making cotton goods rotproof. In the early 1960s the problem of making fabric fireproof without making it uncomfortable to wear was at last within sight of a satisfactory solution, due to the discovery of a range of organic derivatives of phosphoric acid.

Perhaps the discovery that has had the most profound effect on cotton and rayon finishing was the outcome of research into crease resistance, carried out in 1918–39 by an English firm that discovered a way of producing a synthetic resin within the fibre by combining chemicals like formaldehyde and urea. These resin treatments became almost legion and are the basis of drip-dry, minimum-iron and related finishes. (J. C. Wi.)

II. VARIETIES OF COTTON PRODUCTS

1. Yarn.—*Yarn Numbering or Count System.*—The fineness of yarn is measured, in English-speaking countries, by the number of hanks of yarn that weigh one pound. In the U.S. this is known as its number, in the U.K. as its count. A hank is 840 yd. long, and so, for example, one pound of no. 10 (10s count) cotton yarn would unwind to 8,400 yd. In other countries metric units are used. It is difficult to compare cotton yarns with those of wool, rayon and silk since the hank of wool in English-speaking countries is 560 yd. and the number for silk and rayon is based on the weight in grams of 9,000 m. of yarn. Thus numbers for cotton and wool are based on length per unit weight and are higher for fine yarns than coarse, and numbers for silk and rayon are based on weight per unit length and the fine yarns have the small numbers. Since mills tend to spin, and manufacturers to use, more than one type of fibre, a change-over to a universal system based on weight in grams per kilometre, or per ten kilometres, for all fibres was being widely considered in the early 1960s.

Yarn Twist.—Traditionally such terms as regular, reverse, twist-way and weftway were used to describe the direction of twist in a yarn. These were found very confusing and so the practice of designating the twist Z-way or S-way according to the direction of slope of the stems of these capital letters became established; this plan was first suggested in the U.S. in 1934. The magnitude of the twist is recorded as the number of turns per inch or by a twist factor (loosely termed a constant or multiplier) determined by dividing the number of turns per inch by the square root of the count.

Yarn Strength.—The strength, or breaking load, of cotton yarn is measured by a tensile-testing machine applied either to a single yarn or to a lea (120 yd.) that is wound on a reel 54 in. in circumference; when leas are tested, the breaking load is applied to 160 yarns at the same time. The breaking load of a cotton yarn depends only to a minor extent on the intrinsic strength of a cotton fibre; the important factors are number and twist. Breaking load increases with twist up to a certain point and then declines. A useful basis on which to compare different cottons is the product of the lea strength and number; spinning conditions are best when this product is a maximum.

The number to which a given type of cotton can be spun commercially depends mainly on its staple length; the long cottons yield the finer yarns. Short Indian cottons spin up to about 16s, American cottons to 44s, Egyptian cottons to 150s and Sea Island cotton to 400s.

2. Varieties of Cotton Yarns.—Practically all U.S. spun yarns have Z twist; S twist is used for special purposes only, especially for making ply yarns. British spun yarn, when used for warp, has Z twist and is called twist yarn; yarn for filling (weft) is generally S twist unless otherwise specified.

The twist factors of warp yarns usually vary between 3.5 and 4.75. Filling yarns generally have fewer twists and are softer, fuller yarns. Their factors vary between 3 and 4.25. Cloths that are to have a raised nap are manufactured from soft-twist fillings with factors from 2.50 to 3.

Condenser waste yarns used as weft yarn for such products as blankets, sheetings and twills are made from waste fibres that are carded, rubbed between a pair of endless leather belts into cylindrical or sliver form on a condenser card, and are spun on a condenser mule into 1s to 12s yarns without any drawing processes.

Knitting (hosiery) yarns are coarse, medium or fine-count single or ply yarns that are spun with a softer (knitting) twist than usual for weaving. Their factors vary from 2.50 to 3.

Ply yarn (U.S.), which is also called folded yarn (U.K.), is made by plying (doubling together) two or more ends of yarn. Usually the direction of twisting is opposite to that already used in the single yarns unless very wiry yarns are required; *e.g.*, voile yarns. The majority are two-ply and are used where special strength is required, as in army ducks or airplane cloth.

Cable yarns are made of two or more ply yarns twisted together. Several varieties are made for cordage, twine, fish nets, etc. When made with ZSZ twists, it is known as cable twist; that with a ZZS or SSZ twist is called hawser twist and is a tighter, wiry yarn. Both cable- and hawser-twist yarns are used in making fishing nets; in machine-manufactured nets they are used alternately to balance the shrinkage or contraction.

Thread or spool cottons used for sewing and embroidery are ply or cable yarns that have been specially twisted, combed and processed. Only Sea Island and the finest and strongest Egyptian cottons are used. After being twisted either wet or dry, the yarn is gassed to remove projecting fibres. It is then bleached or dyed; most yarn is also mercerized to give it a silky finish and finally

is waxed. If it is not processed it is described as soft finished. Crochet yarn is usually combed and is then carded before being softly twisted into a two-, three- or four-cord thread. Lace thread, which is made from Sea Island, Egyptian and fine American cottons, is supercombed, hard-twisted and gassed.

Coloured yarns are generally obtained by dyeing single yarns in solid colours. They can also be made from stock-dyed cotton fibres. A blended or mixture yarn, like that used in heather mixtures, is a plied yarn made by blending contrasting stock-dyed yarns. A mottled, or two-tone yarn, on the other hand, is a single yarn spun from a blend of different-coloured rovings. They are called mock twist (U.S.) or mock grandrelle (U.K.) and are used mostly in converts (finished fabrics) and mottled flannels. Sometimes roving, single yarns or ply yarns are printed throughout with a pattern of one or more colours. They are used in warp for decorative flannels, shirtings and tie fabrics and are called printed yarns. Yarn is also treated chemically to resist dye; this resist yarn is used, for example, in the manufacture of striped fabrics since after it is woven the ground cloth can be dyed without being affected.

Ply yarns with special effects are usually called novelty yarns.

Spiral yarn is made by plying two different-size yarns together and feeding the heavier yarn in excess so that it curls round the lighter one.

Chenille yarn is not a spun yarn but is cut from a specially woven cloth known as chenille weft fabric. The cut yarn has projecting tufts (cut-weft yarns) along its sides; the tufts are held tightly in place by the firm-woven warp ends. Ratiné yarn has loop effects throughout and is made of three or more different-size yarns that are unevenly plied. Bouclé yarn is similar to spiral yarn but is more exaggerated.

Slub yarn (himalaya, shantung, cloud, flake or snowflake yarn) is usually a simple yarn that has been spun unevenly by means of special gears at the spinning frame. The heavy patches in flake, snowflake, cloud or shantung are shorter than those in himalaya slub.

Core yarn is manufactured by plying a single cotton yarn with a heavy, bulky one (usually of Chinese or Indian cotton). It is used as filling yarn for blankets and, when napped, retains most of its strength. Woolen and cotton-and-woolen mixture yarns are also made with a cotton core. Rubber-core yarns are those with a round or flat rubber core, around which is wound a fine, single combed yarn (80s, 100s) and afterward a second fine yarn in the opposite direction. Such yarn is described by the number of yards that weigh one pound; *e.g.*, 1,600-yd. yarn.

Union or mixed yarn is a single yarn made from cotton and wool or other fibres mixed or blended together. Part-wool yarns are made with varying percentages of wool and cotton and are manufactured into hosiery and underwear. The British name for a fine wool and cotton mixture is angola. Linen, cut rayon and silk are also used.

Coarse blanket yarns, usually heavier than no. 1, are known in the U.K. as bump yarns. They are measured in yards per ounce and are used as wadding or stuffer yarns to give weight in heavy quilt fabrics.

3. Varieties of Cotton Fabrics.—Cotton cloth traded in U.S., Canadian and British markets is classified in three broad divisions: (1) gray cloths—those woven of unbleached yarns and in some cases used in that state; (2) finished or converted cloths, which are gray cloths converted by bleaching, dyeing, printing and finishing; (3) woven coloured-yarn cloths, or mill-finished cloths—those woven and finished ready for use by the mills making them.

Another classification, with more general significance, is made according to use: the divisions then are: (1) apparel or clothing materials; (2) domestic or household goods, such as sheets, curtains, upholstery fabrics and towels; and (3) industrial fabrics. The last group includes tire fabrics, wagon covers, filter cloths for liquids and air, conveyor belts for mines, tentage, sailcloths and a host of other heavy fabrics. The most important types of cloth are described below and in separate articles, such as: Brocade; Buckram; Calico; Cambric; Chenille; Cheviot Cloth; Chintz; Corduroy; Crash; Crepe; Cretonne; Damask; Dimity; Duck; Flannel; Gabardine; Gingham; Holland; Moiré; Moleskin; Muslin; Serge; Voile.

Airplane and balloon fabrics, two of the strongest cloths made, are plain woven from Sea Island, Egyptian or long-staple American cotton. The former is usually made from two-ply combed yarns (mercerized or plain). Balloon fabric is manufactured from extra-strong, long-staple cotton and is usually a single-yarn cloth.

Beach cloth is a strong cotton fabric with a loose weave; it is made of two-ply carded yarn. Bunting is a thinner, equally loosely woven fabric that, like beach cloth, is used chiefly for flags and draperies.

Bouclé is a rough-surfaced material woven from bouclé yarn (see *Varieties of Cotton Yarns*, above).

Cheesecloth and gauze are loosely woven, soft, light, plain-woven fabrics with a low thread count that are used as surgical dressings, tea bags, linings and bookbinding and for wrapping meat and cheese. A similar fabric, lightly stiffened, is tarlatan.

The rough pebbly surface of crepe is obtained in various ways: by using high-twist crepe yarns; by altering the yarn tensions during weaving, as for example in seersucker (crimp); by weaving fine warp and coarse filling in granite or mock leno weaves; or by finishing the cloth with caustic soda, printing and then embossing it with crepe rollers.

Donegal, originally an Irish peasants' homespun cloth, is a tweedy fabric made with coarse ply yarns twisted together.

The ribs in grosgrain, a close, hard-finish fabric, are formed by weaving a number of filling yarns as one. It is heavier than poplin and used for women's wear and trimmings.

Lawn is the basic fine, combed-yarn, plain-woven gray cloth used for converting into fabrics such as batiste, mull, muslin, nainsook and organdy. It is also the name of a starched crisp finish known variously as india lawn, victoria lawn and persian lawn (which is the finest made). Handkerchief lawn usually has a high thread count and a soft finish. Batiste is a highly mercerized, soft-finished, lightweight fabric used for lingerie, summer dresses and linings. (In the U.S. corset trade the term refers to a heavy, plain-woven, poplin-type fabric.) Nainsook is a bleached material; it is dyed pastel shades, soft finished and has a slight lustre. Such fabrics are used for underwear and infants' clothing and are frequently embroidered. British nainsooks are also known as white shirtings in the export markets. Muslin is made from lawn that has been bleached, dyed or printed. In the U.S. it is also the name of a finish given to white piece goods, such as sheetings. Organdy has a transparent, stiff finish and is one of the finest and sheerest fabrics made. It is usually bleached, dyed or printed, mercerized and given a very crisp permanent finish or a firm but temporary starched finish.

Leno fabrics have an open, gauzelike appearance that is obtained by causing certain warp threads, called doups, to swing across one or more adjacent warp threads in the course of weaving. Many beautiful fabrics are made by combining these cross weaves with other weaves. Marquisette is a sheer, leno-woven curtain fabric.

Osnaburg is plain woven from rough, uneven yarn and is a gray cloth with a low thread count. It is used for bags or is converted when it has a linenlike appearance. Hop sacking is similar to osnaburg but is made from cleaner yarn; it has a lower thread count, is given a soft finish and is used, unbleached or dyed, for men's wear.

In the U.S. piqué is always a carded- or combed-yarn fabric with narrow raised cords running warpwise. The very narrow corded material is known as pin wale; the heavier varieties are called bedford cloth, which is used for riding clothes, uniforms, car upholstery, etc., and is sometimes napped on the back for warmth. In Britain, piqués also have welts running weft-wise. Fancy piqués are compound fabrics made with quilted, or puffed, designs.

Print cloth is a carded-yarn, plain-woven, medium-weight staple fabric. It is made with yarns from 28s to 42s and is the fabric most widely used in the U.S. market for converting. It appears with different finishes under various names—such as printed

percale, cambric, organdy, printed shirting, muslin, crepe, canvas, chintz, interlining, bias binding—and is often used as a substitute for better cloth of the same name. The British fabrics known as Burnley printers are similar to print cloth. They are basic gray cloths used for converting into printed shirtings, white shirtings and drapery fabrics.

Dobby- or jacquard-woven fabrics in white or white and coloured yarns with quilted, raised or flat designs are used for counterpanes. British fabrics include patent satin or mitcheline, toilet and Marseilles, all compound fabrics (that is, two fabrics woven back to back and closely interwoven by bringing occasional warp threads from the back to the front and vice versa) that use fine yarns for the design on the face of the cloth and heavy yarns for the back cloth. Alhambra, honeycomb and crochet quilt fabrics are cheaper and lighter. U.S.-made quilt fabrics include a number of white and coloured fabrics of various weights with flat or quilted design that are generally referred to as jacquard bedspreads or according to the type of pattern used, such as colonial, peasant, dimity, crinkle stripe, etc. For ratiné, see *Varieties of Cotton Yarns,* above.

Sateens are smooth-faced cotton fabrics made with a satin weave, either warp faced or weft faced. Five harnesses (heddle shafts) are used. In weaving a warp sateen, each warp yarn floats over four weft yarns and interlaces with the fifth; for a weft sateen, the weft yarns float over the warp ones. The bindings or interlacings are as far apart as possible to obtain a smooth surface and avoid a diagonal line effect, and because of their smooth surface they take a highly lustrous surface when mercerized and schreinered (passed between special rollers). Sateens are used for linings, underwear and umbrellas, and are bleached, dyed and printed for numerous other purposes such as tropical suiting, uniforms and draperies.

British sheetings are made in plain or twill weaves. The regular plain-woven narrow sheetings are generally given a white finish and are strong and serviceable. Medium-weight narrow British sheetings are also called domestics. Wide bed sheetings are strong and have a high thread count. Twill-woven sheetings usually have heavy condenser weft yarns that give the fabric a soft texture. American sheetings are always plain woven, mostly of carded yarns. Narrow sheetings up to 40 in. are largely used for converting into various standard finished cloths including canvas, cretonne, suiting and crash. They are also used unbleached for grain and feed bags, as a base for coated fabrics and as covers for mattresses and cushions. Wide bed sheetings are sold unbleached as brown sheeting or are bleached and given a muslin finish.

Shirting is the general name for plain- and fancy-woven (any weave that is a combination or extension of a plain, twill or satin weave) fabrics such as poplin, broadcloth, oxford, harvard and grandrelle. It is given mercerized, chased and preshrunk finishes. White-finished shirting is also a general British term for white-finished fabrics that include longcloths, cambrics, muslins and various fabrics with pure-sized and back-filled finishes used in export markets. Poplin is a plain-woven fabric with about twice as many ends as picks so that its characteristic ribs run widthwise. The best qualities are made with ply- or single-combed yarns or with single-carded yarns; in the U.S., those made with fine yarn and a high thread count are called broadcloth. Poplins may be white, printed in solid colours or yarn dyed. The lighter varieties are used for shirtings and summerwear; the heavier are used for rainwear and sportswear. Oxford is heavier than broadcloth and is made with a fine warp and heavy filling yarn. Except in those cloths specifically called single-end oxfords, every pair of warp ends runs together and weaves as one with each pick. The fabric is generally bleached or dyed; British oxfords are made with stripes and checks. Harvard is a British shirting that has a reversible 2/2 twill and a soft texture. Grandrelle is also British and is woven with stripes of both solid-colour yarn and mottled grandrelle yarn. Madras is a lightweight fabric made with fancy stripes or all-over patterns that are jacquard- or dobby-woven from combed single yarn. Shirting woven from dyed warp and white or unbleached yarns is called chambray. In work chambray the yarn is carded, the warp ends are usually blue and the material is starched. Dress chambray has combed yarns, is always bleached and is often preshrunk; when made with alternating white and coloured warp ends, it is called end-and-end chambray or end-and-end madras.

Ticking, a strong fabric, is used for covering mattresses, the best qualities being closely woven satin or twill weaves in various weights and constructions. It is usually warp striped but is also made in elaborate jacquard panel designs. Warp sateen, drills and lightweight narrow sheetings are made into cheaper quality converted ticking and are usually printed with floral designs.

British twilled cloths are generally called drills if formed by warp yarns, irrespective of the number of harnesses (heddle shafts), and twills if formed by weft yarns. American drill is always a three-harness, warp-faced twill that is medium or heavy in weight. Jean is similar to American drill but has a higher thread count. It is dyed and used chiefly for work clothing. The most important working fabric is denim, also known as dungaree cloth. It is a three-harness twill, usually woven with indigo-blue warp yarns and unbleached filling but also made in other colours, stripes and checks. It is a mill-finished fabric, usually starched and preshrunk, that is used for work clothing and sportswear.

(X.)

III. ECONOMIC DEVELOPMENT OF THE COTTON INDUSTRY

1. Development up to 1914.—The earliest known piece of cotton cloth was discovered in excavations in the Indus valley of remains dated about 3,000 B.C.; cotton is also known to have been spun and woven in Peru by about 2,000 B.C. Before the Industrial Revolution the main centres of cotton manufacture were the cotton-growing countries: India, China, Turkey, the near east and Brazil, and at that time hand-spun and hand-woven cottons were imported on a large scale from India to Europe by the Dutch and English East India companies. Cotton manufacturing had, however, been introduced into southern Europe by the Moors in the middle ages; in England it took root in the 17th century in Lancashire, where a woolen and linen industry already existed.

The decisive revolution in the industry was brought about by the great inventions in the art of spinning, especially those made in England in the second half of the 18th century, and by the application of power, which led to the concentration of spinning in factories. Weaving underwent a similar revolution at a slightly later date. In England the abundance of water power and coal, the proximity of major ports, the humid climate and the extensive existing domestic industry all favoured the location of the new factory industry in Lancashire, and in the course of the 19th century the other centres of the industry—west Scotland, Derbyshire and Nottinghamshire—declined relatively in importance. By 1900 well over 80% of the operatives employed in the industry were in Lancashire and adjacent Cheshire.

The enormous increase in the productivity of labour as a result of the revolution in techniques greatly reduced production costs, and this in turn led to a tremendous expansion in the market for cotton goods all over the world. The demand was satisfied partly by exports, which were supplied to an overwhelming extent by Great Britain, and partly by the spread of the industry itself. The first mills in the United States were established late in the 18th century and others were established about the same time on the continent of Europe, most of them being protected by a high import tax. Until the mid-19th century the mill industry was virtually confined to Europe and North America; afterward began the wider diffusion that has continued ever since and has brought so many problems to the longer-established industries. The cotton industry has always been one of the first to be established in newly industrialized countries, since it does not present great technical difficulties and does not require large amounts of capital. The foundations of the Indian mill industry in Bombay date from the 1850s. The Japanese cotton industry began about 1870 although it did not really flourish for another 20 years. Before World War I extensive industries had also developed in China, Brazil, Mexico and Canada.

The spread of the industry across the world was paralleled by an equally remarkable territorial shift within the United States. The original location of the industry was New England, but after the Civil War a combination of lower wages and the financial inducements granted by state governments attracted more and more mills to the cotton-growing states, particularly the Carolinas, Georgia and Alabama. In 1908 about 51% of the raw cotton consumed in U.S. mills was manufactured in the cotton-growing states, as compared with only 15% in 1880. The trend continued later in the 20th century. By the early 1960s about 95% of all raw cotton processed in the U.S. was manufactured in the cotton-growing states; the amount manufactured in New England was only about one-eighth of the amount processed there in the peak year of 1916.

The development of the industry up to 1914 is demonstrated by a few figures. In 1790 mill consumption of raw cotton totaled about 25,000,000 lb. (It has been estimated that hand spinning and other consumption may have amounted to about 500,000,000 lb. a year at that date.) In the years immediately before World War I mill consumption of cotton throughout the world averaged about 10,500,000,000 lb. a year. Consumption outside Europe and North America accounted for about 20% of this total, as compared with only about 5% in the early 1880s.

The Lancashire cotton industry expanded until 1914 (although the rate of growth slowed down considerably after about 1860) but by 1910–13 Lancashire's share of total world mill consumption was down to about 20% and it had been surpassed by the United States in volume of production. Even in the export field its supremacy was challenged. Although Lancashire's exports of cotton piece goods continued to expand, reaching more than 8,000,000,000 yd. in 1913, exports from continental European countries and the United States were expanding much more rapidly, and Japan had also begun to compete. As a result the U.K. share of total international trade in cotton yarn and manufactures fell from about 82% in 1882–84 to 58% in 1910–13, when more than four-fifths of Lancashire's production was being exported. Between 1910 and 1913 the U.S. exported about 4% of its cotton goods; this amount accounted for 3% of the world trade.

It is doubtful whether any other industry in modern times has so dominated international trade and at the same time been so dependent on it as the Lancashire cotton industry. It was a unique achievement—and left Lancashire uniquely vulnerable.

2. Development After 1914.—Mill consumption of raw cotton more than doubled in the half century after 1910; this increase compares with an estimated population increase over the same period of rather more than 60%. The difference between the two rates reflects rising standards of living and becomes even more remarkable when it is recalled that the man-made fibre industry developed in this period. World consumption of man-made fibres, which compete directly with cotton in a large number of uses, equaled about 30% of the world consumption of cotton in the 1960s.

Distribution of the Industry.—After 1910 a continued dispersion occurred in the industry. The interruption of supplies during 1914–18 stimulated the expansion of the industry in India, China and Japan, while between World Wars I and II the Indian industry continued to expand, under the protection of tariff barriers, and the Japanese industry initiated a rapidly growing export trade. After the great depression of the early 1930s industrialization proceeded and, with the help of protective tariffs, cotton industries were established or expanded in many countries. World War II boosted this process, leading to a considerable expansion of the industry in Latin America, Egypt, Turkey, South Africa, Australia and elsewhere. After 1945 the industry was established or greatly expanded in South Korea, Formosa, Israel, the Philippines and Nigeria, among other countries. Spinning mills were built in Hong Kong from 1948 onward with refugee Chinese capital; the growth of the industry there was phenomenal and Hong Kong became a major exporter. The partition of the Indian subcontinent left almost all the cotton mills in India but a very important part of the cotton-growing area in Pakistan. The latter country embarked on a rapid development of its industry, becoming more or less self-sufficient by 1957 and entering the export field on a big scale. Cotton manufacturing developed rapidly in the Communist countries, particularly China. The Japanese industry, after being virtually destroyed during World War II, expanded strongly afterward, although by 1961 it had not regained its prewar size because of the shrinkage in world trade, increased competition in the international field and the substitution of man-made fibres. Consumption in the United States increased rapidly until after the war and then from 1951 showed a slight tendency to decline on account of decreasing exports and increasing imports. As a result of all these changes consumption outside Europe (including the U.S.S.R.) and North America amounted by 1957–59 to about 45% of total world consumption, as compared with about 20% before World War I. In the early 1960s there was no sign of a halt in the spread of the industry, since important developments were under way in many countries, including Indonesia, Ceylon, the Sudan and Ethiopia.

World Trade in Cotton Piece Goods.—World exports of cotton piece goods expanded up to 1910–13, but the growth of the Indian and Chinese industries during World War I led to a reduction in trade. This decline accelerated after the great depression of the early 1930s as more and more countries began to manufacture cotton goods and to tax cotton imports. Despite the world trade decline, Japan managed to increase its exports of cotton goods very rapidly because of cheap labour and efficient production methods; by the late 1930s Japan was easily the largest exporter of cotton piece goods, accounting for slightly more than 40% of the total world trade. The combination of a declining total trade and an increasing Japanese share naturally struck hard at the other exporting countries—the U.S., Europe and above all the U.K. The expansion of domestic industries in importing countries during and immediately after World War II led to another fall in world trade. By then India was a major exporter and the U.S. had also greatly increased its exports, mainly to Canada and Latin America, taking some 14% of the world trade in 1949–51 against 3.5% in 1936–38. After World War II the losers were Japan and, once again, the U.K.; in both countries, it was inability to expand production quickly enough after wartime contraction that held exports down.

The period of postwar reconstruction ended about 1951. Thereafter world trade in cotton piece goods did not decline any further and by the end of the 1950s it even appeared to be expanding. Japan re-emerged in 1949–51 as the principal exporting country and was still expanding its exports by 1960, though its share of total world trade—about 23%—was considerably smaller than before the war. After a period of decline western European exports increased in 1958–60; this increase was mainly in intra-European trade, stimulated by the Common Market. Exports from the U.K. fell very sharply after 1949–51 and exports from the U.S. declined almost as sharply. A considerable number of other countries became exporters, particularly Hong Kong, Pakistan (mainly in the yarn trade), Egypt, Formosa, South Korea, Yugoslavia and Canada. There was also a big expansion in exports from Communist countries, particularly China.

World trade in cotton textiles by 1960 amounted to about 10% of world production, as compared with about 16% in 1936–38 and about 28% in 1910–13. Imports were largely concentrated in two groups of countries: first, countries that were not self-sufficient in cotton textiles, notably the continent of Africa, parts of Asia (particularly Indonesia) and Latin America, Scandinavia, Canada, Australia and New Zealand; secondly, the exporting countries of Europe and the U.S. The imports into the western European countries mostly came from other European countries, while the imports into the U.K. and U.S. mostly originated in Asia. It was the imports into the U.S., U.K. and western Europe that were tending to expand.

The Cotton Industry in the United Kingdom.—Immediately before World War I four-fifths of U.K. production was for export, and about 40% of the exports went to India. The expansion of the cotton industries in India, China and other countries and formidable competition from Japan for the trade that remained reduced U.K. exports from an annual average of 6,550,000,000 sq.yd.

in 1910–13 to 1,720,000,000 sq.yd. in 1936–38. Over the same period the average annual consumption of raw cotton in the U.K. declined by 37% and cloth production fell by about 54%. It has been estimated that Lancashire's losses in the Indian market alone were sufficient to account for a contraction of one-third in its cotton-cloth output between 1912 and 1938. As a result, the interwar years were ones of chronic depression, characterized by the closing of mills, heavy unemployment and cutthroat competition. During World War II the industry suffered compulsory contraction, and during the postwar period recovery was limited by shortages of labour. Even in the peak postwar year, 1951, production (including man-made fibres processed in the cotton industry) was no more than about three-quarters of the 1937 level. After 1951 exports of cotton piece goods began to fall, and in 1961 they were still declining. In 1958–60 they averaged only 350,000,000 sq.yd. per annum, as compared with 860,000,000 sq.yd. in 1949–51. The proportion of world trade in cotton piece goods accounted for by the U.K. in 1958–60 was only just over 6% and a large proportion of these exports consisted of cloth that had been imported in the gray state and merely finished in the U.K. before being re-exported. In 1954 India began to export goods intended for consumption in the U.K., not for re-export, and was soon joined by Hong Kong and later by Pakistan, all of them taking advantage of the fact that commonwealth goods were allowed to enter the U.K. duty-free. These imports continued to expand and, coupled with the decline in exports, led to a further substantial contraction in the output of the U.K. industry. From the end of 1954 to well into 1959 there was a great deal of short-time work (less than full capacity), with only a comparatively brief respite in 1957; although many mills closed down, a vast amount of surplus capacity remained.

Many efforts were made by the U.K. cotton industry to secure some limitation of duty-free imports from the commonwealth, and in 1959 the government introduced reorganization schemes in an attempt to put the industry back on its feet. Mill owners were offered compensation for scrapping machinery or going out of business entirely, two-thirds of the cost to be met by the government and one-third by means of levies on firms remaining in the industry. The government also offered to pay one-quarter of the cost of approved schemes of modernization. Under the first provision, almost half the spinning capacity of the industry and about 40% of the looms were scrapped. This, coinciding with a world-wide boom, brought a flood of orders to the remaining mills and full-time work was the rule, with some exceptions, until 1961. However, a shortage of labour again made it impossible to take full advantage of the opportunity and the gap was filled by imports, partly speculative, from nonrestricted sources, notably Spain but also Portugal, Yugoslavia, Formosa, the U.S. and Canada. In the early 1960s imports of cotton cloth were entering at a rate equivalent to about one-third of total home consumption and the U.K. was then the largest importer of cotton cloth in the world. Mill consumption of cotton in the U.K. was less than half what it was before World War II and only about 30% of the level before World War I; it accounted for only slightly more than 3% of total world mill consumption.

The Cotton Industry in the United States.—The consumption of cotton by United States mills expanded very rapidly during World War I. The wartime rate of use was not maintained during the immediate postwar years, but a new peak was established in the years 1926–28. The great depression caused another setback, and by 1936–38 the recovery in cotton consumption had hardly done more than equal the previous peak. The main reason was that exports of cotton textiles, though never very important to the U.S. industry, had fallen quite sharply. Throughout this period the New England section of the cotton industry had been contracting severely, causing great distress to those communities heavily dependent on the industry. World War II caused another great expansion in the U.S. cotton industry, and after a decline in the immediate postwar years the Korean war brought another boom. Cotton consumption in 1951, however, was not quite as great as in the peak World War II years. After 1951 cotton consumption in the U.S. declined gradually. One reason for the decline was that exports of cotton cloth, which expanded rapidly during World War II and reached 1,490,000,000 sq.yd. in 1947, subsequently declined steadily until in 1960 they amounted to no more than 440,000,000 sq.yd. The second main reason was that from 1953 onward imports of cotton goods from Japan began to increase rapidly, re-establishing a trade that had been important before the war. In 1955 the Japanese cotton industry was persuaded, under pressure, to put a voluntary ceiling on its exports to the U.S. In 1959 and 1960 imports began to flood in from a number of other countries, notably from Hong Kong but also from India, Pakistan, South Korea, Formosa, Egypt, Spain, Portugal and France. In 1960 U.S. imports of cotton products from all sources were equivalent to about 6% by weight of total U.S. home-market consumption. In 1961 a request from the U.S. government to the Hong Kong industry for a ceiling on exports similar to the Japanese undertaking was turned down. The U.S. cotton industry suffers a special handicap in that American raw cotton is sold to foreign mills considerably more cheaply than it is to domestic mills.

World Problems.—On a world scale, the most intractable problem facing the industry in the early 1960s was undoubtedly that of competition between low-wage and high-wage countries since wages account for a relatively high proportion of the cost of yarn and cloth. Since about 1954 the battle has been extended from third markets to the home markets of the high-wage exporting countries themselves, notably the U.K. and the U.S. There have been two principal methods of dealing with the problem: (1) quotas imposed by importing countries and (2) voluntary restrictions undertaken by exporting countries. Quotas were imposed on imports of cotton goods from China by almost all western countries, on imports from Japan by most European countries (including the U.K., France, western Germany, the Netherlands, Belgium and Austria) and on imports from India, Pakistan and Hong Kong by a few European countries; but a wider use of the quota weapon has generally been felt undesirable in view of the trend toward more liberal trade policies. Examples of the second method are the voluntary ceilings placed by the Japanese on their exports to the U.S., Canada, Denmark and Switzerland and similar undertakings of the Indian, Pakistan and Hong Kong industries in respect of their exports to the U.K.

3. Machinery.—In spite of the steady increase in the quantity of cotton consumed by the world's cotton mills there has been a decrease in the amount of machinery installed. Figures published in *International Cotton Industry Statistics* by the International Federation of Cotton and Allied Textile Industries show that the total number of spinning spindles in place reached a peak of 165,000,000 in 1928, subsequently declining to 148,000,000 in 1939. After wartime destruction and postwar reconstruction the figure in the early 1960s was about 130,000,000. Most of this decline can be attributed to the replacement of the less-productive mule spindle by the ring spindle. The number of mule spindles declined from 71,000,000 in 1913 to 3,000,000 in 1959. The number of "ring-equivalent" spindles in place (reckoning one ring spindle as being equivalent to one-and-a-half mule spindles) reached a peak of about 145,000,000 in 1930, declined to 135,000,000 in 1939 and totaled about 127,000,000 at the end of 1959. The International federation's first world-wide census of cotton power looms in 1930 recorded 3,159,000 in place. The total had fallen to 3,070,000 in 1936 and to 2,633,000 in 1959. The proportion of automatic looms increased from 23% in 1930 to 41% in 1959. The disparity between the decreasing amount of machinery in place and the increasing consumption of cotton is explained by the increased speed of the machinery and, more important, the considerable increase in the number of operating hours, since shift working became the rule rather than the exception. The decline in the amount of machinery has been concentrated in the U.K., the rest of Europe (excluding the U.S.S.R.) and the U.S. In other parts of the world, particularly Asia, capacity has increased.

4. The Uses of Cotton.—According to estimates made by the Food and Agriculture organization of the United Nations, the average consumption of cotton per person throughout the world

was about 7½ lb. a year in 1956–58 (Commodity Bulletin Series, 31). This global average, however, concealed a vast difference between the consumption per person in different countries. At the top of the list came the U.S. with an annual consumption per person of about 23 lb. Next came a group consisting of the northwestern European countries, Canada, Australia, New Zealand, Argentina, Israel, Japan, the U.S.S.R., the German Democratic Republic and Czechoslovakia, with averages between 10 lb. and 15 lb. a year. In contrast, average consumption in the whole of the African continent was only about 2½ lb. a year, and in large parts of that continent, and also in some Asian and South American countries, it was lower still.

The overwhelming bulk of the world's cotton, except for small amounts used for hand spinning and for such other uses as stuffing mattresses, is consumed in spinning mills. In the U.K., for example, only about 1% of the total is used for other purposes; *e.g.,* wadding and cotton wool. By far the greater proportion of cotton yarn (about 80% in the U.K. and the U.S.) is manufactured into broad-woven cloth composed wholly of cotton or of cotton mixed with other fibres (particularly the man-made ones); these other fibres are woven with the cotton yarn or are blended with it at the spinning stage. The remainder of the yarn is used for knitwear, thread, ribbons, ropes, nets, lace, carpets and other purposes. The broad-woven cloth is woven either of gray or of bleached or dyed yarn and usually has to be finished in some way; *e.g.,* bleached, dyed, printed, shrunk and made crease resistant. It may, however, be virtually ready for use in the loom state without finishing. Examples of this are gray cloth used in industry and yarn-dyed cloth used for curtains or upholstery.

Cotton products are divided conventionally into three main categories according to their use. First there is apparel, including linings. Then there are the household goods such as sheets, towels, curtains, upholstery and also domestic sewing thread. The third main category is usually referred to as industrial uses. This includes the use of cotton in manufacturing equipment—for example, factory belting and filter cloths, and also uses in which the cotton forms part of an article, *e.g.,* tire cord, car upholstery, book cloth and electrical insulation. In the U.S. just over half of the cotton consumed is used for apparel, slightly more than one-quarter for household uses and about one-fifth for industrial uses. In France the corresponding proportions are rather over a half, rather less than one-quarter and about one-quarter respectively. In the U.K., as far as it is possible to judge, the proportion used in apparel seems to be less than in the U.S. and France, and the proportion consumed in both household and industrial uses seems to be greater than in either of those countries. In the newly emerging countries, of course, almost all the cotton is used for apparel.

5. Organization of the Industry.—When the power loom was first generally adopted, the normal method of organization in Lancashire was for spinning and weaving to be carried on in the same establishment. There are, however, certain economic advantages in separating the two processes, and spinning and weaving in Lancashire came to be carried on in separate mills and by separate firms. There was even a geographical separation of a minor sort in that spinning became concentrated in the south and weaving in the north of the Lancashire cotton region. At the same time, the overwhelming importance of the export trade favoured a separation of weaving from styling, and a large class of merchant converters grew up, many of whom specialized in exporting to particular markets. Thus the classic Lancashire form of organization developed: the spinner sells the yarn to the weaver, and the weaver then sells the gray cloth to a converter, who has it bleached, dyed or printed on commission by a specialist finisher. The converter then sells the finished cloth abroad or to a wholesaler, garmentmaker or other user in the U.K. Because of technical developments and the decline in the export trade, the traditional structure of the Lancashire industry was not well suited to modern conditions, and after World War II there was a distinct trend toward more vertical integration, with the result that spinners and weavers gained greater control over the distribution of their products.

The structure of the U.S. cotton industry is very different. Spinning and weaving have always been integrated to a very large extent, not only in the same companies but in the same mills, which often have long runs on a few standardized products. The main reasons for this are the size and comparatively low density of the population; the fact that selling was concentrated in a comparatively small number of sales agents, who could instruct the mills they represented to concentrate on particular constructions; and finally the growth of the large multi-unit concerns, which also could order concentration of production of certain cotton goods in the mills they owned. In the past, spinning and weaving were largely separated from converting. Before World War II there was a movement on the part of mills, particularly those in the household textiles field, to finish, make up and sell their goods as branded products in order to secure outlets for their productions. At the same time, users of industrial textiles (tire manufacturers, surgical dressing manufacturers, bag manufacturers, etc.) were buying mills in order to control the quality of their supplies. The trend toward vertical integration accelerated during and immediately after World War II as mills began to convert their cloth in order to secure additional profits at a time when prices were controlled and selling was easy, and as converters acquired mills in order to assure themselves of supplies of cloth. In the early 1960s the majority of U.S. mills converted their own fabrics, usually in their own finishing plant.

The European industries tend to fall between the extremes of the U.K. and the U.S. in point of structure. There is a good deal more vertical integration than in Lancashire, including integration with finishing, but less than in the U.S. The Japanese industry is dominated by the integrated spinner-weavers who produce mainly for export, but a large number of independent weavers are supplied with yarn by specialist spinners and from the surplus yarn production of the spinner-weavers. Many of these "independent" weavers, however, merely weave on commission for spinners or merchants. The large spinner-weavers convert their own fabrics, usually in their own finishing plants, but the selling and distribution is left entirely to merchants. The Hong Kong industry is in many respects similar to the Japanese industry; *e.g.,* it has a strongly integrated sector directed mainly to the export trade and flanked by specialist spinners and weavers. In India, power-loom weaving is integrated almost completely with spinning. There is also an important Indian hand-loom industry that is protected by government policy against competition from the mills; it is supplied with yarn mainly by specialist spinning mills but also from the surplus yarn production of integrated mills. The structure of the Pakistan cotton industry is in many respects similar to that of the Indian industry and also includes an important hand-loom sector.

There are numerous other points of contrast between the various cotton industries of the world. As regards machinery, for example, Britain was virtually the only country in 1961 in which mule spinning survived; even there, however, there were fewer than 3,000,000 mule spindles, as compared with 23,000,000 in 1945 and 45,000,000 before World War I. In weaving, automatic looms were practically universal in the U.S. and Canada, the high wage level being an overwhelming incentive to labour-saving methods. In the U.K. less than 30% of the looms were automatic—a smaller proportion than in almost any other important western European cotton industry. The proportion of automatic looms in India was among the lowest in the world, mainly because of government restrictions on the mill sector of the industry, and even in Japan it was only just over one-sixth; in Japan, however, the vast majority of the looms owned by the integrated spinner-weavers were automatic.

Lancashire has for long had the melancholy distinction of working its machinery for fewer hours during the year than any other industry. Until the 1959 reorganization schemes, single-shift working was almost universal in spinning and largely predominant in weaving, but the scrapping of so much machinery made an appreciable difference. In the 1960s double-shift and three-shift work schedules were fairly widespread, particularly in weaving. In contrast, three-shift working was practically universal in the U.S. and in the spinning and integrated spinning-weaving mills in Hong

Kong. Double-shift working was the rule in the Japanese spinning and integrated mills, and in all other cotton industries two- and three-shift working was far more common than in Lancashire.

In the early 1960s more than 60% of the employees in the U.K. cotton industry were female, many of them married women. The proportion of women in the Japanese industry was even higher—more than 80%—but they were almost all young girls who were working for a few years before marriage and living in dormitories attached to the mill. The percentages of women in western European cotton industries varied greatly, ranging from about 80% in Italy to less than 20% in the Netherlands. There were more men than women workers in the United States and Hong Kong industries, and in India 94% of the labour force were men.

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COTTONMOUTH, a venomous snake native to North America and also called cottonmouth moccasin or water moccasin. *See* MOCCASIN.

COTTON RAT, one of several species of American rodents of the genus *Sigmodon,* occurring from the southern United States into South America. The commonest, *S. hispidus,* the hispid cotton rat, is typically ratlike in appearance. It measures 10 to 14 in., about one-third of that length being a thin, scaly, sparsely haired tail. The colour is a grizzled blackish brown. Cotton rats are exceedingly prolific, producing several litters of two to ten young each year. Where they occur, they are likely to be numerous and the dominant small mammal. The habitat is varied, but a preference is shown for weedy fence rows and ditch banks. The nest, in a shallow runway or tunnel, is constructed of any available fibrous material. Cotton rats are aggressive and pugnacious. They eat virtually anything edible and often become serious agricultural pests. They do not climb, hibernate or store food.

(K. R. KN.)

COTTONSEED. Cottonseed is obtained as a by-product of cotton production. For each pound of fibre, cotton plants yield approximately two pounds of seed. The commercial importance of cottonseed lies in the four principal products obtained through processing—oil, cake or meal, linters and hulls.

History.—Although cotton fibre has been a product of commerce for centuries, large-scale commercial utilization of cottonseed is a comparatively recent development. In ancient times the Chinese and Hindus used cottonseed oil as a medicine and in lamps and developed crude methods for its recovery, but it was not until the production of cotton began its rapid increase following the invention of the cotton gin in 1794 that systematic and continuing efforts were made to develop machinery for the commercial processing of cottonseed. Even as late as 1875 the principal use of cottonseed was for planting purposes, while the remainder over and above these requirements was regarded mainly as a waste product that frequently was disposed of by burning or dumping into streams near the cotton gins. This practice created a serious health problem, and several states passed laws making it a punishable offense to accumulate seeds around gins to the detriment of the health of the nearby inhabitants, or to dump cottonseed into streams used for drinking water or fishing.

The history of the development of the cottonseed industry is almost wholly a history of the development of the industry in the United States. In the 18th century various individuals and organizations recognized the potential value of cottonseed as a source of oil and other products and urged producers to develop feasible methods for obtaining these products. Among the first was Bodo Otto of Pennsylvania, who in 1768 presented the American Philosophical society with samples of oil he had obtained from cottonseed. In 1783 the Society for the Encouragement of Arts, Manufactures and Commerce in England offered a gold medal to any planter in the West Indies who was able to express one ton of oil and produce 500 lb. of cake from cottonseed. Two years later a premium was offered by the South Carolina Agricultural society in an effort to encourage the expressing of oil from cottonseed. (There is no record that either of these awards was ever claimed.)

Between 1800 and 1825 several cottonseed-oil mills were built in various parts of the U.S. south, but they were all financial failures and none of them was very long in operation. The first mill that could be called successful was established in Natchez, Miss., about 1833 and operated for nearly ten years.

Beginning about 1850 a number of improvements were made in cottonseed processing machinery that led to a more successful operation of the mills. By 1860 there were seven active mills crushing a total of approximately 50,000 tons of seed annually. Progress was stopped by the Civil War, but in the years following the war the industry again began to expand. By 1870 there were 26 active mills and by 1930 about 850 mills.

In 1876 only 5% of the cottonseed crop was crushed for oil and other products, but after 1910, 80% of the crop reached the oil mills. No cottonseed is now wasted. Cottonseed that is not crushed remains on the farms and is used for planting, as fertilizer for crops and as farm feed.

World production of cottonseed in the early 1960s was over 20,000,000 tons. The United States, India, China, Mexico, Egypt and Brazil provided more than half the world supply. The United States produced about 6,000,000 tons annually.

Processing.—Processing consists essentially of (1) cleaning; (2) removing the fuzz or linters; (3) hulling; (4) flaking and cooking the kernels; and (5) recovering the oil by pressing or by solvent extraction. The residue remaining after oil removal is cottonseed cake, which is usually ground and marketed as meal.

Cottonseed is cleaned by means of a variety of devices to remove foreign substances, and passed through delintering machines to remove the short fibres. These machines are similar to cotton gins but have circular saws with much finer teeth. Linters are removed by successive cuts known as first, second, third and fourth cuts. Each type has different uses (*see* below).

The delintered seed are hulled and the kernels separated from the hulls. The kernels are flaked and cooked to facilitate maximum oil recovery; they are passed between steel rollers to flake them to a thickness of about .007 in. The flakes are tempered with moisture and heated in steam-jacketed cookers equipped with mechanical agitators to a temperature of about 235° F. for 30 to 90 minutes.

For many years hydraulic pressing was the only method used for recovering oil from the prepared flakes. In this method the flakes are formed into cake, wrapped in thick haircloth and pressed in a hydraulic press. For some markets the pressed cake is broken and sold as cottonseed cake, but most of it is ground and sold as meal.

A later process used by many oil mills is the continuous screw-pressing method. The flaked kernels are conditioned as for hydraulic pressing and fed into a slotted cage made up of steel bars set a few thousandths of an inch apart. A revolving screw carries them along inside the cage or barrel. The screw is so designed that high pressures and temperatures are developed. The oil flows out through the openings between the bars and the cake is discharged at the end of the barrel.

Solvent extraction is now used to some extent for commercial processing of cottonseed. The kernels are prepared in a manner similar to that for hydraulic pressing and then extracted with commercial hexane, a petroleum solvent. The solvent is recovered by distillation from both the oil and the extracted flakes for reuse. In some mills a prepress-solvent extraction process is used in which

he flakes are screw pressed at low pressures and the residual oil n the pressed cake removed subsequently by extraction with ommercial hexane.

As oil is the most valuable product obtained from cottonseed, he trend has been toward the use of the newer processes for its ecovery. Although both hydraulic pressing and screw pressing roduce oil of acceptable quality, both processes leave from 3.5% o 7% of oil in the cake. The processes using solvent extraction educe the oil content of the meal to less than 1%. The newer lants are generally of large capacity, processing up to 900 tons f cottonseed a day or more. The estimated annual average world roduction of cottonseed oil is more than 5,000,000,000 lb. This s about 23% of the production of edible oils and 7.5% of the roduction of fats and oils from vegetable, animal and marine ources.

Crude cottonseed oil is generally dark in colour and contains nany constituents that must be removed before the oil can be used or food purposes. Removal is accomplished by filtration, refin- ng, bleaching and deodorizing. The filtered crude oil is refined y treatment with solutions of sodium hydroxide and other alkaline ompounds that combine with the free fatty acids forming soap nd remove nonglyceridic materials. For many years the standard ractice was to use large, conical kettles for refining. The alkali olution reacted with the free fatty acids is separated by settling o form soap stock. The oil is drawn off and water washed to re- nove remaining soap particles. Continuous centrifugal refining is ow generally used in the United States. In this process the crude il is intimately mixed with the proper proportion of alkali solu- ion and the separation of soap stock is accomplished by use of high-speed centrifuge. The oil is then treated by washing and rying to remove the last traces of soap and water.

When the oil is to be used as a salad or cooking oil, it is further urified by bleaching, "winterizing" and deodorizing. Bleaching s done by mixing bleaching agents with the refined oil and remov- ng them by use of filter presses. The bleaching agents used are uller's earth (*q.v.*) and acid-activated bleaching clays. The latter re sometimes used in combination with activated charcoal. These naterials absorb colouring substances. The refined oil is "winter- zed" to remove the saturated glycerides so that the oil will be iquid at usual refrigeration temperatures. This is done commer- ially by chilling the refined oil, allowing the solidified portion to ettle and separating the clear oil by decantation and filtration. Deodorizing is accomplished by vacuum distillation of the heated il to remove odoriferous materials by both batch and continuous rocesses.

The most important uses for cottonseed oil are in shortening nd margarine or plastic fat products. For these purposes the il is further processed by hydrogenation to produce a fat product ith any desired melting point up to about 140° F. The unsatu- ated fatty acids (oleic and linoleic) are in part converted to aturated stearic acid in this process by passing hydrogen gas into he oil in the presence of a nickel catalyst. The properties of the ardened oil are varied by control of processing methods to give pecialty shortenings for the prepared food industries.

Acidulated soap stock is obtained by heating raw soap stock foots) with an excess of sulfuric or other mineral acid in a orrosion-resistant vat until the soap is decomposed. After set- ling, a layer consisting of fatty acids and neutral oil forms on top nd is decanted from the aqueous layer.

Fatty acids are obtained by distillation of acidulated soap stock or use by the soap and chemical industries. The feed industries n the United States are now using increasing quantities of cidulated soap stocks and inedible fats to increase the energy value f mixed feeds. The residue after distillation of the fatty acids s the fatty acid pitch of commerce.

Utilization of Cottonseed Products.—Although cottonseed roducts have been used variously for centuries, their greatest com- nercial utilization has been in the United States. The commercial rocessing of cottonseed has been increased in other countries, rincipally Mexico, Brazil, India and Egypt. The yield of prod- cts is influenced by the variety of cotton, the environment under hich the cotton crop is grown and the efficiency of the processing methods used for recovery of the oil. Typical average yields per short ton of seed crushed are: 314 lb. of crude oil; 901 lb. of cake or meal; 466 lb. of hulls; 184 lb. of linters; and 135 lb. of process- ing waste and loss.

Oil.—Thoroughly refined and processed cottonseed oil is one of the principal high-grade edible oils of commerce. The average factory consumption in the United States of refined cottonseed oil is approximately 30% of the total of all edible and inedible vegetable oils used annually. About 29% of the refined cotton- seed oil consumed annually goes into the manufacture of marga- rine; 35% into shortenings; 30% into salad oil, salad dressing, mayonnaise, cooking oils and other products; and 2% into inedible products. "Winterized" cottonseed is a superior salad and cooking oil because of its good keeping quality. About 75% of the "win- terized" vegetable oils are obtained from cottonseed oil. Owing to studies of the relation of fats to health there has been a trend toward increased use of salad and cooking oils and decreased use of shortening.

The use of cottonseed oil in inedible products is limited largely to off-grade oils and soap stocks. The oil and fatty acids obtained from them and acidulated soap stocks are used in the manufacture of soaps, lubricants, protective coatings and chemical products. The fatty acid pitch is used chiefly in the production of floor cover- ings, composition roofing and insulating materials.

Cake and Meal.—Cake and meal are used principally as high- protein supplements in feeding cattle. They contain up to 45% protein as usually produced. The annual production provides be- tween 25% and 30% of the supply of high-protein feeds in the United States. Methods of processing were developed to reduce the influence of gossypol, a pigment peculiar to the cotton plant, to a low level, with the result that cottonseed meal can and has been used in mixed rations for single-stomached animals (swine and poultry). Cottonseed meal also is used to some extent as a fertilizer, and small quantities are used in making starch-free flour for human consumption.

Hulls.—The hulls are used as roughage for feeding beef and dairy cattle. Considerable quantities are ground and incorporated in mixed feeds. They are rich in pentosans and are potentially a source of material for the commercial production of furfural, an important industrial chemical.

Linters.—Linters are the short fibres left on the seed after re- moval of the staple cotton fibre by ginning. They are largely cel- lulose and are transformed into many useful products. First-cut linters are used in making high-quality mattresses and in the manu- facture of coarse cotton yarns.

Some quantities of linters are used in the production of high- quality writing paper. Second- and subsequent-cut linters, after mechanical and chemical purification, are used in the manufacture of explosives, cellulose acetate, rayon, plastics, ethyl cellulose, lac- quers, sausage casings and many other cellulose products requiring high-quality cellulose as a raw material. In many of these end uses linters compete with wood cellulose, rubber and synthetic products.

See A. E. Bailey (ed.), *Cottonseed and Cottonseed Products* (1948). (T. H. Hr.; X.)

COTTONTAIL, the common name in the U.S. for several species of rabbit (*q.v.*) of the new world genus *Sylvilagus*. Cot- tontails are grayish to dark brown in colour, lighter below, with a whitish tuft under the tail. *See* also Hare.

COTTONWOOD: *see* Poplar.

COTTRELL, FREDERICK GARDNER (1877–1948), U.S. teacher, scientist, inventor of the Cottrell electrostatic smoke (fume) precipitator and founder of Research corporation, a non- profit foundation to support basic research in colleges and univer- sities, was born in Oakland, Calif., on Jan. 10, 1877. Educated in chemistry at the University of California, Berkeley, with post- graduate work in Germany under Liebig and Ostwald, he was in- structor of physical chemistry at the university, 1902–06, and assistant professor, 1906–11. Retained by local industry in the San Francisco bay region to combat air pollution, Cottrell began his successful work on electrostatic precipitation in 1906, turning over the basic patents he was granted to Research corporation, ad- ministered by the Smithsonian institution. By the second half

of the 20th century the corporation had contributed more than $21,000,000 in grants for research and eight grantees had received the Nobel prize for their work. Cottrell thus gave up a large personal fortune and lived and died in moderate circumstances, but his outgoing personality and his catholicity of scientific interests sparked the success of thousands of younger men.

Serving with the U.S. bureau of mines, 1911–20, he developed and administered the process of separating helium from natural gas, led in the development of the bureau's mine safety division and served as director of the bureau (1920). He also served with the U.S. department of agriculture (1922–43), specializing in fixed nitrogen research. He died in Berkeley on Nov. 16, 1948.

See also PRECIPITATION, ELECTROSTATIC.

See Frank Cameron, *Cottrell, Samaritan of Science* (1952).
(JH. W. B.)

COTY, FRANÇOIS (FRANÇOIS MARIE JOSEPH SPOTURNO) (1874–1934), French perfume manufacturer and newspaper owner, was born in Ajaccio, Corsica, on May 3, 1874. He started his career as secretary to the Corsican deputy and journalist Emmanuel Arene. Attracted toward the chemistry of perfumes, he started a small business and from 1900 evolved perfumes that were highly successful. In 1905 he opened a plant at Suresnes, near Paris, and during World War I became one of the richest men in France, though in later years his wealth was much reduced. Prompted by political ambitions and by concern at the social disorganization after the war, he gained control in 1922 of the conservative Paris daily paper *Le Figaro*, of which he was proprietor and director from 1924 until 1932, using it to advocate a strong nationalistic policy. To carry his message to the masses in an effort to check the growth of socialism and communism in France, he founded in 1928 *L'Ami du Peuple* and *L'Ami du Peuple du Soir*. Both were subsidized by the scent business and sold at half the price of other daily papers, which assured them a wide circulation. He also founded La Solidarité Française, an organization aimed at furthering his political and social ideas. Coty died at Louveciennes, Seine-et-Oise, on July 25, 1934.

COTY, RENÉ (1882–1962), last president of the fourth French republic, was born at Le Havre (Siene-Maritime) on March 20, 1882. A graduate of the University of Caen, he became a barrister and soon entered local politics. From 1923 to 1935 he served as a deputy of the Gauche Républicaine (a label which implied conservatism) and then became a senator. In Dec. 1930 he was undersecretary of state for the interior for a few weeks.

Politically inactive during the German occupation, Coty after World War II was again a deputy (1945–48) and a senator (1948–54). He was minister of reconstruction from Nov. 1947 to Sept. 1948 and a vice-president of the senate from Jan. 1949. Respected for his courtesy and his spirit of conciliation, he was induced to become a candidate for the presidency in Dec. 1953, when the election seemed likely to produce a deadlock. Elected on Dec. 23 on the 13th ballot, he served with dignity, but was less active in trying to influence policy than his predecessor, Vincent Auriol, had been. In the crisis of May 1958 his threat to resign helped to induce the national assembly to elect Gen. Charles de Gaulle as prime minister. He retired on Jan. 8, 1959, when De Gaulle was installed as the first president of the fifth republic. Coty died at Le Havre on Nov. 22, 1962. (P. W. C.)

COTYLEDON, the name applied to the first leaf or leaves of the embryo in seed plants; also called seed leaf. The number of cotyledons is so constant that it provides one of the characters for the primary division of angiospermous plants, as monocotyledons with one seed leaf and dicotyledons with two seed leaves. Although cotyledons sometimes perform the function of foliage leaves, they more generally serve as storage organs for foods used in germination. (*See* ANGIOSPERMS; SEED.)

Cotyledon is also the genus name for a group of succulent plants of the old world, native mostly to South Africa and the Mediterranean region and belonging to the orpine or stonecrop family (Crassulaceae; *q.v.*). (J. M. BL.)

COTYS (COTYTTO), a Thracian goddess worshiped with orgiastic rites, especially at night. Her worship, first mentioned by Aeschylus, was apparently adopted publicly in Corinth by the last quarter of the 5th century B.C., and perhaps privately in Athens; it then included a baptismal ceremony. Later relief sculptures from Thrace show her as a huntress-goddess similar to Artemis. But in literature she is rather compared with Cybele, and her cult is synonymous with immoral practices. This aspect can be linked with some rites to Artemis as practised among the Dorians.

See W. Roscher, *Lexikon* (1924); M. P. Nilsson, *Geschichte der griechischen Religion*, vol. i, p. 835, 2nd ed. (1955). (H. W. PA.)

COUCY (now part of Coucy-le-Château-Auffrique in the *département* of Aisne), a small town of northern France, 18 mi. W.S.W. of Laon, important in the middle ages both for its castle and for the family of the sires de Coucy. A commune from 1197, the town itself was strongly fortified, the most remarkable feature in its wall being the great Porte de Laon.

Castle.—The first recorded castle, on the hill above the town, was founded by Hervé, archbishop of Reims, at the beginning of the 10th century. Long disputed between the archbishops and various feudal magnates, it passed at the end of the 11th century to Enguerrand de Boves, founder of the house of Coucy. Rebuilt early in the 13th century by Enguerrand III, the castle then had a *donjon* about 180 ft. high and 103 ft. in diameter. Sold to Louis de France, duc d'Orléans, in 1400, Coucy passed to the French crown on the accession of Louis XII. Granted in apanage to Claude de France (later Francis I's queen), to Diane de France (from 1576 to 1619), to François, comte d'Alès (d. 1622), and, in 1673, to Philippe, duc d'Orléans, it remained with the house of Orléans, except during the Revolution and the first empire, till 1856, when it became state property. During the Fronde, Cardinal Mazarin had its fortifications dismantled (1652). Restored in the 19th century, the castle was destroyed by the Germans in 1917–18.

Sires de Coucy.—Enguerrand de Boves (d. 1115) distinguished himself as a crusader. His son Thomas de Marle was a brigand and rebel against whom Louis VI of France had to undertake two expeditions. Enguerrand III fought for Philip Augustus at Bouvines, but took part in the disturbances during Blanche of Castile's regency. In the 14th century, as Enguerrand IV left no heirs, Coucy passed to a nephew, Enguerrand de Guynes. Enguerrand VI, who married Catherine, daughter of the Habsburg Leopold I of Austria, was killed at Crécy in 1346. His son Enguerrand VII, who married Isabella, daughter of Edward III of England, tried to stay neutral in the Anglo-French war, attacked the Austrian possessions in Switzerland (1375–76) on the pretext of securing his mother's inheritance and finally joined the Hungarian crusade against the Turks. Captured at Nicopolis (Nikopol), he died in Turkey in 1397. His daughter Marie sold Coucy to the duc d'Orléans in 1400.

See E. Lefèvre-Pontalis, *Le Château de Coucy*, 2nd ed. (1928).
(MI. M.)

COUÉ, ÉMILE (1857–1926), French psychotherapist whose formula, "Every day, and in every way, I am becoming better and better," became proverbial, was born at Troyes on Feb. 26, 1857. From 1882 to 1910 he worked as an apothecary at Troyes, and in 1901 began to study hypnotism and suggestion under H. Bernheim and A. A. Liébault. In 1910 he established a free clinic at Nancy for the practice of his own psychotherapeutic method. Based on the power of imagination rather than of the will, his naïve and empiric system utilized formulas, repeated again and again in a confident voice, especially at a time when the mind was most receptive, to sink into the subconscious and to eliminate ideas tending to cause distress and disease. Coué always stressed that he was not primarily a healer but one who taught others to heal themselves, although he also claimed to have effected organic changes by means of suggestion. His teaching for a time spread rapidly, and enormous audiences attended his lectures in England and the United States. Coué died at Nancy on July 2, 1926.

See Charles Baudouin, *Suggestion and Autosuggestion* (1921).
(WR. R. B.)

COUES, ELLIOTT (1842–1899), U.S. naturalist who did pioneer research in ornithology and mammalogy, was born in Portsmouth, N.H., Sept. 9, 1842. He was graduated in 1861 from Columbian college (now George Washington university), Washington,

D.C., and from the medical school of that institution in 1863. In 1864 he was appointed assistant surgeon in the U.S. army. At the age of 30, he published his *Key to North American Birds*, which, with its revisions (1884 and 1901) and his revision of *New England Bird Life* (Stearns), did much to encourage systematic study of ornithology in America. This was one of the first works to introduce the "key" method of botanical manuals into zoology, and it is notable for its accuracy and completeness of citation and the convenience of its concise descriptions. In 1873–76 Coues was attached to the United States Northern Boundary commission, and in 1876–80 to the United States Geological and Geographical Survey of Territories, the publications of which he edited. His journeys enabled him to publish admirably annotated editions of the Lewis and Clark expedition (1804–06) and of Zebulon Pike's exploration of the upper Mississippi and Rocky mountain regions (1805–07).

Coues was a lecturer on anatomy in the medical school of Columbian in 1877–82, and professor of anatomy there in 1882–87. He was a founder of the American Ornithologists' union and edited its organ, *The Auk*, and several other ornithological periodicals.

In addition to ornithology Coues did valuable work in mammalogy, his book *Fur-Bearing Animals* (1877) being distinguished by the accuracy and completeness of its description of species. He worked on the *Century Dictionary* for several years, was associate editor of the magazine of ornithology, *The Osprey*, and edited journals of exploration. He died in Baltimore, Md., on Dec. 25, 1899.

COUGH, a reflex initiated when the respiratory tract is irritated by infection, noxious fumes, dusts or other types of foreign bodies. The reflex results in a sudden expulsion of air from the lungs that carries with it excessive secretions or foreign material from the respiratory tract. Cough is beneficial; pneumonia frequently results when an effective reflex is lost as a result of chest injury, disease or oversedation. Repeated and severe coughing, however, is physically exhausting and interferes with rest. Under these circumstances drugs (especially opiates) may be used to suppress the reflex.

Cough occurs in many of the acute infectious diseases including the common cold, in the majority of chronic pulmonary diseases and frequently in heart disease. Any cough that persists longer than a few weeks should receive medical attention because it may be the first warning of serious disease. (H. A. D.)

COULOMB, CHARLES AUGUSTIN DE (1736–1806), French physicist, a pioneer in electrical theory, was born in Angoulême, on June 14, 1736. He was a military engineer, and after spending nine years in the West Indies he returned to France with his health much impaired. In 1789, on the outbreak of the revolution, he retired to a small estate at Blois and devoted himself to scientific research. In 1802 he was appointed an inspector of public instruction; he died in Paris on Aug. 23, 1806. The coulomb, an electrical unit, was named in his honour.

Coulomb designed the torsion balance independently of Michell in 1777. He published papers on friction as applied to machinery (1779); on windmills (1781), and on the torsional elasticity of metal and silk fibres (1784). His electrical papers were published in the *Mémoirs de l'Académie royale des sciences* between 1785 and 1789; these formed the basis of the mathematical theory of electricity of Poisson.

The first three memoirs appeared in 1785, the following numbers in 1786, 1787, 1788 and 1789. In these memoirs Coulomb gave an account of his work with the torsion balance in verifying Priestley's law of electrical repulsions. He extended the case to include attractions and finally stated that the force is proportional to the product of the charges and inversely proportional to the square of the distance between them (Coulomb's law). He also verified the inverse square law for particles of magnetic fluid; he believed in the two-fluid theory, but assumed that the magnetic fluids could not be separated but that the electric fluids were separable.

In the fourth memoir Coulomb showed that an electric charge is confined to the surface of a conductor and he compared the distribution of charge on the surface of conductors. He virtually established the result that the electric force near a conductor is proportional to the surface density of electrification (this was later proved by Poisson); he also stated that in the case of action at a distance the intervening medium played no part. Cavendish had anticipated Coulomb in the statement of the inverse square law, but this work was unpublished until many years after his death.

See ELECTRICITY: *Electrostatics: Coulomb's Law; see* also references under "Coulomb, Charles Augustin de" in the Index.

COULSDON AND PURLEY, an urban district of Surrey, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with Croydon to form the new London borough of Croydon (*see* LONDON). The urban district, largely residential, includes Sanderstead, Kenley, and Selsdon, and lies on the North Downs. It has more than 1,700 ac. of public woodland and commons. Pop. (1961) 74,926. Area 17.4 sq.mi. The parliamentary constituency is East Surrey. The area, especially Sanderstead, is rich in Mesolithic finds. Bronze Age remains have been discovered at both Purley and Coulsdon. On Farthing Down, near the Brighton Road, are outlines of Celtic fields and a series of Saxon burials. All Saints' Church at Sanderstead has medieval wall paintings.

COULTER, JOHN MERLE (1851–1928), U.S. botanist and educator, whose work centred on plant morphology and taxonomy, was born at Ningpo, China, on Nov. 20, 1851, the son of missionary parents. He graduated from Hanover college, Hanover, Ind., in 1870 and pursued further study there and at Indiana university, receiving from the latter in 1882 the degree of doctor of philosophy. After serving as botanist with the U.S. geological survey in the Rocky mountains in 1872–73, he was professor of natural sciences at Hanover college in 1874–79, professor of biology at Wabash college in 1879–91, president and professor of botany at Indiana university in 1891–93 and president of Lake Forest university in 1893–96. From 1896 to 1925 he was professor and head of the department of botany at The University of Chicago. In 1923 Coulter was made a member of the National Research council and in 1925 became adviser of the Boyce Thompson Institute of Plant Research at Yonkers, N.Y.

For more than half a century Coulter was an active botanical investigator and educator, producing early in his career valuable manuals for the study of Rocky mountain and Texan plants and later building up an important graduate department in botany in which many U.S. leaders of plant research were trained. In 1875 he founded the *Botanical Gazette*, of which for more than 50 years he was editor.

Coulter died at Yonkers, N.Y., Dec. 23, 1928.

Coulter's longer works include: *Manual of Rocky Mountain Botany* (1885); *Botany of Western Texas* (1891–94); *Plant Relations* (1899); *Plant Structures* (1899); *Morphology of Gymnosperms* (1901; 3rd ed., 1910) and *Morphology of Angiosperms* (1903), both with C. J. Chamberlain; *New Manual of Botany of the Central Rocky Mountains*, with A. Nelson (1909); *Fundamentals of Plant Breeding* (1914); *Evolution of Sex in Plants* (1914); *Plant Genetics* (1918); and *When Evolution and Religion Meet*, with Merle C. Coulter (1924).

COUMARIN, a fragrant chemical substance that occurs in sweet woodruff, the tonka (tonqua) bean, sweet clover (*Melilotus*) and many other plants. The fragrance of newly mown hay is largely due to its presence. Coumarin is widely applied in perfumery for the preparation of the sweet woodruff essence, as a flavouring agent and to scent tobacco. It can be obtained from the tonka bean, known to the natives of tropical South America as *cumaru*, by extraction with ethanol.

Coumarin, $C_9H_6O_2$, is the lactone derived from *cis-o*-hydroxycinnamic acid (coumarinic acid), which is not known in the free state because it cyclizes to coumarin as soon as it is liberated from solutions of its salts.

Coumarin was the first natural perfume to be synthesized from a coal-tar chemical and was made by the action of acetic anhydride and sodium acetate on salicylaldehyde (Sir William Perkin, 1868). It forms rhombic crystals melting at 67° C., which are readily soluble in ethanol and moderately soluble in hot water.

The coumarin nucleus is comparatively resistant to oxidation and the benzene part of the ring system is not as reactive as that of a simple benzene derivative. The chemical behaviour of coumarin is explained only partly by the lactonic structure since the α-pyrone ring is rather difficult to open with alkali while acids likewise do not readily affect it.

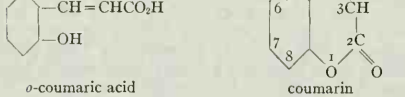
On boiling with concentrated potassium hydroxide, coumarin yields the potassium salt of *o*-coumaric acid. The double bond between carbon atoms 3 and 4 in the coumarin nucleus (*see* structural formula, below) is highly reactive; it adds bromine, hydrogen cyanide and sodium bisulfite with great facility. Catalytic hydrogenation under pressure converts coumarin to dihydrocoumarin which upon opening of the lactone ring forms melilotic acid, $C_9H_{10}O_3$.

There are many coumarin derivatives widely distributed in the plant world. Most of them are hydroxycoumarins—the 6,7-dihydroxy derivatives being dominant. Some occur as glycosides. Alkylated hydroxycoumarins also occur.

Coumarin itself has very little physiological action on mammals, but many of the synthetic 3-substituted-4-hydroxycoumarins have potent anticoagulant properties. The causative agent of the hemorrhagic sweet clover disease of cattle is 3,3′-methylenebis-(4-hydroxycoumarin). The synthetic product called Dicumarol (U.S. registered trade-mark) is widely used in clinical practice as an orally administered anticoagulant to combat various thromboembolic syndromes (coronary thrombosis, pulmonary embolism, etc.).

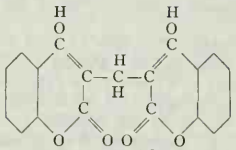
Another synthetic 3-substituted-4-hydroxycoumarin, the highly potent warfarin, has revolutionized rat and mouse control. Its anticoagulant action is not detectable by the rodent. When baits containing 0.025% warfarin are eaten for from three to five days, fatal internal hemorrhage results in from seven to ten days. The 3-sodium derivative of warfarin is also used clinically like Dicumarol®.

Structural formulas of coumarin and related substances are:

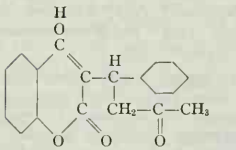


o-coumaric acid

coumarin



Dicumarol®



warfarin

(K.P.L.)

COUNCIL, in the Christian Church, is a meeting of bishops and other leaders to consider and rule on questions of doctrine, administration, discipline, etc. An ecumenical or general council is a meeting of bishops of the whole church; local councils representing provinces, patriarchates and so on are often called synods. According to Roman Catholic doctrine a council is not ecumenical unless it has been called by, and its decrees are not binding until they have been promulgated by, the pope. Decrees so promulgated possess the highest authority.

Outside the Roman Catholic Church, most Christians assert that there have been no ecumenical councils since the schism that divided Eastern and Western churches; hence only the first seven councils are recognized. Roman Catholics accept 14 later councils (including the Vatican council that began in autumn 1962) as ecumenical.

Synods, councils and conferences on a small scale have played a part in the Protestant churches and in times of crisis have achieved more than local or temporary significance. Examples of such are the Westminster assembly (1643), whose purpose was the reformation of the English church; the Synod of Dort (1618–19), an assembly of the Dutch Reformed Church to deal with Arminianism; and the Synod of Barmen (1934), at which the major German Protestant confessions declared their opposition to Nazism. In the 19th century there was a growth of national and world consultative organizations in the various Protestant denominations, and this has continued. The formation of the World Council of Churches (*q.v.*) in 1948 may herald the beginning of a Protestant conciliar movement of ecumenical scope. (X.)

Origins.—The name council was applied in the most primitive times to any church meeting and even to buildings where services were held. As the theory of government by bishops was expounded during the 3rd century, the word council came to have the special sense of meetings of bishops, though not only bishops were present, for the administration of the church. There had long been meetings of the entire congregation, the bishop with his presbyters and deacons and the faithful, and this was the foundation of the later diocesan synod. But as the church grew, its problems could be solved only by meetings of the heads and representatives of the various churches. Each bishop was regarded as the special voice of his church and its tradition, as the apostolic teacher representing an apostolic tradition. He came to a provincial council to utter his judgment upon such pastoral problems as the treatment of apostates or adulterers, or, if there were question of heresy, to declare the faith received in his church and presumed always to have been taught there since its foundation.

The earliest-known provincial councils were held in the 2nd century to pronounce judgment upon an eastern sect of Phrygia, the Montanists, and to settle a disagreement between churches over the mode of celebrating Easter. In Cappadocia during the 3rd century there seem to have been annual meetings. Persecution was a fruitful source of pastoral problems, and many of the earliest councils were concerned with it. By 300 the meetings of bishops in the province had become the habitual mode of church government. These gatherings looked back to the apostolic meeting at Jerusalem in Acts xv as their prototype, and believed that such meetings were specially under the inspiration of the Holy Spirit. Their decisions, known as canons, were already beginning to form a series of precedents, though the work of collecting and codifying had not yet begun (*see* CANON LAW).

The growth of conciliar action was especially affected by the development of the authority of the greater sees. The bishop of a provincial capital soon gained a special place in councils, but even in the capital cities, like Rome and (after the transfer of the capital) Constantinople, there was often a local synod of resident or visiting bishops gathered round the pope or patriarch.

In nearly every provincial synod in this primitive period presbyters, deacons and sometimes laymen shared with the bishops in the council. But it is clear from the writings of Cyprian that bishops were always the decisive voice, and only the bishops signed the letters issued by the synods in the province of Africa. Elsewhere presbyters often signed as representatives of their bishops, but other presbyters and laymen are also found signing. After the conversion of Constantine I the emperors summoned and sometimes presided at councils. In the kingdoms of the west lay lords sat with the bishops; and in England, Spain and France the distinction between the ecclesiastical council of the nation and the national council was not always easy to perceive. Nevertheless the distinction was never submerged. It was understood that there was a difference between the local law of the land and the universal law of the church, and that in the declaration of the latter the laity were subject to the decisions of the bishops.

General Councils.—With the end of persecution under Constantine I, it seemed possible and natural that bishops from more

than one province should be convened to a general council. Even before the conversion of Constantine, a decision accepted by a series of provincial councils became in normal practice a binding one. Thus Tertullian wrote of the "councils of the churches" which declared the *Shepherd* of Hermas (*see* APOSTOLIC FATHERS) not to be an authentic part of the New Testament. To a council from a wider area was inevitably attributed a more general authority, and as early as 314 Constantine had summoned such a "general" council to Arles to deal with the problems of the Donatist schism.

A distinction must be made at first between councils loosely called general and those which later achieved the status of general or ecumenical councils. No one knew in the beginning that there was such a status to achieve; and any great council, with bishops representing several provinces, would regard itself as especially important and its authority as proportionately higher than that of a provincial council. When the idea of an ecumenical council had come into existence and had been fully established during the 5th century, there were several attempts by councils to be ecumenical and several councils which believed themselves to be ecumenical, though their claim was disallowed, and occasionally abhorred, by the later tradition of the church.

The idea of an ecumenical council was slow to take shape or, rather, its authority was defined but slowly. The term ecumenical synod was first used by the historian Eusebius (in his life of Constantine) to describe the council summoned by Constantine to meet at Nicaea in 325. Between such imperially summoned synods and ordinary provincial synods there was a patent difference, but a difference more of practice and repute than of defined authority. The decisions of such a council were obviously more binding than were those of earlier councils, since the emperor made them effective in secular law. The Council of Nicaea met not in a church but in part of the royal palace and the emperor was present for some of the time, taking an effective part in the discussion. The government made provision to pay the expenses of bishops who attended the Council of Nicaea and later councils of the 4th century. Ammianus Marcellinus grumbled that the imperial postal service was seriously hindered by the bishops going to and from councils, and Pope Liberius tried to persuade the emperor Constantius to summon a council with the plea that the bishops would travel at their own charges. It was soon observed that the privilege might diminish the independence of the bishops in a matter where the emperor was known to hold strong opinions; at the Council of Ariminum (Rimini) in 359 most of the bishops refused their expenses on this ground, and it was noted as a sign of the poverty of three bishops from Britain that they were compelled to accept help from the public funds.

But though the relation to the emperor and the possibility of summoning bishops from all parts of the empire patently made much practical difference to the nature of the council, it was not at first evident that there might be a peculiar sacredness about the decisions of such a council. All councils were believed to meet under the guidance of the Holy Spirit. In matters of faith, since theoretically the bishops came to the councils not to make new decisions but to declare the ancient faith of the church, it was not clear how a council assembled from the whole empire was more "irreformable" than a series of councils in parts of it. In matters of discipline later councils habitually corrected or revised the decisions of earlier councils. The eastern bishops who disliked the Creed of Nicaea continued for many years to work for its revision. The long fight, led by Athanasius, to defend the Creed of Nicaea and its word *homoousios* began about 359–360 to attribute a peculiar and exceptional sanctity to the decision of Nicaea, a sanctity which carried with it the implication that the Creed of Nicaea was not reformable by a later council. Athanasius was not slow in arguing that this specially sacred nature of the council arose from its universal representation. By the 5th century the historian Socrates declared that the Nicene fathers could not depart from the truth because they were enlightened by the grace of the Holy Spirit. The Councils of Ephesus (431) and Chalcedon (451) declared that the decisions of Nicaea were unalterable.

It was assumed, rather than formally stated, that ecumenical councils, once recognized to be such, could not err. In the 6th century the emperor Justinian I ordered all bishops to subscribe to the first four councils, on the ground that we receive them as we receive the Holy Scriptures; and a little later Pope Gregory the Great mentioned the four councils in the same breath as the four Gospels. In practice this idea of irreformable canons was often confined to matters of faith. In matters of discipline later councils continued to alter the decisions even of the councils recognized as ecumenical, for changing circumstances had made the old canons irrelevant or unenforceable. Nevertheless there was never a clear distinction of doctrine between the canons of faith and the canons of discipline.

Ecumenical Councils

Recognized by Both Eastern Orthodox and Roman Catholics

1. First Council of Nicaea (325)
2. First Council of Constantinople (381)
3. Council of Ephesus (431)
4. Council of Chalcedon (451)
5. Second Council of Constantinople (553)
6. Third Council of Constantinople (680–681)
7. Second Council of Nicaea (787)

Recognized by Roman Catholics

8. Fourth Council of Constantinople (869–870)
9. First Lateran Council (1123)
10. Second Lateran Council (1139)
11. Third Lateran Council (1179)
12. Fourth Lateran Council (1215)
13. First Council of Lyons (1245)
14. Second Council of Lyons (1274)
15. Council of Vienne (1311–12)
16. Council of Constance (1414–18)
17. Council of Ferrara-Florence (1438–*c.* 1445)
18. Fifth Lateran Council (1512–17)
19. Council of Trent (1545–63)
20. First Vatican Council (1869–70)
21. Second Vatican Council (1962–)

The Roman Catholic Church recognizes eight and the Orthodox Eastern Church seven ecumenical councils before the schism between east and west in 1054 (*see* table). For the east this in practice closed the series; for the west, the nature of a general council changed. Hitherto it had in every case been held under imperial protection, summoned by the Byzantine emperor, and in only one case (Ephesus in 431) held more than a few miles from Constantinople. After the schism the increasing centralization of the Latin Church under the see of Rome made that see the single effective convener of general councils, which only special circumstances kept away from the Lateran or Vatican.

COUNCILS TO THE 9TH CENTURY

First Council of Nicaea (325).—After Constantine I had made himself sole emperor in 324, he addressed himself to healing the principal conflict raging in the Eastern Church, that over Arianism; in this effort he used the same method he had used in the west over Donatism when he summoned the Council of Arles of 314. It was originally decided that this ecumenical council should meet at Ancyra (Ankara), but, perhaps for the convenience of the western delegates as well as of the emperor, the meeting was transferred to the royal palace at Nicaea. To Nicaea came about 220 bishops, out of whom only five are known to have come from western countries, though the list is incomplete. The five included Ossius, the bishop of Córdova, but not the pope, who sent two representatives. (The pope was not personally present at any of the first eight ecumenical councils; and though he was in Constantinople while the fifth council was being held in 553 he pleaded as a reason for not participating that it was not the custom of his predecessors. He was represented by legates, except at Constantinople in 381 where he was neither summoned nor represented.)

No reliable account of the proceedings has survived; only the agreed creed, the 20 canons and the synodical decree are extant. It is difficult to suppose that no report of the proceedings was taken, but none was extant even in the later 4th century. The emperor, though unbaptized and a catechumen, presided in state at the opening and took an active part in the discussions. It seems

to have been his personal influence which decisively swayed the divided council to accept, almost unanimously, the proposed creed supported by his chief advisers and containing the word *homoousios*, "of one substance"; *i.e.*, with the Father, applied to the Son. (For a discussion of the theological issues, *see* ARIANISM; CREED: *Nicene Creed.*)

No one knows whether Constantine himself understood what was at stake. The word *homoousios* appeared to rule out the subordination of the Son to the Father for which Arius had contended. But many eastern bishops were reluctant to accept the word. They shrank from including in the creed a word not drawn from scripture; they feared that its suggestion of absolute equality or even identity between Father and Son would encourage the error of the Sabellians, who regarded Jesus' life as a simple manifestation of the Creator God. The language of some eastern bishops indicates that their acceptance of the term was not due to theological conviction. The council also condemned Arius; and the eastern bishops, with two open exceptions, did not question that he had rightly been condemned. The emperor exiled Arius from Egypt until he accepted the Creed of Nicaea. It thus appeared convenient that the decisions of a council should be implemented by the secular power; but as an inconvenient consequence, it soon became apparent, bishops of a small minority need not despair if they could secure the support of an emperor.

The synodical decree of the Council of Nicaea attempted, though unsuccessfully, to establish a uniform date of celebrating Easter, in accordance with the custom of the great majority of the churches. The canons confirmed the authority of the bishop of Alexandria over other bishops in Egypt and Libya, and of other metropolitans (canon vi), thereby taking a long stride toward the creation of effective patriarchates; and allowed the bishop of Jerusalem a primacy of honour in his province, though it left him without jurisdiction (vii). They decreed a time of catechumenate for converts before their baptism or ordination (ii); forbade the clergy to have unmarried women in their houses (iii), apparently even as housekeepers; decreed that a bishop should be consecrated by three bishops at least and with the approval of his metropolitan (iv); condemned the lending of money at interest by clerics (xvii); ordered that Christians should pray standing on Sundays and from Easter to Pentecost (xx); and forbade bishops, priests or deacons to move from one church to another (xv).

The 5th-century historian Socrates says that the council intended to make a canon enforcing celibacy of the clergy upon all bishops, priests and deacons. The unmarried bishop Paphnutius from Egypt said that "too heavy a yoke ought not to be laid upon the clergy," and prevented the canon, though he would have permitted a canon forbidding those who were ordained when unmarried to marry after ordination.

Councils Between 325 and 381.—After the death of Constantine (337) the eastern bishops put out various creeds and doctrinal statements which condemned Arius but did not contain the *homoousios* and were directed against the Sabellians. The prolonged controversies of the 4th century were part doctrinal, part personal. The only weapon of the church for solving these problems was the council, and indefatigable endeavours at numerous councils were needed to reach any solution that would be generally acceptable in east and west. The personal acrimonies and rival orthodoxies left even some contemporary observers with a distaste for councils—"Venerable bishops," said Gregory of Nazianzus ironically, "who put their personal squabbles before questions of faith." "For my part," said the same writer sadly, "to speak the truth, I prefer to avoid all councils of bishops. I have never seen a council which ended well or cured evils—on the contrary." For the last 16 years of his episcopate, Martin of Tours, whose experience of bishops had been as unhappy as Gregory's, refused to attend the provincial councils of Gaul. But these consequences were probably inevitable during the political divisions of the empire during the 4th century. No other ultimate authority was in those days conceivable, whatever eminence in jurisdiction might be accorded to the patriarchs.

Probably the most important council, in long perspective, of this period of councils between 325 and 381 was the Council of Sardica (Sofia) in 342 (or, as some believe, 343). This had been intended as an ecumenical council, but the easterners refused to attend when they found that the western bishops insisted on the presence of Athanasius and others who had already been deposed by lawful synods. The decisions of the western council at Sardica did nothing to solve the conflict. But the canons passed there were taken into western canonical collections, tacked on to the Nicene canons without break or scribal mark, in such a way that sometimes they were quoted as "Nicene" and thereby gained spurious ecumenical authority. The canons of Sardica ruled that a bishop must first have been ordained reader, deacon and priest, and not consecrated as a simple layman (xiii); bishops ought not to be consecrated for every little town, for fear of lowering the dignity of the episcopate (vi); translations of bishops from see to see are forbidden (i); bishops must reside in their dioceses and (characteristic of the 4th century) must not travel to other dioceses without good reason, and even with good reason must remain there as short a time as possible (xiv, xv). They ruled also that if a bishop is deposed by the bishops of his province he has a right of appeal to the see of Rome: if the pope holds that there is no case for revision, the appeal is disallowed; if he holds that there is a case, he must refer it to the bishops of a neighbouring province as a court of final appeal (vii). This last piece of legislation remained a dead letter. The Nicene faith was not finally established till the Council of Constantinople in 381. In the later stages of the debate the Cappadocian fathers, led by Basil of Caesarea, not only brought the old eastern conservatism to lose its fear of the *homoousios*, but examined the theology of the Holy Spirit in such a way that when the settlement was reached in 381 it was a full definition of trinitarian doctrine.

First Council of Constantinople (381).—Theodosius I, who was a strong defender of the Nicene faith, became emperor of the east in 379 and summoned a council of eastern bishops, some 150 attending. Again the minutes of the council are not extant. The council declared for a creed that was substantially the creed of Nicaea with the alterations that make it the Nicene (Niceno-Constantinopolitan) Creed as subsequently known to the church. It finally declared the doctrine of the equality of the Holy Spirit with the Father and the Son, and therefore may be regarded as the end of a long debate upon the trinitarian doctrine. In both these doctrinal decisions it recovered unity between east and west. The third canon of the council gave the bishop of Constantinople precedence of honour over all other bishops except the bishop of Rome, "because Constantinople is the New Rome." The second canon limited the influence of the eastern patriarchs to their own provinces, thus particularly limiting the power exercised by the see of Alexandria under Athanasius and his successors. Peter of Alexandria had lately and high-handedly consecrated a bishop of Constantinople, and it is probable that the canon was directed mainly against this sort of act. The council requested the emperor to seal the decisions, and Theodosius gave them legal effect.

Though only eastern bishops had been summoned, the Greeks claimed this council to be ecumenical. Pope Damasus (366–384) appears to have accepted the creed but not the canons, at least not the canon upon the precedence of Constantinople. But exactly when the council achieved the ecumenical status comparable with that already achieved by Nicaea is not easy to determine. The third ecumenical council at Ephesus in 431 still held the Council of Nicaea in a unique place of honour. Not until the Council of Chalcedon (451) does the ecumenical status of this council of 381 appear to be undoubted. Rome continued thereafter to protest against the award of precedence to Constantinople. About 485 Pope Felix III wrote of three ecumenical councils, Nicaea in 325, Ephesus in 431, Chalcedon in 451. Pope Gregory the Great and his successors decisively acknowledged the ecumenical character of the creed. The see of Constantinople was first allowed precedence by Rome after it had become Latinized as a result of the fourth crusade (1204). Thus, in inquiring into the nature of the authority of ecumenical councils in the Latin church, it should be observed that the dogmatic authority of this council was not recognized as binding until the 6th century, and its regulation of see not until the 13th.

Council of Ephesus (431).—After the settlement of the Arian question, and its corollary in the doctrine of the Holy Spirit, theological debate moved into the realm of the doctrine of Christ's Person, the relation of Godhead and manhood in one who was both God and man. One trend of thought, exemplified by Apollinaris and by Monophysitism and expounded in Alexandria, concentrated upon the Word as the subject inhabiting the God-man, emphasizing Jesus as God but appearing to minimize the full and true nature of his manhood. Another trend, exemplified by Theodore of Mopsuestia and Nestorius and in Antioch, emphasized his complete manhood and used uncertain language about the way in which the Word dwelt in that manhood.

Nestorius, who became patriarch of Constantinople in 428, declared that the word *Theotokos* ("God-bearer"), as applied to the Virgin Mary, long used at Alexandria and hallowed in popular devotion, was unsuitable or doubtful. Cyril of Alexandria held that Nestorius had fallen into the opposite error of suggesting two Sons of God who dwelt together in Jesus. (For a detailed discussion of the theological controversy, *see* CYRIL, SAINT; JESUS CHRIST: *The Dogma of Christ in the Ancient Councils;* and NESTORIUS.) The conflict between the ancient rights of the see of Alexandria and the new claims of the see of Constantinople played a large part in the struggle. Theodosius II summoned a general council to meet at Ephesus on June 7, 431.

The proceedings at Ephesus were extraordinary. The bishops from Antioch and its province failed to arrive till June 26; and meanwhile, on June 22, Cyril of Alexandria held a council of some 200 bishops under his own presidency and deposed Nestorius, who refused to attend or recognize it. On June 26 the Antiochenes arrived under their patriarch, John, and held a council of 43 bishops in which they deposed Cyril. On July 10 the pope's legates arrived from Rome and declared for Cyril's council; this is the council recognized as ecumenical.

The principal decision of the council was the condemnation of Nestorius, a decision primarily disciplinary, not doctrinal, especially as doctrinal debate continued as ardently after the council as before it. The council looked with favour upon 12 anathemas pronounced by Cyril against Nestorius and read at the council, evidently approved by the delegates, included in the acts over their subscriptions, but not formally declared to be binding. It has commonly been assumed in Christendom that the council thus condemned the disapproval of *Theotokos* and other particularly Nestorian language which minimized the unity of Godhead and manhood or treated the incarnation as an association between God and the man Jesus rather than as the assumption of manhood by the divine Word.

The council declared that no one might make innovations on the Creed of Nicaea (proper, not the creed of 381 now called Nicene) and condemned the opinions of the Pelagian Celestius, though without specifying which opinions it was condemning (perhaps his alleged denial of original sin and the doctrine that the grace of God is given to a man in accordance with his merits). The Roman legate Philip asserted at the council that St. Peter still lives and judges in his successors, and these famous words were received by the council without protest.

In default, however, of any indubitable statement of what opinions in Nestorius and Celestius the council was condemning, it is not easy to consider the decrees of the Council of Ephesus as being of decisive dogmatic authority. Nestorius in fact was sent into exile by the emperor. The continuing conflict between the Antiochene bishops on the one side and Cyril and Rome on the other was resolved by the "formulary of union" in 433, which accepted *Theotokos* with an explanation, used the phrase "union of two natures" and in one phrase allowed that the two natures persisted after the union. It was left uncertain whether Cyril's 12 anathemas, which to some had suggested a fusing of natures and had been abhorrent to the Antiochene bishops, had or had not been withdrawn.

From Ephesus (431) to Chalcedon (451).—Since the Council of Ephesus had defined nothing, the debate over the Person of Christ—his relation to the Father and the relation of divine and human within him—continued for the next 20 years. Cyril's extreme supporters regretted that he had accepted a formula with the phrase "two natures," the extreme supporters of Antioch continued to regard Cyril as heretical. When Cyril died in 444 the more rigid wing of his party took control under his successor, Dioscorus, who was determined to reassert the "one-nature" language. In 448 the controversy centred upon the archimandrite Eutyches (*q.v.*), who taught that there were two natures before the incarnation, one nature after. He was excommunicated. Flavian, patriarch of Constantinople, informed the pope, Leo the Great, of Eutyches' heresy; and this was the occasion of the celebrated *Tome* of Leo (June 13, 449), which showed the vigorous opposition of the Roman see to the one-nature language. Eutyches appealed to Dioscorus, who persuaded the emperor to summon a general council at Ephesus (Aug. 449). This synod (known by Pope Leo's contemptuous nickname as *Latrocinium*, the "robber synod") vindicated Eutyches, deposed Flavian and all the chief defenders of two-nature language, dismissed the formula of union and anathematized the proposition that there were two natures after the incarnation.

Council of Chalcedon (451).—In 450 the emperor Theodosius II died and was succeeded by his sister Pulcheria and her husband Marcian, who were favourable to the two-natures group. Marcian summoned a general council (originally to Nicaea but transferred to Chalcedon before it began its sessions on Oct. 8, 451), the largest of the early councils, with about 520 bishops or their representatives present, and the best documented.

Unlike the bishops at Ephesus in 431, the bishops at Chalcedon defined doctrine. Their mode was to approve documents: the Creed of Nicaea (proper), the Creed of Constantinople (381, the so-called Nicene Creed), Cyril's two letters against Nestorius (which excluded Nestorianism as Cyril believed it to be and therefore insisted upon the unity of persons in Christ, and approved the *Theotokos*), Leo's *Tome* (which excluded the one-nature language and insisted upon two natures after incarnation). They also composed a confession of faith:

> Jesus Christ is one and the same Son, the same perfect in Godhead and the same perfect in manhood . . . begotten from the Father before the ages as regards his Godhead, . . . and from the Virgin Mary, the *Theotokos*, as regards his manhood; . . . made known in two natures without confusion, without change, without division, without separation, the distinction of natures being by no means taken away by the union.

The council also deprived Dioscorus and others of his party.

The council made certain regulations for pastoral discipline, especially subjecting monks to their bishops, prohibiting the clergy from farming or business and ordering that no one should be ordained without a pastoral charge. It elevated the see of Jerusalem to the status of a patriarchate in Palestine, hitherto under the see of Antioch, and elevated the see of Constantinople to the status of a patriarchate over Pontus, Asia and Thrace. This last resolution (the 28th canon) encountered the protests of the papal legates, and the see of Rome never accepted it. Its existence delayed Pope Leo's acceptance of the dogmatic definitions until 453.

The Council of Chalcedon, by its first canon, confirmed a code of canons which its members were using, and thereby gave a measure of ecumenical authority to canons of earlier local or provincial councils. The collection of canons included not only the ecumenical councils of Nicaea (325) and Constantinople (381) but also local synods of Ancyra (314), Neocaesarea (early 4th century), Gangra (middle of the 4th century) and Antioch (ascribed to 341, but probably held about 328–330). This book of canons seems to have been received implicitly in the east before the Council of Chalcedon stamped it with a more authoritative approval. But the nature of this approval is douhtful, nor perhaps would Latins have perceived clearly what was being approved. Many of the earlier canons are concerned with pastoral problems of the lapsed and are appropriate only to conditions of persecution. The tenth canon of Ancyra permits deacons to marry after ordination if they have given notice at ordination of their intention. The 15th canon of Neocaesarea orders that the deacons be seven in number "even if the city be very great," and the first canon decrees that the priest who marries after ordination shall be deposed. For the most part this collection of canons bears

witness to a primitive state of church life that had passed away when the Council of Chalcedon met.

After Chalcedon.—By the time the fathers met at Chalcedon in 451 the western part of the Roman empire had already begun to break into the pieces which later became the barbarian kingdoms. There was a period of codification, both in Italy and the east (*see* CANON LAW), and the four general councils were canonized as the rule of orthodoxy, so that Gregory the Great at the end of the 6th century could say that he reverenced them as he reverenced the four Gospels. In the east the decrees of Chalcedon encountered resistance from the churches which were disciples of the one-nature doctrine, and in Egypt, Syria or Armenia there was Monophysite schism (*see* MONOPHYSITES). The emperors in Constantinople vacillated about the best means of holding together their religiously divided empire. A proposal by the emperor Zeno (the *Henoticon*, 482) that Chalcedon be quietly dropped and agreement founded upon the first three councils failed disastrously, and its failure showed that no agreement could be reached except by receiving the decree of Chalcedon while seeking to modify it. Justinian I, emperor from 527 to 565, himself theologically qualified and the more concerned for the religious division because his troops were recovering control of Rome and Italy, tried various expedients for modifying Chalcedon.

One scheme (543) was to condemn the "Three Chapters," the Antiochene two-nature subjects that had been approved by Chalcedon: the person and writings of Theodore of Mopsuestia; the writings of Theodoret of Cyrrhus against Cyril's 12 anathemas; and a letter of Ibas, bishop of Edessa, which also attacked the 12 anathemas. These three were much complained of by those inclined to Monophysitism. The plan of condemnation ran into vigorous opposition from all those for whom Chalcedon had become sacred. To condemn the Three Chapters seemed to be calling in question the immutable nature of the decrees and therefore the ecumenical status of the council. Justinian summoned a general council in 553 and used stringent measures to persuade all the parties to conform.

Second Council of Constantinople (553).—The council opened on May 5, 553, with 165 bishops under the presidency of Eutychius, patriarch of Constantinople. Pope Vigilius of Rome, who had been summoned to Constantinople, opposed the council and took sanctuary in a church. The council condemned the Three Chapters. The pope continued his resistance until Dec. 8, 553, when he informally accepted the verdict of the council; he ratified it formally on Feb. 23, 554.

The 14 anathemas put out by the council further strengthened the case against any Nestorian interpretation of Chalcedon by insisting yet further upon the unity of the Person of Christ in the two natures. The only other important act of the council was to ratify an earlier condemnation of Origen, though what opinions were condemned is not evident from the acts of the council. From the relevant documents used by the bishops, it appears that the doctrine of the soul's existence before birth was the chief offense. The western church, devoted as it was to Chalcedon, could not bring itself to accept the decrees of the council of 553, even though the pope had accepted them. In Africa imperial troops were able to force acceptance. North Italian bishops refused their allegiance to the see of Rome and found support in France and Spain. The opposition hung on in northern Italy until the end of the 7th century. By then the coming of Islam into those provinces of the east which had been inclined toward Monophysitism rendered obsolete all such plans for compromise.

Third Council of Constantinople (680) and Trullan Council (692).—The arguments over Chalcedon, however, were not ended. Some easterners, forbidden to talk of one nature, thought to enforce the unity of the Person of Christ by talking of one will (Gr. *thelema*) and one operation (*energeia*) from the two natures, and thereby are called Monothelites (*q.v.*). Sergius, patriarch of Constantinople from 610 to 638, seems to have been the principal author of this language. The doctrine of one will was enshrined in the *Ecthesis* of 638, published under the name of the emperor Heraclius but probably drafted by Sergius. The pope of Rome, Honorius I, appears to have declared for the doctrine, though his language leaves room for doubt. In reply to Constans II's edict of 648, which imposed silence on all parties, a Lateran synod held under Pope Martin I in 649 supplemented the definition of Chalcedon by a statement affirming two wills and two operations. Martin was exiled to the Crimea, and the struggle between Rome and Constantinople continued. But with the emperor Constantine IV conciliation prevailed. In 680 he summoned a council at Constantinople which in its first session assumed that it was ecumenical. It condemned the Monothelites, among them Honorius, and asserted two wills and two operations. "Each nature with the communion of the other willed and wrought that which was proper to itself."

Another council met in 692 in the same imperial banqueting hall, called Trullus, at Constantinople, and this is known as the Council *in Trullo*, or, because it intended to be a supplement to the fifth and sixth general councils, the Quinisext council. Though Rome and the west were probably not represented, the fathers claimed to be a general council; but some of their canons were most unacceptable to the west and were in part directed against Roman customs (*e.g.*, celibacy of the clergy, rules for fasting). In the east the 102 canons of this council were added to those of the sixth ecumenical council and thereby acquired ecumenical authority (they were quoted as such by the seventh ecumenical Council of Nicaea in 787). Under this impression the west also received some of them.

Second Council of Nicaea (787).—In 726 the emperor Leo III the Isaurian issued his decree against the worship of icons and thereby precipitated the iconoclastic controversy. During all the middle years of the 8th century the controversy raged in the east (icons were condemned at a council, claiming to be general, at Hieria, near Chalcedon, in 754), slowly driving the popes, who decisively opposed iconoclasm, out of the arms of the Byzantine emperors to look for protection from the new western power in Carolingian France. In 780 the empress Irene began to retract the iconoclastic policy; and her iconodulic patriarch, Tarasius, requested the summoning of a council to re-establish the peace of the church (787). It was intended to be an ecumenical council, and on this ground Pope Adrian I sent legates. Tarasius presided, but the Roman legates signed first. The dogmatic decrees anathematized all heretics, including Pope Honorius and the leading iconoclasts, but did not condemn the Three Chapters. It declared that icons deserved reverence (Gr. *proskynesis*) but not adoration (*latreia*), which was due to God alone.

There were 21 disciplinary canons, one of which forbade further foundations of double (*i.e.*, for both men and women) monasteries.

The decrees of this council, though confirmed by the pope, were at first not well received in the empire of Charlemagne. This was partly the fault of the incompetent Latin translator of the acts, who, for example, translated *proskynesis* and *latreia* as though they were identical, thereby making it appear that the council was ordering Christians to worship icons as they worshiped the Holy Trinity. At the Council of Frankfurt (794) the dogmatic decree of Nicaea was repudiated, and the English church agreed with the repudiation. Even the great Pope Nicholas I, in the middle of the 9th century, still referred to the six general councils. As late as the 11th century the church in France recognized only six ecumenical councils, and some writers still gave the first four a place of special honour. But Rome's original verdict stood, and the second Council of Nicaea was accepted by the canonists as the seventh ecumenical council.

Fourth Council of Constantinople (869–870).—The fate of the canons of the Council *in Trullo* had proved that east and west were already slipping asunder, and the iconoclastic controversy had further driven a wedge between Rome and Constantinople. The rise of the Carolingian empire turned Rome's eyes westward and there was never again to be the harmony between east and west that had earlier prevailed for such long periods. Later the eastern church for the most part recognized only the seven ecumenical councils. The Roman Catholic Church, after a period of uncertainty during which two popes allowed only seven ecumenical councils, by the end of the 11th century recognized a ecumenical the Council of Constantinople (869–870) that con

irmed a Roman sentence of excommunication against the patriarch Photius (*q.v.*), though that act was reversed, with the approval of the Roman legates, at a further Council of Constantinople in 879–880. The 22nd canon of the council of 869–870 prohibited lay interference in episcopal elections; and for the canonists of the investiture struggle at the end of the 11th century this canon assumed great importance. (W. O. C.)

COUNCILS OF THE WESTERN CHURCH

A period of over 250 years separated the eighth ecumenical council from the ninth. It was a period during which the papacy reached its lowest level of degradation, in which lay control and feudalism took possession of the western church, and in which, at least until the mid-11th century, theological activity was almost nonexistent. When, from 1059 onward, the reformed papacy became itself a principal agent of reform, and under Gregory VII and his successors pursued a policy of direct control and centralization, and when, concurrently with this, intellectual life revived and the study of theology was once more pursued at a high intellectual level, the pattern of the church had changed essentially in many respects.

In the first place, Christendom was now divided into Eastern and Western churches, though the ecclesiastical link was not broken till 1054 and even then not without hope of repair; and while the eastern emperor regarded himself as the heir and representative of the ancient empire, the emperor of the west was committed to a struggle for supremacy with the papacy. The papacy, for its part, had never retreated from its traditional claims and had been strengthened in their exposition by elements of law derived in part from the pseudo-Isidorian collection (*see* Decretals, False); in consequence the pope now explicitly claimed that his was the sole and complete right of summoning a general council. At the same time the Eastern Church had fallen entirely out of the purview of Rome; both popes and western emperors had come to regard the Byzantines with suspicion and distrust, while the leaders of the Eastern Church regarded Rome as both barbarian and overbearing. Between the two parts of Christendom—of which the eastern was the more civilized and economically developed and the western the larger and now at last the more progressive—there existed no sympathy or sense of common cause.

Synods and councils were the principal means used by the popes of the reform in promulgating and enforcing their measures, and several such meetings were held in Rome. At the same time categories of those summoned had been widened to include abbots, representatives of cathedral chapters, and lay potentates, and the meetings had been called upon to settle or to register political and ecclesiastical measures rather than purely dogmatic questions. Thus Pope Calixtus II in 1122 had concluded an agreement with the German emperor, Henry V, at Worms on the question of investitures which terminated a long and vexatious conflict, and wished to clinch his achievement by a ratification by the clergy of the west.

First Lateran Council (1123).—No acts or any contemporary account of this council survive, and there is no reason to suppose that the pope consciously aimed at reopening the series of ecumenical councils. He did, however, invite bishops from all over the west, and the most credible estimate of those actually present is 300, to whom must be added abbots and others. The council probably lasted for ten days (March 18–28, 1123), and a number of canons (probably 22) were promulgated, many of which did no more than reiterate the decrees of earlier councils or the (forged) decretals. A large place was occupied by disciplinary or quasi-political decisions, of which some were corollaries of the recent settlement at Worms; thus simony was denounced, clerics in major orders were forbidden to have wives, laymen were prohibited from disposing of church property, uncanonical episcopal consecration was forbidden and marriage between cousins was prohibited in general terms. There was no specifically dogmatic canon.

Second Lateran Council (1139).—This council was convoked by Innocent II in April 1139 primarily to condemn the followers of Arnold of Brescia (*q.v.*) and to end the schism caused by the antipope Anacletus II, who had been elected almost immediately after Innocent. Opinion was divided at the time, and is still among scholars, as to where the precise canonical right lay in transactions of doubtful legality on both sides. In any case, St. Bernard's support of Innocent II, given largely on a moral judgment between the claimants, and later that of the emperor Lothair III decided the issue and were followed by a general recognition of Innocent II. The council, which counted among its members at least 500 bishops from all over the west and the Christian Levant, was styled "plenary" by the pope.

There were some 33 canons, many of them reaffirmations of previous conciliar decrees, but several had an importance and an influence greater than any in the first Lateran council. Thus while one canon reiterated the previous decree against clerical marriage, another declared all marriages of those in major orders and of professed monks, canons, lay brothers and nuns formally invalid —a decree that has remained substantially in force—while others fulminated against those who attacked a cleric or a monk and prohibited usury, tournaments and the study by monks of law and medicine. Canon 28 acknowledged by implication the right of a chapter to elect the bishop, and canon 23 is of interest as mentioning some of the characteristic heresies of the later 12th century: denial of the sacramental Eucharist, of infant baptism, of holy orders and of matrimony. The council probably lasted from April 4 to 17.

Third Lateran Council (1179).—This council was convoked by the ablest pope of the mid-12th century, the famous lawyer Roland Bandinelli, now Alexander III, who wished bishops from far and wide to witness the treaty he had made at Venice (1177) with Frederick I by which the emperor agreed to abandon his antipope and the church property he had seized. The council met in March 1179, and the 291 bishops present included those from the British Isles, Spain, Dalmatia, France, Germany, Denmark, Iceland, Hungary and the Levant, as well as abbots and envoys of princes. The council approved 27 *capitula*, of which the first established the principle of a two-thirds majority of the college of cardinals for a papal election and the third that candidates for the episcopacy must be of legitimate birth and 30 years old. The 27th was directed against the heretical Cathari (*q.v.*), who were anathematized, ostracized and refused Christian burial. Wandering robbers and vagabonds were also condemned, and Christians were authorized, with the bishop's permission, to take up arms against them not as heretics but as outlaws. The Waldenses (*q.v.*) sent representatives to the council, presumably to obtain some kind of papal sanction, and according to contemporary accounts they were kindly received by the pope but forbidden to preach.

Fourth Lateran Council (1215).—The first three Lateran councils were not convoked in direct imitation of the great councils of the early church. They were merely peaks in the long range of papal councils, noted at the time as "general" or "universal" and subsequently accorded ecumenical status by canonists and theologians. The case was other with the fourth Lateran council. This was the object of long deliberation and preparation on the part of Innocent III and was clearly envisaged by him as the continuation in the Europe of his day of the series of great councils of the past. It differed from them, however, in several particulars. First, the council was appointed, convoked and directed by the pope himself. Second, the church was now regarded as a great society, of which all members should in measure be represented. Third, Innocent's conception of his position *vis-à-vis* the emperor and other rulers led him to give them also a place. The broadening of its composition, however, in no way implied a wider extension of voting or consultative powers. Though little is known of the preparations or proceedings, it is clear from the fact that the general sessions of the council occupied only three days (Nov. 11, 20 and 30, 1215) that the fathers did no more than assent to the voluminous legislation proposed, presumably by select committees.

The summons was sent out to all bishops, abbots and ruling priors of Europe and the Latin east, to the heads of religious and military orders, and to princes and their representatives; some civic authorities and barons also were present. The purpose of

the assembly was twofold: the recovery of the Holy Land and the reform of the church. A list of 400 bishops survives, and there were probably numerous others present. Among the political business dealt with was the conveyance of the county of Toulouse to Simon de Montfort, the settlement of the disputed succession to the empire in favour of the young Frederick II as against Otto of Brunswick, and the excommunication of the English barons and Stephen Langton. Decision for a crusade was also taken.

The council passed various doctrinal and reforming decrees: a long profession of faith was directed against the errors of the Albigenses and Waldenses, though neither of these bodies was explicitly named; the existence of dual principles of good and evil was denied; the character of the Catholic priesthood was asserted; and the term transubstantiation was used of the eucharistic consecration. Unauthorized preaching was forbidden; the errors of Joachim of Fiore were condemned and the teaching of Peter Lombard on the Trinity approved. The practice of rebaptism by the Greeks was reprobated, and the primacy of Constantinople among the patriarchates denied. Yearly confession and paschal communion were imposed by the decree *Omnis utriusque sexus;* impediments to marriage were reduced in number; a system of provincial chapters and visitations was imposed upon the Black Monks and the Augustinian canons. In addition numerous decrees were passed affecting the life and administration of the clergy and the reform of clerical and lay morality. Indeed, alike in its scope and its influence on subsequent practice, the fourth Lateran council has been surpassed in importance only by the Council of Trent in the history of the Western church.

First Council of Lyons (1245).—This council held its sessions on June 28, July 5 and 17, 1245, at the summons and under the direction of Pope Innocent IV. His primary purpose was to secure the judgment and condemnation, followed by the excommunication and deposition, of Frederick II; hence the 22 *capitula* of the council were legal and judicial, not dogmatic, in content. Only some 150 bishops were present, mainly from France and Spain, since the emperor hindered the Germans from attending.

Second Council of Lyons (1274).—This council held its six sessions between May 7 and July 17, 1274. It was summoned by Gregory IX with the threefold aim of ending the Greek schism, rescuing the Holy Land and effecting a moral reform, but the last object occupied little time in the council. Only some 200 western bishops were present, but the council was distinguished by some notable participants, among them Albertus Magnus and Bonaventure (who died at Lyons on July 15). The kings of the west, the Byzantine emperor and the catholicos of Armenia were invited, but the emperor did not attend. A creed was approved for the reunion of the churches which included sections on purgatory, the sacraments and the supremacy and primacy of the pope; this was accepted by the Byzantine envoys and the reunion (soon to be repudiated by the Byzantines) was solemnly celebrated. The council also decreed that all cardinals should take part in papal elections and that strict measures with the conclave should ensure a speedy result. All minor orders of friars were suppressed, but the Carmelites and Austin hermits succeeded in escaping. Apart from the profession of faith there was no dogmatic decree.

Council of Vienne (1311–12).—Clement V convoked this council at the demand of Philip IV of France, and it held three solemn sessions (Oct. 16, 1311; April 3 and May 6, 1312). All bishops of the west were invited, but only some 230 were ordered to come. The selection was made by the king of France, and in fact fewer than 120 bishops attended, though many others sent proxies; France and Italy accounted for almost all who came. The primary aim of Philip IV was to secure a posthumous trial of Boniface VIII and the suppression of the Knights Templars. The trial did not occur, but the Templars, after long discussions, were suppressed outside the council by an act of power of the pope on March 22, 1322. Another task of the council was to hear the complaints of the conventual or moderate party of the Franciscans against the extremists or Spirituals, who stood for the observance of absolute material poverty. The moral strength of the Spirituals was impaired by the charges of heresy leveled against their principal leader, Pierre Olivi, and the council decided in favour of moderate poverty (the so-called *usus pauper*) against Olivi, though his name was not mentioned in the condemnation of his teaching. The pope, who had not been present at the later sessions, gave the decisions force of law by his approval.

The councils of the 12th and 13th centuries are of a single pattern: that of a gathering of bishops and other prelates and (later) notables in a great body summoned, presided over and "managed" by the pope, and the series shows a growing tendency, seen also in the history of the Roman Curia during the period, for the representative and deliberative function of the members of the council to be reduced to a mere assent, at least in the public sessions. These councils, in other words, reflect the strongly monarchic, unitary, autocratic development in papal theory and practice that reached its limit in the pontificate of Boniface VIII.

Yet concurrently with the Aristotelian postulate that all agencies must in the end be reduced to unity there was the characteristically medieval doctrine that society, and in particular the Christian society, was a corporate body whose head was a representative rather than a ruler and which could achieve its end best when acting as a body and could correct or depose any representative who failed in his duty. This doctrine was applied by canonists both to the college of cardinals and to the totality of the faithful as seen in action in a general council. The first application of this theory to practical politics followed upon the abdication of Pope Celestine V (1294) and the subsequent conflict between the pope and the king of France. Philip IV appealed to a general council against Boniface VIII and threatened his deposition. Some 30 years later, Marsiglio of Padua and William of Ockham in their different ways looked to the university of the faithful, or to a council representing them, as a remedy against papal tyranny and specifically against the alleged heresy of John XXII. When, therefore, the contested election of 1378 left the church with two popes and all efforts to restore unity had failed, a general council, which *ex hypothesi* would be able to judge and if necessary depose a pope, came to be regarded as the only hope for the church. In these circumstances, a council would be something far more powerful as an organ of ecclesiastical government than had hitherto been suggested.

Council of Pisa (1409).—It was after 30 years of disunion, and when the powers and advantages of a general council had been debated on all sides, that a group of cardinals of both obediences summoned a council to meet at Pisa in 1409. This meeting, which has never been admitted by canonists or theologians to be ecumenical, was well attended; it proceeded to depose the two existing pontiffs and to elect a third, Alexander V; Western Christendom was therefore divided into three parties.

Council of Constance (1414–18).—The effort of Pisa, however, had not been wholly in vain, for it had shown that the idea of a council rallied the forces desirous of unity. The emperor Sigismund, therefore, summoned a council to Constance; his summons was followed by that of the antipope, John XXIII, successor of Alexander V. The council met in Nov. 1414. Never before had such an assembly of ecclesiastics been gathered together, for besides some 200 bishops and 100 abbots at least 300 doctors of theology and proctors of all kinds were there. Very soon political rivalries resulted in an essential change of the system of voting by which the members were organized in four blocs—known as the nations, Italian, English, German and French—each of whose votes had equal weight, while the college of cardinals had a fifth vote and later the Spanish nation a sixth. After a few weeks John XXIII fled from Constance, and the council, faced with the dilemma of its authority, declared in the decree *Sacrosancta* that it drew its powers immediately from Christ and that even the pope was subject to it. It then proceeded to negotiate for the withdrawal of the other two papal claimants. In the meanwhile it anathematized the doctrines of Wycliffe and Huss, and tried and executed the latter and his friend Jerome of Prague. Then it proceeded to frame some decrees of reform, of which the most important was the decree *Frequens* of Oct. 9, 1417, which aimed at making general councils a permanent institution in the life of the Church. It then elected Martin V, thus at last restoring unity to the church.

The Council of Constance is reckoned as ecumenical, but its position is unusual in that it was neither summoned nor confirmed as to all its decrees by a legitimate pope. Its most important dogmatic pronouncements, those regarding Wycliffe and Huss, subsequently were given papal approval, but the decrees asserting the superiority of council over pope and laying down the principle of a perpetual series of councils were never accepted, though Martin V did in fact summon a council after an interval of five years. This was the council of Pavia (1423–24), later transferred to Siena and soon closed by the pope because of poor attendance. (*See* further CONSTANCE, COUNCIL OF; PAPACY: *The Great Schism, 1378–1417*.)

Council of Basel (1431–37).—Seven years later Martin V summoned to Basel a council which he did not live to see. His successor, Eugenius IV, sent Giuliano Cardinal Cesarini as legate to inaugurate the council (July 23, 1431) though no bishop had arrived, and in December the pope closed what was just beginning to be a sizable assembly. The council refused to be dissolved, and renewed the decree *Sacrosancta* of Constance; its numbers increased, and, though the number of bishops never equaled that of the doctors of theology and abbots, it proceeded to deal with the Hussites, the majority of whom were received back into communion by the Compact of Prague (Nov. 30, 1433). A fortnight later (Dec. 15) the pope revoked his decree of dissolution. In the negotiations and discussions that followed the council and the pope were at loggerheads and the council gradually lost prestige. Its efforts at reform were stultified by the impracticability and antipapal bias of the measures proposed, and in 1437 the pope, who had been long negotiating with the Greeks with a view to reunion, transferred it to Ferrara. (*See* further BASEL, COUNCIL OF.)

Council of Ferrara-Florence (1438–c. 1445).—This council was principally concerned with effecting union with the Greek church. This was in fact carried through, and the bull *Laetentur coeli* was promulgated on July 6, 1439, to be followed some months later by a similar reunion with the Armenians. The Greeks accepted union simply in the hopes of receiving pecuniary and other aid; the Greek prelates were consistently hostile, and when help was not forthcoming from the west the Greeks withdrew their adherence once more. Doctrinally speaking, the Council of Florence is of interest on account of the exposition of the Catholic doctrine of purgatory and of the primacy and plenary powers of the pope as set out in the decree for the Greeks, and the long exposition of sacramental theology in the decree for the Armenians. (*See* further FERRARA-FLORENCE, COUNCIL OF.)

Fifth Lateran Council (1512–17).—With the Council of Florence and the reassertion by the papacy of its independence and supremacy the epoch of the councils came to an end. It left a double legacy. The one was a persistent belief in many quarters, encouraged by interested monarchs and seemingly justified by the behaviour of the Renaissance popes, that only a council could succeed in renovating the life of the church. The other was the Gallican doctrine of the relationship between the French monarchy and the papacy, which rested much of its weight upon the assertion by the Council of Constance of the superiority of a council to the pope (*see* GALLICANISM). It was in fact the hostile action of a few cardinals, working in the French interest, who summoned a council apart from the pope in 1511, that led Julius II to issue his bull of convocation to the fifth Lateran council, ostensibly to meet the demand for a drastic reform of the church within and without the city of Rome. The council remained in being from May 3, 1512, to March 16, 1517; the maximum number of bishops present never exceeded 100, most of them Italians. The death of Julius II took place on Feb. 20, 1513, but the council was continued by Leo X. Its principal results were the extinguishing of the threat of schism and the supersession of the Pragmatic Sanction of Bourges (1435) by a new concordat with the French king. In the theological sphere there was a condemnation of a contemporary Averroistic opinion of the mortality of the soul, and a reaction of the decrees of Basel and Constance exalting a council over the pope. A few reforming decrees were passed, but they were unimportant and were not put into effect. (M. D. K.)

Council of Trent (1545–63).—The Council of Trent is regarded as the 19th ecumenical council by the Roman Catholic Church, whose morale it restored and whose doctrines and discipline it overhauled and tightened after the challenge of the Reformation. The day-by-day proceedings of the council, and its decrees, are discussed in detail in the article TRENT, COUNCIL OF; this article is concerned chiefly with the historical context in which its deliberations were held.

The spread of Protestantism renewed the demand for a general council, both to reform and reunite Christendom, but no Protestant would accept a council acknowledging papal supremacy. Nevertheless the emperor Charles V, in his anxiety to restore religious unity among the Germans, pressed for a council on German soil that was prepared to offer the maximum concessions consistent with the essentials of orthodoxy. This policy was not agreeable to Rome, where dangers to Catholicism, together with an overstrengthening of the emperor's power, both ecclesiastical and political, were feared. Pope Paul III, faced with the threat of an autonomous German religious settlement as an alternative, negotiated, but the chronic warfare between Habsburg and Valois, together with French suspicion of anything calculated to increase Habsburg power, created long-drawn-out difficulties. At last in 1544 the peace of Crépy brought Franco-imperial agreement to a council at Trent, technically on German soil, but accepted only unwillingly by Paul III who saw in a site within Italy proper the only real safeguard of Roman and orthodox interests, the supremacy of pope over council and the security of the curia. In his eyes the council's main business was to clarify Catholic doctrine against the new heresies and to reform the morals and administration of the church without revolutionary structural changes. Charles V, for his part, persisted in conceiving the council as primarily a "reunion" council for Germany, one which should adapt itself to his own ideas and wishes in this respect.

This basic papal-imperial conflict over purpose (not lessened by a military alliance for a war in which Charles V hoped to crush the Schmalkaldic league of Lutheran princes and force them to submit to the council if it would give them generous treatment) was evident when, after opening on Dec. 13, 1545, with three presiding papal legates but only a very small attendance, the council had to improvise both program and procedure. Rome ordered that definition of doctrine should precede reform. This was contrary to Charles's idea of leading up to doctrine by first making reforms that would attract favourable Lutheran attention. The Spanish bishops, and many others also, were passionately anxious that reform should not be delayed. Feeling in the council forced Rome's grudging acceptance of the compromise of simultaneous treatment. But this was so implemented that in fact doctrine got the lion's share of the council's time.

In the 15 months before the removal to Bologna the basic lines of division between the principles of Catholic and Lutheran theology were drawn—the last thing the emperor had wanted—by decrees defining the Catholic position and condemning contrary propositions on the canon, interpretation and use of Scripture; original sin; the key subject of justification, on which seven months were spent; the number and nature of the sacraments in general, and baptism and confirmation in particular. The debates had shown agreement to seek the substance of Catholic doctrine without canonizing "school opinions." But there was much argument between Thomists and Scotists, and many well-worn points between them were left unresolved.

The doctrinal program was skilfully steered by the second legate, Marcello Cervini, later Pope Marcellus II. The first president, Giovanni del Monte, later Pope Julius III, was in charge of reform. The imperialists and the Spaniards complained that reform was not receiving adequate attention. The duties and powers of bishops and the restoration of their efficiency as pastors formed the crucial point. This involved their obligation to preach, the thorny question of their powers over preachers belonging to religious orders (which were increased) and their obligations to reside in their diocese which many wished to be declared an obligation of divine law. This last was strongly opposed by the legates. The impositions and interferences of the Roman curia—in exemptions,

dispensations, taxation, patronage, etc.—were widely denounced as hindrances to fruitful episcopal residence, as also were hindrances from the secular arm. Not much time was allowed for the discussion of all these points, and the decrees passed were far from satisfying those who wanted treatment of the diseases of plurality of benefices and nonresidence far more drastic than the touching up of old canonical rules that could be freely circumvented in practice.

The papal legates and the Italian bishops had all along disliked the location at Trent, so accessible to imperial influence. Plans and negotiations for a removal south had been unceasing, especially after the emperor's war against the Lutherans started in the summer of 1546, but all these had broken down on the emperor's refusal. The transference to Bologna was thus the fulfillment of a long-felt Italian desire. It was made suddenly by a majority decree, on March 11, 1547, at the legates' prompting, but without the knowledge of the pope, on a plausible but not wholly convincing plea based on the fact that an epidemic had broken out in Trent. It proved self-defeating. The 13 opponents of the decree remained behind and subsequently received imperial orders not to move; while, unable to persuade Paul III to reverse the council's action, Charles V, whose victory over the Protestant princes at Mühlberg on April 24 gave him at last his supremacy in Germany at the very moment when the council had left German soil, delivered formal protests of nonrecognition of the council of Bologna at Bologna itself and at Rome in Jan. 1548. This was followed up in the summer by the *Interim* settlement in Germany. Not even increased French support for Bologna could outweigh this. The council was made impotent. There were many valuable discussions on matters later settled at Trent, but no decrees could be passed. Not until Sept. 1549, however, shortly before his death, did Paul III allow the council at Bologna to disperse.

His successor, Julius III, showed unexpected flexibility in recalling the council to Trent, where it reassembled in April 1551. There seemed now a better understanding between pope and emperor, and it was hoped that with the attendance of about a dozen German bishops (only one had previously appeared other than the cardinal of Trent), including the three ecclesiastical electors, the emperor's policy toward the German Protestants might still be made to bear fruit. These hopes were shattered by the rejection of the council by the French; the intransigence of the legate Marcello Cardinal Crescenzio toward Spanish and other efforts for effective reform; and finally by the impossibility of finding common ground for talks with the Protestant delegations, which had actually arrived from Saxony, Württemberg and elsewhere, and whose ministers claimed equality of status. Nevertheless the council, continuing its former doctrinal program, passed decrees on the sacraments of the Eucharist, penance and extreme unction together with some minor reforms. In April 1552 it was suspended owing to the outbreak of war in Italy and the revolt in Germany which overthrew Charles V's supremacy, both disturbances promoted by the French. The elector Maurice of Saxony, who had allied himself with France, marched southward by way of Innsbruck. The emperor, taken by surprise, fled, and the council, fearing for its safety, decreed its own suspension.

When the council reassembled ten years later under Pius IV in Jan. 1562, the demand for it came from France, newly troubled by the Calvinist movement. The treaty of Câteau-Cambrésis (1559) had restored international peace; Charles V was dead, the German and Spanish crowns separated, and Germany pacified by the settlement of Augsburg (1555). The third assembly at Trent was more widely representative than its predecessors, and numbers rose to about 250 against the previous 70 or 80. Nonetheless, the German bishops, as well as the Protestants, stayed away, and in England the invitation was not even published. The Italian majority was rather more coherent and Roman control more systematic. The papal legates' exclusive right of proposition was now specifically laid down and, though constantly challenged by the French and Spaniards, was maintained. It was used to make it clear that the council was a continuation—whereas the French and Ferdinand I wanted a new start—and also (as previously) to keep a firm grip on both doctrinal and reform proposals.

In spite of the efforts of Ferdinand, who, still hoping for the return of the Protestants, wished to defer the discussion of dogmatic issues, the doctrinal program was completed by decrees on the Mass, holy orders and matrimony. Reform proposals involving radical changes in ritual and discipline, and including permission for clerical marriage and lay communion under both kinds, came from the French and imperialists, both still hoping to pave the way toward general religious agreement by concessions. But most of these were resisted in Rome as was also the renewed demand for the residence of bishops to be proclaimed *de jure divino* as the only way to the restoration of episcopal efficiency. A vote taken on April 20, 1562, showed the strength of the *jus divinum* party. It so annoyed the pope that the two principal legates, Ercole di Gonzaga, cardinal of Mantua, and Cardinal Seripando, were nearly recalled. Worse was to follow, however, when in the discussions on holy orders, the same party —comprising bishops of all nationalities present—pressed for a statement that episcopal jurisdiction came to each bishop direct from God and consequently not mediately through the pope. Determined to prevent this, the Roman authorities attempted to insert into the decree the definition by the Council of Florence of the papal universal episcopate, unacceptable to both French and Spaniards. Months of negotiation did not succeed in breaking the deadlock, which held up the council's work and even threatened its collapse.

Eventually, the deaths of Cardinals Gonzaga and Seripando opened the way for their replacement by the able Cardinal Giovanni Morone, whose skilled diplomacy secured the surrender of the extremists on both sides and general agreement to a plain statement that bishops were placed by the Holy Ghost to rule the church (Acts xx, 28).

Mutual concessions were also made on reform principles. In return for the safeguarding of curial rights, Rome would agree to as searching a reform as possible. Only the Spanish ambassador stood out, in principle, against the general *détente* acquiesced in by the emperor and the cardinal of Lorraine, leader of the French.

The effective reforms of the Council of Trent, which gradually restored the pastoral efficiency of the Roman Catholic Church, were the work of the final two sessions. They represented, as it were, the middle-of-the-road conservative Catholic reform ideas, giving a new deal to bishops (empowering them, however, in many cases to act as representatives of Rome), laying down a new code for the religious orders and including the decree ordering the establishment of diocesan seminaries for the education of intending clerics. There were, however, none of the radical changes desired by the French and the imperialists (under both Charles V and Ferdinand I) for the appeasement and eventual hoped-for reduction of Protestantism, nor was any diminution allowed in principle of the rights of the Roman see or the Roman curia, nor were the more rigorous Spanish demands met. An ambitious scheme for the "reformation of princes" had perforce to be abandoned in favour of a simple admonition to rulers to respect the rights of the church. The council handed over to the pope its unfinished tasks of drawing up an index of forbidden books and reforming catechism, missal and breviary. It concluded harmoniously on Dec. 4, 1563, and its decrees were confirmed by Pius IV on Jan. 26, 1564. (H. O. E.)

First Vatican Council (1869–70).—An interval of more than three centuries separated the Council of Trent from that of the Vatican. Never before had so long a period elapsed without a meeting of the bishops of the church. Many circumstances had brought this about, not least the work of Trent and the popes of the Counter-Reformation, which had given to the church and the papacy a program, a directive power and a centralized organization adapted to the needs and sentiment of the modern world. Moreover, though the papacy had emerged with renewed strength in those parts of Europe and the rest of the world that had not been lost to the Roman Church, the growth of national spirit and the claims of the secular ruler, which had so greatly influenced the Reformation, were equally influential in the Catholic monarchies of Spain, France and Austria, in all of which papal authority though acknowledged as paramount, was in practice neutralized

by the limitations set by old customs or new concordats.

But whereas in Spain and Austria the obstructive forces were almost wholly political or social, in France under Louis XIV the ancient claims of the Gallican church were reasserted more precisely in the realm of theology and political thought, with the doctrine, based on the decrees of the Council of Constance, that a general council was superior to the pope and that papal pronouncements required the assent of the church to acquire binding force. This attitude of the most powerful Catholic nation was enough to prevent any thought of a general council, and it weakened only when Europe was swept by the waves of rationalism and secularism, culminating in the French Revolution. When that great earthquake and the tidal wave of Napoleon that followed were over, a great religious revival took place, but the papacy found itself at issue with foes both domestic and foreign. Within the church, a large section of the older clergy, especially in France and Germany, was imbued with the Gallican or "Josephist" ideas of the old regime, while the largely antireligious forces of liberalism and communism and the new sciences of nature and documentary criticism threatened to penetrate and to overthrow the church. In addition, nationalist sentiment in Italy made the "Roman question" a burning issue.

It was with this background that the long-lived, well-loved and much-enduring Pius IX, whose pontificate, the longest in the history of the church (1846–78), witnessed the Italian *risorgimento* and the disappearance of the States of the Church, decided in 1864 to convoke a council "to discover the necessary remedies against the many evils which oppress the church." The bull of convocation was dated June 29, 1868. At the suggestion of Bishop K. J. Hefele, the historian of the councils, two procedural changes were made in advance, as lessons from Trent: business was prepared by commissions before the council met, and the right of proposing subjects for discussion was reserved to the pope.

Meanwhile the attention of Europe was concentrated on two topics: the relation of the church with the modern state, and the teaching authority of the pope. The first topic, made immediate by the reactionary outlook of Austria, the secularist government of Bismarck and the new liberalism in Italy and France, was not in fact dealt with by the council. The second had become a storm centre, violent if somewhat artificially exploited, between the semi-Gallicans of France and the heirs of Febronianism and Josephinism in Germany and Austria on the one hand, and the Ultramontanes who favoured centralization in Rome and wished for a speedy and certain doctrinal pronouncement on every controversial topic on the other. Papal infallibility, though so much to the fore both before, during and after the council, was, on the purely theological level, not a major topic of controversy. Almost all the bishops present at the council, as private theologians, held the substance of the teaching that was subsequently defined. They opposed the definition, partly from motives and habits of mind too deep to analyze, exacerbated to some extent by extremists on the other side; partly because they feared its consequences in provoking hostility to the church or discouraging those outside; and partly because they feared the lengths to which their opponents might go.

In all these matters there was mutual distrust and exasperation giving to partisan propaganda on both sides. But without exception all Catholic bishops were devoted both to the papacy as an institution and to the reigning pope, and in fact not a single bishop went into schism. The fears and the enthusiasms of that day have passed, but they may be recaptured in part by anyone who reads the letters of Janus and Quirinus (both the work of Ignaz von Döllinger) on the one side, and of Louis Veuillot in the French Catholic liberal paper the *Univers* on the other.

The council met on Dec. 8, 1869, and from first to last a total of 774 bishops (nearly three-quarters of the total number of bishops in the universal church) took part. In addition representative superiors from the religious orders were summoned, and each bishop had his theologian. Sovereigns of states were not invited, as they had been at Trent, and despite threats no government demanded representation, and all disclaimed any intention of intervening. The procedure was as follows. All suggestions previously sent up by bishops and others to Rome were sifted by papal commissions, which prepared drafts (*schemata*) on the various subjects. The council itself elected four "deputations" to deal with specified topics: faith, discipline, regulars and eastern missions. The *schemata*, duly printed, were then debated in general congregations and referred back to the relevant deputations, which made what amendments they thought fit. When finally approved the formal decision was voted on as a whole and then for a second time at a public session presided over by the pope, who then promulgated the decree. The program was far too ambitious and the members too loquacious for the achievement of more than a small part of the agenda.

The first four months (Dec. 8–April 24) were occupied with the decree of faith, and resulted in the first dogmatic decree on the existence of God and the capacity of the human intelligence to know this; the necessity of divine revelation; the nature of faith; and the relation between faith and knowledge. Valuable for theologians and apologists, this seemed a small and not very practical result of so many weeks' discussion, while the burning questions of the day were shelved.

Although papal infallibility was not the professed topic of conciliar action and did not appear on the original *schema,* the alignment of parties, infallibilists and inopportunists, had taken place at once, with lobbying and intrigues on both sides, and it had already become evident that the infallibilists were greatly in the majority. Among them V. A. I. Dechamps (Malines), I. Senestrey (Ratisbon), K. Martin (Paderborn) and H. E. Manning (Westminster) were eminent. The leaders of the inopportunists were G. Darboy (Paris), F. A. P. Dupanloup (Orléans), J. O. Rauscher (Vienna), F. Schwarzenberg (Prague), L. Hayald (Kalocsa, Hung.), J. Simor (Esztergom), K. J. Hefele (Rothenburg), W. E. Ketteler (Mainz), P. Kenrick (St. Louis) and D. Moriarty (Kerry). While the former group chafed at the delays, the latter feared an attempt to define by acclamation without a debate and pleaded the necessity of moral unanimity for a definition.

The documents and debates of the council were in theory secret, but leakages were constant and garbled versions were available for the diplomats and the correspondents who were covering the council. Thomas Mozley's very inaccurate dispatches to the *Times* in London and the more accurate but biased reports which Johannes Friedrich and Lord Acton passed on to Döllinger, for his letters to the Augsburg *Allgemeine Zeitung,* embittered minds abroad, while the atmosphere of intrigue and campaign, reflected in the caballings and even the social life of Rome in the salons of the *matres ecclesiae,* gave the council a repute which the debates and the conduct of the bishops as a whole did not deserve.

The plea of the minority, that to raise the infallibility question would be to advertise the divisions among Catholics, invited the retort that to smother the issue would be to admit the division as irremediable. Meanwhile the pope, who in the early weeks of the council had expressed his desire to leave all initiative and decision to the council, came out openly, from January onward, in favour of a definition, and on March 6 the public announcement was made that infallibility was to come up as an addition to the original *schema de ecclesia* ("of the church"), which originally contained the questions of papal primacy and jurisdiction only. These latter were debated on June 6–14 and defined as the bestowal by Christ on the pope, as the true successor of St. Peter, of

an ordinary immediate jurisdiction over the whole church and over every particular church, but without prejudice to the ordinary and immediate power of episcopal jurisdiction wielded by the bishops set by the Holy Spirit in place of the apostles.

The council forebore to elucidate any further the source of episcopal jurisdiction.

On the precise point of infallibility two long debates took place, the first (May 13–June 6) on the desirability or otherwise of the definition, the second (June 15–July 4) on the actual text of the decree. Both debates were cut short, the first by an agreed closure, the second by an agreed withdrawal of speakers in view of the heat and discomfort of Rome in July, and (at last) of the threatening international situation. At a vote on the decree

(called *Pastor aeternus*) on July 16, out of 552 present, 88 voted *non placet* ("no") and some 30 more desired qualifications of the decree (actually, 62 voted conditionally, but half of them wished for a more extreme definition); these represented the hard core of the 200 odd who at the beginning of the year had expressed their opposition to any definition. The minority were for recording their votes at the public session, but Dupanloup overbore the decision and instead they left Rome before the voting took place. The final session on July 18 was accompanied by a violent thunderstorm; 533 voted *placet* ("aye") and 2 *non placet*. The pope then promulgated the solemn definition. On the following day war was declared between France and Prussia and on Sept. 20 the Italian armies captured Rome. In due course all the bishops of the minority accepted the definition, but in southern Germany and Switzerland the schismatical church of the Old Catholics (*q.v.*) was set up, with governmental support in both cases.

The infallibility decree was couched in terms more moderate than many of the minority had feared. During the debate the gap had been narrowed between the two parties and almost all the minority would have accepted a form of words such as "using the counsel and seeking the help of the universal church" to qualify the papal infallibility, while on the other hand no attempt had been made to satisfy the wide extension desired by the extreme Ultramontanes. The decree limited the gift of infallibility to the occasions when the pope, speaking *ex cathedra* as pastor of the universal church, defines a doctrine concerning faith and morals, and the council declared this guarantee to be equivalent to that possessed by the church itself. As no previous decree had declared the exact limits of the infallibility enjoyed by the church it was open to theologians to restrict the papal power to the narrowest limits consistent with the words of the decree.

The Vatican council, though in many ways resembling that of Trent, was in others without precedent. The railway and the steamship had permitted a greater number of the bishops of the world to be present than at any other previous council, and representatives did in fact come from every part of the world where the Roman Church had obtained a foothold. In addition, the electric telegraph and the technique of journalism allowed the whole world to follow its fortunes and comment upon its personalities, even if the oath of secrecy led to many inaccuracies and misrepresentations. As regards the many charges of unfair dealing that have been made, no one who reads the reports of the debates and other literature will deny that freedom of speech was enjoyed, and in the matter of intrigue and propaganda there is nothing to choose between the two parties.

Two important grievances of the minority deserve fuller attention. The one was the direct influence of the pope, who certainly threw all the weight of his personal authority on the side of the majority, even though it was the influence of a revered father in Christ, not of a ruthless autocrat. The second was the undue weight given to a reputedly obscurantist section by the presence of a great number of Italian bishops from small sees.

Both these circumstances were regrettable, but in the broad view it would seem clear that the movement in favour of the definition was both in origin and in strength independent of any action of the pope, and that it was supported throughout the Catholic world by a body of theological and popular support sufficient to ensure a large majority in any great assembly. Moreover, the excitement and partisan feeling in the council were largely factitious, the result of 20 years of public debate. It is probable that few of the minority would have been willing at any time to subscribe to a negation of the decree. The circumstances of the time made of the council a focus of controversy greater even than Trent.

For another discussion of the deliberations of this council, and comments on the results of the decree *Pastor aeternus*, *see* VATICAN COUNCILS. Other aspects are discussed in PIUS; INFALLIBILITY; GALLICANISM; ULTRAMONTANISM.

Second Vatican Council (1962–).—For this, *see* VATICAN COUNCILS.

CONCILIAR THEORY

The ecumenical council as it has developed during the centuries has been affected both by historical circumstances and by the theological teaching of the Roman Catholic Church. It is canonically defined as an assembly of bishops and others, convoked by the pope and presided over by him, to formulate decisions on matters of faith and discipline. A constant feature of its history is the belief that the testimony of a large and representative body of bishops of the universal church, each having apostolic succession and engaged in an apostolic office within a single communion of authority, will be a sure witness to the Christian faith, not only as a majority opinion, but in virtue of Christ's promise of indefectibility to his church.

In the centuries after Constantine when the church was, or was still regarded as, coterminous with the Roman empire, the councils were convened by the emperor and their decisions passed into imperial law, though from the beginning the privileged position of the bishop of Rome was acknowledged. When the political severance of the west was finally effected by Charlemagne it seemed likely that the western emperor might claim the position of the eastern, but the disorder of western Europe prevented this, and one of the results of the papal-imperial controversy of the 11th century was to leave the papacy in undisputed possession of spiritual jurisdiction. Henceforward for three centuries the councils were primarily courts of record, summoned to give assent to political, disciplinary or doctrinal decisions of Rome.

The procedural impasse and the bankruptcy of counsel during the Great Schism allowed the "corporative" school of canonists and publicists to propose a program in which a council "represented" the universal church, with the pope as its delegated executive, in some such way as the general chapter and master-general stood to the members of certain religious orders. After some decades of popularity this view, which lacked theological and papal support, lost its appeal and the monarchical papacy reasserted its claims, though the "conciliar theory" remained in favour, largely for political reasons, with the French monarchy and the Gallican church. In the authoritarian, controversial atmosphere of the 16th century, the Council of Trent was fully "papal" and "Catholic," but a spirit of debate and party appeared that was a new thing in western councils. The Vatican council resembled Trent, but the venue of the council, the topics debated and the personality of Pius IX combined to make papal control more constant and pervasive.

It has often been urged that the definition of papal infallibility in 1870 ended the need for and would in fact end the series of councils. Neither history nor theology support this view. Several of the medieval councils did little if anything more than accept and record a papal decision, while on the other hand a council still remains a normal and under some circumstances the best means for a pope to use in order to assure himself of the traditional teaching of the church on a disputed point of doctrine, or to receive advice on matters of high policy concerning the unity of all Christians and the spread of the faith. Pope John XXIII recognized this fact when, in 1959, he announced his intention of calling an ecumenical council on the unity of the church. (M. D. K.)

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COUNCIL BLUFFS, a city of southwestern Iowa, U.S., and seat of Pottawattamie county, is located on the east side of the Missouri river across from Omaha, Neb. The business district i

ituated on the bottoms along the foot of the bluffs about 3 mi. ack from the river.

While Council Bluffs was founded by the Mormons, they were ot the first to visit the area. Lewis and Clark passed there on eir expedition to the far west in 1804 and held a council nearby ith the Indians at a place they called Council Hill or Council luff. This name was later applied to the area in general on both ides of the river.

A settlement was started by the Mormons on their way west in 846 after they had been driven from Illinois. At first it was alled Miller's Hollow, but in 1848 the name was changed to anesville in honour of Col. Thomas Leiper Kane who had be friended them. During the next few years this was a focal point or Mormons going to Utah; many California gold seekers also ame this way. By 1853 the Mormon influence had waned, the ame was changed to Council Bluffs and the town, which was lready an important outfitting point for the west, was incorpo ated by the Iowa legislature. Six years later Abraham Lincoln isited Council Bluffs and was so impressed that he designated the ity as the eastern terminus of the Union Pacific railroad.

Since then Council Bluffs has been an important trade and ransportation centre. It is served by several major railroads and as one of the largest railway mail terminals in the country. Large rain elevators and extensive greenhouses are located there and its ıdustries include the production of agricultural implements, bat eries, railroad equipment and radio parts. The council-manager ype of city government was adopted in 1950. The population in 960 was 55,641. For comparative population figures *see* table in OWA: *Population*. (F. W. A.)

COUNSEL AND COUNSELOR: *see* LEGAL PROFESSION.

COUNT (Lat. *comes;* Fr. *comte;* It. *conte;* Sp. and Port. *onde;* Ger. *Graf;* Pol. *hrabia;* Russ. *graf*), a European title, in ıe early middle ages one of certain royal officials, later one of ohility. For the English equivalent *see* EARL.

The Roman Comes.—Under the early Roman empire persons ho accompanied the emperor on his travels were called his companions" (*comites Augusti*), but *comes* was not an official tle. Constantine I, however, in the 4th century A.D. created a egular order of "companions," graded in three classes. The title, hich was held during the emperor's pleasure, was bestowed both ı senators and on those of lower station; later the first grade ıtomatically carried senatorial rank. It was naturally given first ıd foremost to members of the imperial court (*comitatus*), in uding those sent out on special missions, but it was soon ex nded to others as an honorific distinction. In its primary sense ıe title (first grade) was held by the members of the imperial ouncil (*comites consistoriani*) and by the higher civilian minis rs and military officers of the court. In some cases the title *mes* superseded the original designation of the minister or of cer. Thus the director of the mints, mines and money taxes ıme to be known as the *comes sacrarum largitionum*, the di ctor of the imperial domains as the *comes rei privatae*, and the ommander of the corps of officer cadets as the *comes domesti orum;* and in the 5th century the title was extended to lesser fices such as the director of the imperial stables or *comes stabuli*, ıe original of the medieval constable (*q.v.*). Outside the palace onstantine used his *comites* to preside at church councils on his ehalf and as special commissioners to supervise the dioceses of ıe empire and receive complaints against the provincial gover ors; these *comites provinciarum* did not survive after the reign f Constantine except for the *comes Orientis*, who replaced the car of the diocese of the Orient. "Military companions" *comites rei militaris*) were used to command detachments of ıe field army, and several of these commands (*e.g.*, that of the *mes Africae*) became permanent. The second and third grades f the order were widely bestowed on lesser officials and private ersons, and their value had by the 5th century become debased. (A. H. M. J.)

The Frankish Officials.—In the Germanic kingdoms that ıcceeded the Roman empire in the west the title *comes* was freely nployed. The Ostrogothic king Theodoric gave it to those whom e placed at the head of the various towns. These Ostrogothic *comites* were civil judges and decided quarrels between Goths and Roman citizens, with the help of Roman jurists.

The title was likewise taken over by the Visigoths and by the Franks. In the *Historia Francorum* of Gregory of Tours, covering the early Merovingian period, the *comes* appears as city commander and, as with the Goths, as a judge even in criminal cases. Gregory already speaks of the area of jurisdiction of a *comes* as *comitatus* (countship, county), but Frankish royal documents of the 7th and 8th centuries usually give the name *pagus* to those districts which corresponded in area to the ancient city districts. The Frankish title *grafio*, meanwhile, etymologically linked with Ger. *raffen* ("gather"), at first denoted the royal official who collected the fines imposed by the popular court: one-third of the fine went to the *grafio* as his pay. In the edict of Chilperic (*c.* A.D. 570) the *grafio* is still a subordinate official who may not come to court until called by the *Rachinburgen* (jurors), and in royal documents after 669 he is still below the rank of *comes*, though sometimes holding a similar position. It is not precisely known when the *grafio* replaced the *Thungin* as president of the court. It was probably not until the 8th century, under King Pepin, that *comes* and *grafio* became equal.

The capitularies of Charlemagne describe the legal position of the *comes* much as Gregory of Tours does. They contain many regulations on the conduct of recruitment and preparation for war by the *comes* and also show how the officials known as *centenarii* had concurrent jurisdiction with the *comites*. The older view that each countship was divided into several *centenae* (hundreds) has been superseded by modern research. Rather the *centenae* are now regarded as the organization of the Frankish occupation forces from Charles Martel's time onward, especially in Swabia and Franconia. In Carolingian documents likewise the district in which a count commands is called *pagus*, though from 775 the name *comitatus* also occurs. (Later, in the documents of German kings such as Conrad I and Otto the Great a double designation often occurs: "*in pago* [name] *et in comitatu* [of such and such a count]," and this formula prevails in German royal documents down to 1100.) The view that each count commanded in a closed district was championed above all by those researchers whose main concern was with historical geography, but it has been established that, especially, wasteland and woods lay outside the divisions into countships. The Franks made these divisions in Saxony and in Bavaria and after 772 introduced them into Italy as well, but in some regions (*e.g.*, in Thuringia) the system seems not to have been introduced. It was partially implemented in the Slav territories conquered by the Carolingians in the southeast, as also in the later march of Meissen, but not in Bohemia or in lands east of the Elbe river.

Feudalization.—The merging of the office of count into the feudal system (*see* FEUDALISM) seems to have proceeded very slowly. Though Carolingian capitularies do sometimes state that a count should swear an oath of fealty, the office of count, down to 900, is described either as *honor* or as *ministerium* (function), never as *beneficium* (grant). In Italy, meanwhile, there is occasional mention of possessions belonging to the countship.

In France, counts became vassals of dukes by 900 at the latest; the counts of Flanders and Toulouse, however, were considered as equal in rank to dukes. As the process of feudalization continued, the counts moreover tended to lose their official character and to become the hereditary lords of little territories. In France this development is already discernible in the 11th century, and with it there grew up the practice of applying the title of count very loosely. By the 12th century any lord of moderate status might style himself count, no less than the great feudatories of Flanders and Toulouse; and even in the 13th, when the organization of the French kingdom became more stable, the title might mean much or comparatively little.

In Germany, though the title of count had become hereditary in most cases as early as the 10th century, the counts retained something of an official character rather longer than in France. In the 12th century, however, apparently by the emperor Frederick I Barbarossa, they were given authority to maintain the public peace in the district under their control—an authority which

up to 1100 had belonged to the dukes. Thenceforward the term countship signified the territory within which the count had powers of life and death.

Already in the 11th century, several countships in Germany had been acquired by bishops (*e.g.*, the bishops of Brixen); and in the 1160s the bishop of Würzburg, as the holder of numerous countships, began to claim the title of duke of Franconia, which was confirmed in 1168 by Frederick Barbarossa. The bishops often handed on to laymen the countships granted to them by the king.

From the beginning of the 12th century, moreover, a number of counts appear in western Germany taking their titles simply from the castles held by them—with no apparent connection with any official status. In Frederick Barbarossa's time certain freemen of the higher class, such as *Vögte* or "advocates," began to style themselves as counts. In the 13th and 14th centuries there are instances of new countships received as fiefs from dukes.

For other developments of the countship, especially important in Germany, *see* LANDGRAVE; PALATINE. For the "free countship" of Burgundy *see* FRANCHE-COMTÉ.

In northern Italy the Carolingian rulers had been represented by a count palatine at Pavia from the early years of the 9th century. He in turn had appointed viscounts to assist him. With the decay of the royal authority a system of countships based on cities had grown up. Several cases are found of a number of countships in the hands of a single margrave (for example in the march of Tuscany, under the margraves of Canossa, and in the march of Este), but it cannot be stated positively that any counts became dependent on dukes (the ducal title was rare in northern Italy). The 10th century, however, saw many countships beginning to pass into the hands of bishops, who were less ready in Italy than in Germany to pass them on to laymen. It was from among the members of the judiciary appointed by the bishops in their countships that the consuls of the communes were largely recruited (*see* COMMUNE [MEDIEVAL]). The rise of the communes meant the end of the countship's former significance. In southern Italy the countship was established by the Normans in the 11th century.

In Spain the countship developed under Visigothic influence in the kingdom of Asturias-León and under Frankish influence in Catalonia and in the country immediately south of the Pyrenees. By uniting the Catalan countships, the counts of Barcelona (*q.v.*) made themselves into practically sovereign princes, comparable at least to the counts of Flanders and Toulouse; and the Carolingian countship of Aragon was the nucleus of the kingdom of that name. The countship of Castile, on the other hand, from which the kingdom of Castile emerged, was originally a frontier district of the kingdom of Asturias-León. In the latter kingdom the official character of the counts as district administrators appointed by the kings was preserved till the end of the 11th century, when the principle of hereditary lordships of one sort or another began to prevail.

In Hungary the office of count was adopted in the 11th century, the designation of *comitat* being given to the castellany and that of *comes* to the dignitary previously called the *iszpan* (from Slavonic *zupan*). On the Hungarian border special countships arose (*e.g.*, Forchenstein and Güssing in the modern Burgenland), in which the petty nobility otherwise so typical of Hungary was absent.

Counts as Nobles in the Modern State.—The reassertion of royal authority over the feudatories, which took place at different times in the different kingdoms and led to the formation of centralized states of the modern type, meant that the counts as such lost their political authority, though they retained their privileges as members of the nobility.

In France the development of the system of royal *bailliages* from the beginning of the 13th century onward served to restrict the counts' rights of legislation, judiciary and private war. Next the counts lost the rights of minting money (in the 16th century). Moreover, the gradual reunion of the great fiefs to the French crown, after which they were granted only in apanage (the territory itself being administered as a province of the kingdom), meant that the only countships surviving as fiefs till the end of the *ancien régime* were little properties whose holders in many cases had had them "erected into countships" within recent memory so as to enter the estate of the nobility.

The French Revolution reduced the counts to the level of "citizens." Napoleon, however, by his decree of March 1, 1808, revived the title, which was assigned *ex officio* to ministers, senators and life councilors of state, to the president of the Corps Législatif and to archbishops. It had no territorial significance, but was made hereditable in order of primogeniture (through nephews in the case of archbishops). Further creations of a similar type followed under the later monarchies.

In Germany the structure of the Holy Roman empire made the reduction of feudalism a slower process than in France. Distinctions, however, came to be made between (1) counts who became princes of the empire (*Reichsfürsten*); (2) counts of the empire (*Reichsgrafen*) who were also members of the college of counts (*Grafencollegium*); and (3) other counts.

When Frederick Barbarossa organized the estate of princes in the 1180s, princely rank was accorded only to immediate vassals of the emperor. At first this meant that, apart from such counts as were equivalent to dukes (namely landgraves, margraves and counts palatine), the only princely count was the count of Anhalt. The first countship thereafter to be "raised to princely rank" (*gefürstete*) was that of Tirol—an elevation due to the fact that the counts of Tirol were also, from 1286 to 1335, dukes of Carinthia. A princely count had his own personal vote in the college of princes, part of the diet of the empire.

Elevation to the rank of count of the empire was rare in the 14th, 15th and 16th centuries. The college of counts was established as a component of the council of princes in the 16th century, but the counts could vote only collectively, by benches (*Grafenbänke*). These benches at first numbered only two, the Swabian and the Wetterau or Veteran, but in the 1650s two more were added, the Westphalian and the Franconian. Meanwhile the emperor Ferdinand II had tried to counteract the Protestant influence in the college by raising a considerable number of Catholic nobles to the rank of count. These elevations were recognized, but from 1648 entry into the college was restricted to those who levied taxes on territorial countships. Thenceforward the title of *Reichsgraf* could be bestowed as the emperor thought fit, but the recipient would not automatically enjoy the full rights of members of the college.

After the dissolution of the Holy Roman empire the counts of the empire were mediatized; *i.e.*, made subject to the sovereigns of the various German states instead of being "immediate" subjects of the emperor alone. The federal diet, in 1829, however, recognized their right to the special style of *Erlaucht* ("Illustrious Highness").

In Italy the title of count was quite liberally bestowed by the popes and other sovereigns of the peninsula. In Spain it was conferred with more reserve. In Russia, where it was not introduced till Peter the Great's time, it came to be given usually to officials of a certain rank in the government service. In Poland there were no counts before the partitions, when the title was introduced by the Russians, Austrians and Prussians.

COUNTERFEIT MONEY. The imitation of money for gain has probably been practised by unscrupulous persons ever since money came into use. The study of counterfeiting, as seen from the point of view of suppression and prevention, is complicated and its aspects vary according to whether it concerns paper or metal currency. Counterfeiting is complicated because it can be accomplished only in successive stages: first the counterfeit item has to be produced by printing, striking or casting; then it must be passed in a clever and underhand way as genuine currency. All this means that it will be some time before the counterfeiter can realize any profit. It is an offense that requires a certain amount of technical and artistic ability and one for which the legal punishment is severe.

Base coin may be cast, struck or produced by a plating process. The casting of coin requires the use of molds made of gypsum, plaster, pulverized earth, cement, iron or wood. The striking of coin is effected by means of engraved dies.

Bank notes may be drawn or traced by hand. Such notes are among the least deceptive counterfeits and cannot be mass-produced by this method. The reproduction of bank notes by printing requires the use of metal frames, called forms, in which set type or other matter from which an impression is to be made is secured. The counterfeiter may utilize typography or letterpress printing (line cuts and half tone); planography (offset, lithography); or intaglio (rotogravure, copperplate engraving).

The terms counterfeiting and forgery are often used without distinction, but in the case of paper currency and coin a differentiation has to be made. Counterfeiting denotes fraudulent imitation of a genuine note or coin but forgery implies (1) falsification of a genuine note by alterations that will make it appear to be a note of higher denomination, or (2) debasement of a coin by clipping or some other process with the intention of palming it off as genuine money.

In the case of gold pieces there is a third form of imitation known as illegal manufacture. This practice is based upon the fact that the market value of minted gold is higher than that of gold bullion. If such gold pieces are no longer legal tender, the coiner does not commit the crime of counterfeiting in the legal sense nor, if the gold content of such coins is in conformity with the statutory fineness, can he easily be accused of fraud. Nevertheless these private coiners are liable to criminal prosecution on the charge of illegal use of official marks.

In the practice of counterfeiting there are two kinds of production, individual and collective or industrial. In the case of one-man production the counterfeiter will often be anything but an expert in graphic arts and may merely have consulted some literature on the technique of engraving and photogravure and have acquired a superficial knowledge of them. Yet the fact cannot be denied that he often succeeds in passing counterfeit notes of poor workmanship. The public at large is generally very careless in the handling of money and most people accept notes and coins without so much as casting a glance at them. There are cases of amateurs who have succeeded in making almost perfect counterfeits, but it very rarely happens that one man combines the qualities of a first-rate draftsman, photographer, plate maker and printer.

Collective or industrial production may be effected by various methods. A printer owning a small but well-equipped printing works may turn his plant into a complete counterfeiter's workshop while, for the sake of appearances, he continues to do some honest work as well. The counterfeits he produces may be very deceptive, as they are made by skilled workers. This method of production under the cloak of a regular business is very rare. Alternatively, a number of persons attracted by prospective profits may plan to make counterfeit currency and, to this end, acquire a likely place equipped as a workshop, the necessary plant and some skilled artisans. They constitute a clandestine organization, comparable to a regular commercial company in which they become the partners. After the notes have been printed, the counterfeiters are faced with the difficult problem of making arrangements for the passing on of their products. Since distribution of small lots to several persons will often require lengthy and tedious negotiations, they prefer another, more hazardous method of solving this problem. Two or three members of the gang visit first-class jewelers, furriers or other dealers in valuable articles that can be easily resold. They buy some precious stones, for instance, and pay for them in genuine currency. Next day they return and purchase a much larger quantity of high-priced articles, this time paying in counterfeit notes. When the jeweler detects the real nature of these and reports his discovery to the police, the criminals have already left the country. Merchants are often duped by this trick and the counterfeiters who use it are generally members of an international gang. Another instance of industrial counterfeiting is the use by the governments of certain countries of counterfeit currency as a means to attain their political purposes or to cause economic ruin to states at war with them; *e.g.*, Reinhard Heydrich's notorious wholesale production of counterfeit Bank of England notes during World War II. For the prevention of this crime it is essential that paper currency as well as coin meet the highest possible standard of quality to provide a deterrent to counterfeiters. (J. W. K.)

UNITED STATES

The constitution of the United States expressly provides in art. I, sec. 8, par. 6 that "The Congress shall have Power . . . To provide for the Punishment of counterfeiting the Securities and current Coin of the United States." The federal agency charged with the suppression of counterfeiting in the United States is the United States secret service, which was established July 5, 1865, as a division of the treasury department (*see* SECRET SERVICE, U.S.).

Records of amounts of counterfeit money seized during those early years are not available, but for the year ended June 30, 1876, the representative value of counterfeit coins and bills captured by the secret service approximated $232,000. At that time the government and the people themselves were handicapped in the suppression of counterfeiting because of the great number of national banks on which notes were issued and the variations in the engraved designs. New notes placed in circulation were quickly counterfeited before the public became acquainted with the appearance of the genuine notes. When counterfeit notes drawn on one national bank began to be widely detected, the counterfeiters would circulate new issues under the name of some other bank.

Crime Prevention Through Education.—During the four peak fiscal years, 1933 to 1936 inclusive, victims of passers of counterfeit notes in the United States lost an average of $771,000 yearly. Although banks were all warned to be on the alert for certain dangerous counterfeit bills, there was no concerted effort to warn retail merchants or others about such counterfeits, and the general policy of the secret service with regard to counterfeiting was one of secrecy since it was feared that alarms about extensive circulation of counterfeits would tend to shake the faith of some of the people in the currency of their country.

When the secretary of the treasury, Henry Morgenthau, Jr., appointed Frank J. Wilson chief of the secret service in 1937, the secretary requested that strenuous efforts be made to reduce to a minimum the losses suffered by victims of counterfeiters. As a departure from the age-old methods of investigation, prosecution and imprisonment, Chief Wilson decided to fight the crime of counterfeiting by teaching the public how to detect bogus money. In a trial of this idea, the secret service printed and distributed to banks and retail stores hundreds of thousands of warning circulars bearing descriptions of counterfeit bills currently in circulation. These warning notices bore diagrams showing the denomination and type of the counterfeit described, the particular defects to aid in checking a suspected bill and directed attention to the "check letter" and "face plate number" appearing in the lower right corner of the face of the bill.

For the fiscal year 1937 losses suffered by victims of counterfeiters were reduced to $519,366, and it was evident that the dissemination of the secret service descriptive warnings had had some good effect. Chief Wilson decided to pursue his idea further and early in 1938 sent a picked group of secret service agents to New York city, where they made a door-to-door canvass of approximately 100,000 retail stores and taught merchants and employees how to tell the difference between good and bad money. For the fiscal year 1938 losses to victims of counterfeiters fell to $407,320.

In 1938–39 secret service agents began a series of instructive lectures to retailers, bankers and others in all parts of the country. For the fiscal year ended June 30, 1939, counterfeiting losses had dropped to $294,057, and the secret service decided to intensify its efforts. Late in 1939 the secret service began a campaign against the counterfeiter under the slogan "Know Your Money." Secret service agents produced a sound motion picture entitled *Know Your Money*, which graphically portrayed methods of detecting counterfeit bills and coins and the *modus operandi* of passers of counterfeit bills. The federal laws prohibit the photographing of United States money in whole or in part, but Secretary Morgenthau granted special permission to the secret service to film genuine and counterfeit bills and portions thereof for this educational campaign.

To supplement the motion picture, the secret service produced millions of copies of a four-page leaflet telling how to detect counterfeit money, and arranged to give one leaflet to every person who saw the picture and to distribute copies to banks and business houses for their information and protection. More millions of the pamphlets were reprinted by banks and stores for distribution to their customers.

In Sept. 1940 the secret service produced a 32-page *Know Your Money* booklet, illustrated with pictures of counterfeit bills and telling in detail how to detect bogus notes and coins. Having in mind as its first objective removal of temptation from the youth of the country to engage in criminal careers, the service inaugurated efforts to have this booklet adopted by high schools in all parts of the country as a part of their regular curriculums. This was a productive effort and soon many schools were instructing their students in the detection of counterfeit money.

With the crime prevention program in full swing, the victims of counterfeit note passers lost only $48,000 during the fiscal year ended June 30, 1942—an impressive drop of 93% compared with the 1933–36 yearly average. Fifteen years later, during the fiscal year ended June 30, 1957, U.S. secret service agents captured $1,548,167 in counterfeit bills. Of that total, however, more than $100,000 was successfully passed on storekeepers and cashiers; the balance was seized before it could be put into circulation.

How to Detect Counterfeit Bills.—Years of experience have proved to the secret service that the best detector of counterfeit money is the properly trained human eye. The person who is best able to see the difference between the bogus bill and one that is genuine must know just what a genuine bill looks like. The only way such knowledge can be gained is through a careful examination of all parts of a genuine bill, and it is such a study that is advocated by the secret service to help Americans defend themselves against the counterfeiter.

The portion most difficult of good reproduction is the portrait on the face of every note. The portraits of famous Americans on United States paper money identify the denominations of the bills on which they appear, as follows:

$1	Washington
$2	Jefferson
$5	Lincoln
$10	Hamilton
$20	Jackson
$50	Grant
$100	Franklin
$500	McKinley
$1,000	Cleveland
$5,000	Madison
$10,000	Chase

The genuine portraits are lifelike and distinct, and the shading which characterizes the facial features consists of numerous delicately executed dots and dashes. The oval background surrounding each portrait comprises a series of tiny squares, formed by the crossing of very fine vertical and horizontal lines. On most counterfeits the portraits are defective in the shading in the face, and many of the little squares in the background are filled with ink or are flecked with white where the vertical and horizontal lines are broken. In the genuine portrait the eyes are always clear and expressive, but in most counterfeits they are dull, distorted or otherwise executed so that they do not compare favourably with the genuine.

These differences alone between the genuine and counterfeit portraits prompt the secret service advice to the individual to compare any questionable bill with another of the same type known to be genuine. Such a comparison will make evident any differences between the two to such an extent that if one is a counterfeit it can be classified as such.

Only three types of currency are in circulation in the United States—(1) silver certificates; (2) United States notes; and (3) federal reserve notes. Part of the design of every genuine bill includes the treasury seal, a small circle edged with sharp points like the teeth of a saw, enclosing an angle square under which is a key and over which is a balance scale, all mounted upon a dotted white shield within the circle. Surrounding the design are the Latin words *Thesaur. Amer. Septent. Sigil.*, representing the "Seal of the Treasury of North America." On silver certificates the seal and the serial numbers are printed in blue; on United States notes they are in red, and on federal reserve notes, in green. Thus, the type of any bill may be quickly determined merely by the colour of the treasury seal and the serial numbers. In addition, the words "Silver Certificate," "United States Note" or "Federal Reserve Note," as the case may be, are engraved at the top centre of the face of a bill.

On many counterfeits the sharp points around the outer edge of the treasury seal are blunt or broken. Here again, a comparison of the seal on a questionable bill with the seal on a genuine bill will show the difference.

The serial numbers on genuine United States paper money are printed in a distinctive type style, and numbering blocks of the kind used for this purpose cannot be obtained except by the bureau of engraving and printing. Therefore, in producing a counterfeit, the counterfeiter must either use numbers unlike the genuine, or must try to copy the genuine numerals. In the first instance a comparison will show the difference in the style, and in the second instance the copies or imitated numbers are usually poorly spaced or crookedly aligned, so that a comparison will indicate they are not authentic.

The border design of every genuine bill includes an intricate lacelike network of fine white lines. The patterns for these lines are produced by a machine known as a geometric lathe, and the lines are technically called geometric lathework. In a genuine bill these lines are clear and unbroken, but on most bogus notes the border is too dark because many of the spaces between the lines are filled with black ink caused by inferior etching, or perhaps too light because the white lines are thicker than the genuine, creating a bleached appearance.

It is believed by some that rubbing a bill on a piece of paper will prove whether it is genuine or counterfeit, through removal of the colour. This is definitely a fallacy because the ink can be rubbed from a good bill as well as a bad one.

How to Detect Counterfeit Coins.—The manufacture of spurious coins does not involve losses as great as those suffered by victims of counterfeit bills. This is due, of course, to the fact that there is a wide margin of difference between the value of metal money and the representative value of paper money.

The passer of counterfeit coins depends upon the carelessness of his victims in the same way as does the passer of counterfeit bills. Genuine silver coins have a corrugated outer edge, known as the reeding. Consisting of evenly spaced ridges, this feature was included on silver coins originally to prevent unscrupulous persons from cutting or filing from the edges of the coins small bits of silver, which they would then sell for the intrinsic value of the metal so derived. Later, however, the reeded edges of silver coins formed considerable protection against counterfeiting since the corrugations on most bogus coins are only partially executed unevenly spaced or entirely missing in places. Thus, a comparison of a questionable coin with one known to be genuine, or even a careful scrutiny of the ridges around a questionable coin, will usually indicate whether it is good or bad.

Most counterfeit coins are made of metal alloy which does not ring as clearly as genuine coins when dropped on a hard surface and which is usually much softer than silver. Therefore, questionable coins should be dropped on a hard surface to test their ring and should be cut with a knife to test their quality. If a coin sounds dull or is easily cut, it is undoubtedly a counterfeit.

It is also a fact that most counterfeit coins feel greasy, so it is wise to feel all coins, and if one feels slippery or greasy it should be further examined for defects in the reeding or other characteristics.

Bogus silver coins may be detected with a mixture of ingredients in a liquid solution, the formula for which is as follows:

Nitrate of silver	10 grains
Nitric acid	1 c.c.
Distilled water	30 c.c.

This "silver test" may be obtained for a few cents in any drug tore. A drop applied to a counterfeit coin which does not have high silver content will turn black. The solution will not dis- olour a genuine silver coin and will not react on a counterfeit oin which is made of silver or which contains a great deal of ilver, but since most counterfeits are made of base metal the cid will detect them. It cannot be used to detect counterfeit ickels or gold coins.

If you receive counterfeit money the secret service recommends he following actions:

1. Do not return it.
2. Notify police at once.
3. Try to delay the passer under some natural excuse.
4. Avoid argument. If necessary, say the police will handle the matter.
5. If the passer leaves, write down his description.
6. Write down the licence number of any automobile used by the passer or his accomplices.

Stamps.—Secret service agents have arrested makers and users f counterfeit United States internal revenue tax stamps which re usually affixed to bottles of taxable alcoholic beverages in an ffort to evade the required tax payments. Such stamps are is- ued by the government and are protected by the laws which pro- ide for the suppression of counterfeit money.

The secret service, in co-operation with post office inspectors, as also captured plants for the manufacture of counterfeit United tates savings stamps and postage stamps, but this type of coun- erfeiting is somewhat unusual and has never been very extensive.

Confiscation of Counterfeits.—The federal laws for the pro- ection of obligations of the United States provide that anyone aving custody or control of any counterfeits of such obligations ho shall fail or refuse to surrender them to an authorized agent f the treasury department shall be fined not more than $100 or mprisoned not more than one year, or both. All banking insti- utions are authorized agents of the treasury department within he meaning of this statute and, as such, are legally authorized to onfiscate counterfeit money from their customers or other persons ho present it.

Penalties For Counterfeiting.—Counterfeiting is a felony. he laws of the United States provide that any person who has nowledge of the commission of a felony recognized by the federal ourts, and who does not at once make such knowledge known to he authorities, shall be fined not more than $500 or imprisoned ot more than three years, or both. Therefore, one who has any nowledge of counterfeiting activities should, for his own protec- on, promptly report such knowledge to the secret service. (Sec. 86, title 18, U.S. code.) (F. J. W.)

GREAT BRITAIN

In Britain, as in every sovereign state, the making of money the prerogative of the government. The crown alone can en- ow money with the authority that will make it acceptable for he purposes of trade and commerce. There have been several oinage acts, of which the principal, as far as counterfeiting is oncerned, is the Coinage Offences act of 1861, whose main ef- ect is to make counterfeiting of coin a felony. Counterfeiting ncludes the colouring or gilding of a low-value coin so as to ake it resemble a gold or silver one as well as the impairing r lightening of a coin. Since 1861 there have been several sup- lementary coinage acts, and provisions have been made for fix- ng the metallic content of coins and the amounts of different oins which may be offered as legal tender. The international onvention of 1929 for the suppression of counterfeiting (*see* be- ow) was implemented in Britain by the Counterfeit Currency (Convention) act of 1935. This sought to apply to foreign cur- ency the provisions relating to British coin and imposed penalties or importing and exporting counterfeit foreign coin.

Gold coin was withdrawn from circulation at the outbreak of World War I in 1914; and for all practical purposes the money in rculation in Great Britain has since consisted of token coins nd currency notes. The Currency and Bank Notes act, 1914, em- owered the treasury to issue £1 and 10*s.* notes which were to be legal tender for any amount and to be current in the same manner and to the same extent as the gold sovereign and half-sovereign. From 1914 onward, consequently, there were two note issues in circulation, those of the Bank of England, *i.e.*, bank notes proper, and those of the government, or treasury notes. The two were amalgamated by the Currency and Bank Notes act, 1928, which provided that currency notes were to be deemed bank notes and transferred the whole of the note issue to the Bank of England. By this statute, too, currency notes were to be deemed bank notes in such special connections as forgery.

The risk of forgery has always been a source of anxiety to those persons legally authorized to issue paper money. As far back as 1697 an act was passed by which forgery or alteration of a bank note was deemed a felony. At common law, forgery was a mis- demeanour; but most forgeries were made felonies by statute and forgery of notes was a capital felony until 1832. The number of persons executed for it has varied. It is said that in 1817 three hundred persons were hanged as forgers; but in the three years prior to 1832 only 15 suffered execution.

In the early days of the Bank of England, notes were written by hand and could be altered. It is a measure of the informality of the 18th century that in 1722 the Bank of England sent an offi- cial to interview a man found guilty of erasing and altering a bank note and, before the latter was executed, obtained his advice on how to counteract the practice. The essence of the problem of forgery is contained in the old maxim that what one man can make, another can copy. Hence there has been a never-ending struggle against forgers and, apart from the legal sanctions avail- able to the state, the only security measures have been the quality and nature of the special bank-note paper, always restricted to this use, and its design and manufacture by one trusted firm. Pro- vided the genuineness of the currency is safeguarded with the ut- most vigilance, it is doubtful if an attempt at wholesale forgery to secure the economic breakdown of a nation, such as Reinhard Heydrich's in 1941, can ever succeed. It is known that many mil- lions of pounds' worth of notes in denominations of £5, £10, £20, £50 and even higher values were forged in the German experiment of World War II; but before mass release of these notes could be arranged the project was abandoned.

Perhaps the most interesting case of forgery and counterfeiting in England came to light during the 1920s. This was the famous Portuguese bank note case. In 1924 Waterlow and Sons, a famous and honourable firm of printers, were deceived into printing an ostensible order of bank notes for the Bank of Portugal. Many thousands of spurious notes were thus printed on genuine plates, smuggled out of England and used as capital for a small Portuguese bank, through which they were distributed. Toward the end of 1925 the unduly large number of 500 escudo notes in circulation aroused the suspicions of the Bank of Portugal. Investigations revealed the plot. Then followed the task of separating genuine notes from false. This was difficult, for both were printed on gen- uine plates. The whole of the issue was withdrawn for study and minute differences discerned in the printing enabled the authorities to distinguish the forged notes. Their total value was equal to £3,000,000, and about one-third of them had passed into circula- tion. In an action brought by the Bank of Portugal against the printers, damages of £610,392 were awarded against the firm in 1932 by the house of lords.

The English law of forgery depends principally on the Forgery act, 1913, as amended by the Counterfeit Currency act, 1935. The 1913 act defines forgery as the making of a false document to be used as genuine and the counterfeiting of seals and dies. The act deals not only with definitions and penalties but includes also provisions regarding the possession of paper or implements for the forging of bank notes. Accessories and abettors clearly are liable; but it is an indication of the gravity of the offense that the act treats them as principals.

Special provisions are also made for the issue of search war- rants. (GA. S.)

INTERNATIONAL POLICE ORGANIZATION

The chaotic conditions in Europe after World War I caused

crime to increase beyond all bounds and led police officials in many countries to create an international police organization. In 1923, when the imperative necessity of checking this wave of crime became evident, the appeal made by J. Schober, superintendent general of the Vienna police, inviting every government to co-operate met with a favourable response. Many countries were represented at the International Congress of Police Officers held in Vienna in Sept. 1923. The fact that counterfeiters were ranking high in the postwar world of international criminals was explained by H. von Liebermann, chief of the criminal police, Berlin, who pointed out that no other crime had such a marked international character. The depreciation of Poland's monetary unit in 1921 was largely due to the wholesale counterfeiting of Polish 1,000-mark notes, with which the central European markets were openly deluged. The wave of counterfeit German bank notes with which Europe was inundated immediately after World War I continued to imperil the parity of the German bank notes as late as 1920. When Hungarian bank notes of a certain denomination had to be exchanged after their withdrawal, an extraordinarily high percentage of them proved to be counterfeits. In 1921 strenuous efforts had to be made in the Netherlands to suppress the counterfeiting of notes of 25, 60, 100, 200 and 300 florins. Czechoslovakia, Italy, Rumania, Belgium, Denmark and Great Britain also had to cope with the counterfeiting of their national currencies. In Great Britain a large percentage of counterfeit Bank of England notes, particularly the £1, £10 and £20 notes, proved so deceptive that even observant and experienced money handlers were unable to identify them.

Counterfeiting committed in any one country may affect other countries as well; *e.g.*, counterfeit U.S. bank notes made in Germany will—even in the event of their being circulated in Germany only—soon pass the frontier of a neighbour country. Speculation in foreign currency creates a great demand for it, with the result that the centres of this speculative trade are likely to become centres of the traffic in counterfeit currency as well. When the market value of the currency of a particular country becomes so low that counterfeiting is unprofitable, counterfeiters can turn to the production of money of a higher parity.

To achieve international co-operation in suppressing this crime, central offices dealing with cases of counterfeiting were in existence in several countries, including the Netherlands, Poland, Czechoslovakia, Germany and Austria and a resolution purporting to constitute an International Criminal Police organization (Interpol) was unanimously adopted. Vienna was designated as the headquarters of the organization in 1923 when it was set up, but this was transferred to Paris in 1946. Its constitution afforded a form of co-operation between police authorities on an international level. The Interpol authorities entrust the repression of counterfeiting to specialized officers, versed in the technicalities of production; they furthermore affirm that the collection of all relevant information should be centralized in every country and that the secretariat general of the International Criminal Police organization, officially designated as International Central bureau, should be regularly notified of every case of counterfeiting and its technical particulars.

At the 40th session of the council of the League of Nations, held on June 10, 1926, Aristide Briand, the French minister of foreign affairs, proposed that counterfeiting be dealt with as an international crime and suggested that the several governments amend their penal codes to provide that the counterfeiting of foreign currency be liable to the same measure of punishment as the fraudulent imitation of their national money. He furthermore recommended the creation of an international bureau to be charged with the collection of all information on counterfeiting and said that it would be advisable to entrust to a committee, selected from competent persons to be appointed by the various governments, the work of framing a draft convention for the suppression of this crime.

A diplomatic conference was held in Geneva on April 9, 1929, and was attended by delegations from 35 governments and by a delegation of the International Criminal Police commission in an advisory capacity. It drew up a convention with a protocol and final act and was concluded on April 20, 1929. It was signed (until closed on Dec. 31, 1929) by the governments of Albania, the United States of America, Austria, Belgium, the United Kingdom, India, Bulgaria, China, Colombia, Cuba, Czechoslovakia, free city of Danzig, Denmark, France, Germany, Greece, Hungary, Panama, Poland, Portugal, Rumania, Spain, Union of Soviet Socialist Republics, Switzerland and Yugoslavia.

The object of the convention was to render more effective the prevention and punishment of counterfeiting currency. To this end the convention provided rules for unifying, to a certain extent, the penal laws of the signatory powers and for the centralization and co-operation of police action in the various countries. Previously in many countries the counterfeiting of foreign currency was punished much less severely than the counterfeiting of national money and in several, the counterfeiting of foreign money was not an indictable offense at all. Again in the various countries, not excepting those where the crime of counterfeiting was liable to most severe retaliation, a differentiation was made between the various phases of the crime, so that the punishments imposed for merely passing counterfeit money, for participation in counterfeiting and for the possession of instruments for counterfeiting, greatly differed. Furthermore, the rules governing extradition were such that it was usually most difficult, and often impossible, to institute criminal proceedings against counterfeiters who had escaped from the country. The convention sought to improve on this state of affairs and in all participating countries legislation had to be such that currency counterfeiters were prosecuted and punished without exception and could nowhere go free with impunity.

The second aim of the convention was to organize international co-operation between the police authorities of the respective countries. To this end it stipulated that in each country a central police office should be established in which all information and investigations relating to the counterfeiting of currency should be centralized, and that provision be made for an international office to act as clearinghouse between the national central offices.

Thirty-two powers, including the Soviet Union, ratified the convention of Geneva. Even those states which did not would be influenced in determining the measure of punishment for counterfeiting by the judicial practice of the other states; their legislation, in accordance with the traditions of international law, would be gradually adapted to the provisions of this convention. Such colonies, possessions and protectorates as acquired independence usually recognized the international obligations of the metropolitan powers to which they formerly belonged and thus adapted their common law to the provisions of the convention. (J. W. K.)

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COUNTERFORT, a form of buttress (*q.v.*) used for the strengthening of walls, originally of medieval fortifications, but later of other walls (*e.g.*, cofferdams). With the introduction of cannon as siege weapons in the 15th century, ordinary masonry walls backed with earth were not sufficiently strong. They were, therefore, strengthened with buttresses or counterforts from the inside of the wall. Later the counterfort often took the form of an arched gallery, built behind the wall under the rampart.

COUNTERPOINT. The word counterpoint has three meanings in music: (1) it may mean a melody accompanying an existing melody; (2) it may embrace the whole art of combining melodies; (3) it may describe a limited number of styles grouped together for purposes of study or examination. This article surveys the history of counterpoint in western European music in the second of the above senses. It must be borne in mind that it is impossible to separate the constituent parts of musical speech into compartments of their own, and therefore many details of contrapuntal technique, insofar as they are harmonic, are discussed in the article HARMONY.

Contrapuntal Forms and Styles.—Strictly speaking the addition of any extra part to an existing part produces counterpoint. There is, however, a distinction between counterpoint that is constantly parallel (similar motion) and that which may also include

contrary and oblique motion. If two parts always move in similar motion, the ear regards them essentially as one part enriched by doubling, but if their melodic direction diverges they take on separate identities. Further, counterpoint whose constituent parts move together in similar rhythm is likewise limited rhythmically. Styles dominated by parallel motion and/or by similar rhythms are said to be homophonic and are contrapuntal only insofar as they may be restricted to a particular number of vocal or instrumental melodic lines. Styles whose different voices are more independent in direction and rhythm are said to be polyphonic and more truly contrapuntal. Independence in this context is a comparative term, because the addition of one note to another also produces harmony; and however independent in direction and rhythm individual voices may be, their combination as harmony is a vital consideration; their melodic and rhythmic shapes are bound by this consideration.

Contrapuntal forms are those that are built on a combination of independent voices or parts, *e.g.*, canon (*q.v.*), in which one voice imitates more or less exactly the melody of another voice.

The earliest known music in more than one part is parallel organum and free organum. The former is homophonic doubling at certain intervals of the original melody while the latter is a little more polyphonic in outlook, the added melody (*vox organalis*) starting and ending with the chant (*vox principalis*) but diverging from it otherwise, though mostly in parallel motion. The two important developments in the age of organum were: (1) the use of contrary motion with the crossing of parts (*c.* 1100) and (2) the use of more than one note in *vox organalis* to one note in *vox principalis*. The latter paved the way for the introduction of a more florid metrical system. As the added part became more complex, the term discantus was introduced.

The school of Notre Dame in Paris developed the use of rhythmic modes in polyphonic writing. The organa of this school use the modes partially, containing sections or voices in freer rhythms, while discantus consisted completely of parts measured by modal rhythms. In the discantus, Pérotin used *clausulae*, which are repeated rhythmic and melodic patterns (derived from the plain chant), in the tenor. The melodic patterns did not necessarily coincide with the rhythmic patterns. Pérotin wrote organa for two, three and four voices. Naturally the individual melodies of organa for three and four voices are more constricted than in two-part writing, the upper parts, slightly decorated, moving in octaves or fifths with the tenor. An interesting feature of Pérotin's work is his use of imitation with (1) an early type of double counterpoint, usually repeated with the voices interchanged; and (2) the use of actual canon.

Example 1 (two of the voices are omitted) shows not only a grasp of the use of contrary motion but also a contrapuntal use of rhythm. The rhythm of the whole is made up of the alternating rhythms of each part.

A second style used by the school of Notre Dame for metrical texts was conductus (*q.v.*). This was characterized by all parts moving in almost similar rhythms and was thus a more homophonic style than organum.

Voices in the 13th-century motet sang different texts simultaneously and the technique included the interchange of voices and the use of tenor patterns, both borrowed from organum. In the early 13th century the upper voices were much in the conductus style but about 1250 a new style developed, called Franconian after Franco of Cologne. In this, triplum, the highest voice in the motet, became more ornate and important and, though constantly crossing with duplum, almost took the character of a tune, the other voices accompanying. The interchange of voices, canon and the *quodlibet* technique of combining existing melodies simultaneously were used. Another partially contrapuntal device used was the hocket, which is characterized by rests between notes in individual parts, the notes of one part filling in the rests in the other. (The top part in Ex. 2 is a typical hocket part in bars 5–7 of the extract.) One of the most important features of good contrapuntal writing of all periods is the completion of a rhythmic pattern by the concerted effect of the rhythms of different parts (as in Ex. 1), and the hocket is an early realization of this.

The secular style was represented, apart from secular motets, by the so-called cantilena, which included polyphonic *rondeau, virelai* and *ballade;* these borrowed melodies from secular monodies and used a conductuslike technique.

The 14th century saw the rise of true counterpoint. In the isorhythmic motets of Philippe de Vitry and Guillaume de Machaut, in the madrigals of Jacopo da Bologna and in the *caccia,* the different voices have much more melodic life and direction. They use isorhythm, a formal device consisting of an extended rhythmic pattern repeated throughout the work in different melodic forms. Isorhythm has a formal function, and Machaut introduced it not only into the structurally important tenor parts but also into the other voices, which thus achieved more independence. An increasing give-and-take characterized the upper parts, and the Italian *trecento* composers favoured newly composed tenor parts, often more quick-moving in keeping with the other parts. The emancipation of the tenor gradually led to its becoming a contrapuntal equal of the other voices. Such a passage as Ex. 2 has no parallel in earlier music.

The canonic form taken by the *caccia* is inherently contrapuntal.

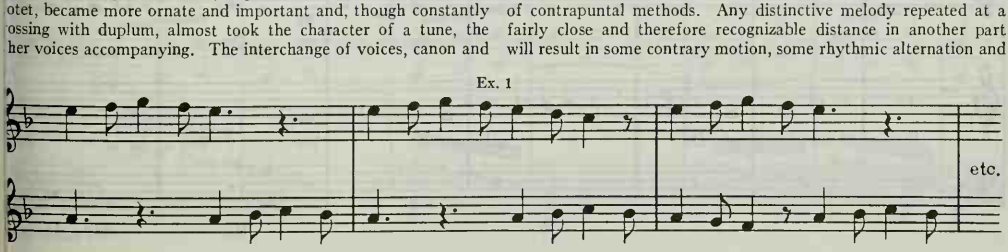
Apart from the equality of voices, the greatest spur to real contrapuntal writing was the introduction of imperfect concords as regular harmony notes. This apparently originated in England, where there is at least one motet of the early 14th century (*Ave miles coelestis—Ave rex patrone—Ave Rex*), in which the parts, though rhythmically very much in conductus style, are melodically remarkably independent, with a distinct sense of line. Such use of imperfect concords enabled John Dunstable to evolve a systemic treatment of dissonance that dominated the harmonic system in use from about 1500 to the 20th century.

Though *cantus firmus* (*q.v.*) methods were used to the end of the 16th century, and indeed to the present day, their use was increasingly different in that the *cantus firmus* was no longer confined to one part. The methods of using the *cantus firmus* included: (1) canons based on the *cantus firmus;* (2) highly decorated melodies following the main outlines of the *cantus firmus;* and (3) the more ancient use with, however, much more equality in other parts, including imitation.

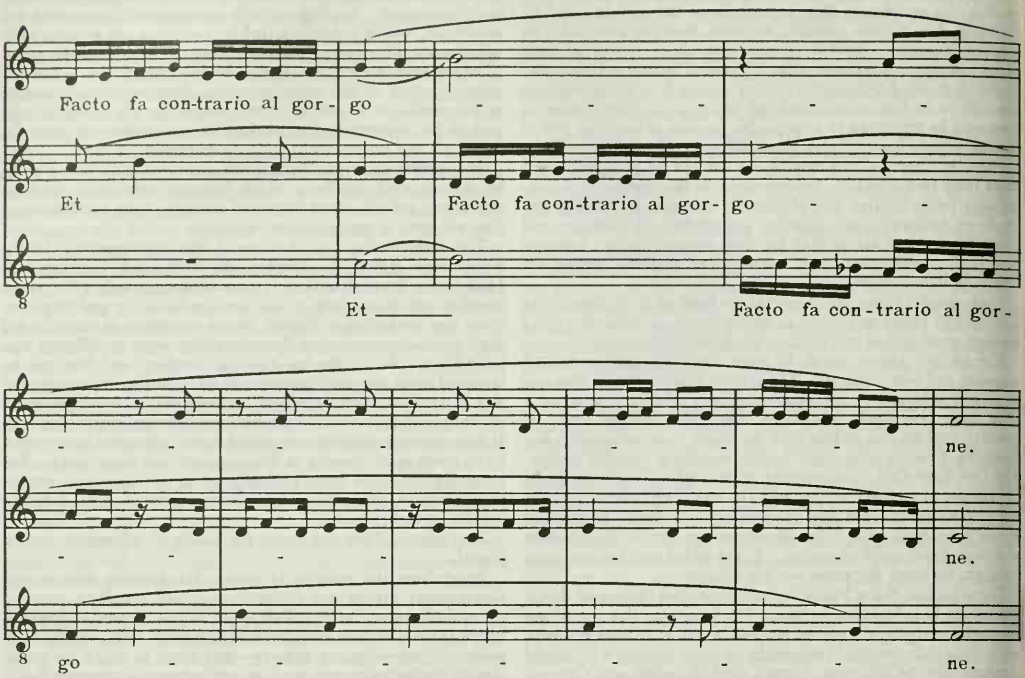
The Flemish school of Jean d'Okeghem, Jakob Obrecht and (a little later) Josquin Desprès developed these trends further, particularly in their church music. In replacing a normal three-part texture with one of four parts, they encouraged the use of the four registers of male voices (treble, alto, tenor, bass). Thematic equality demanded single texts, though there are examples of old-style multitextual motets, even in Desprès.

Single texts also encouraged other means of extension, such as the use of canon, and the sectional treatments, so usual in 16th-century vocal music, which was often a combination of polyphonic and more homophonic styles. Canon and fugue, the latter an extension of the former (*see* FUGUE), are logically the most natural of contrapuntal methods. Any distinctive melody repeated at a fairly close and therefore recognizable distance in another part will result in some contrary motion, some rhythmic alternation and

Ex. 1



Ex. 2



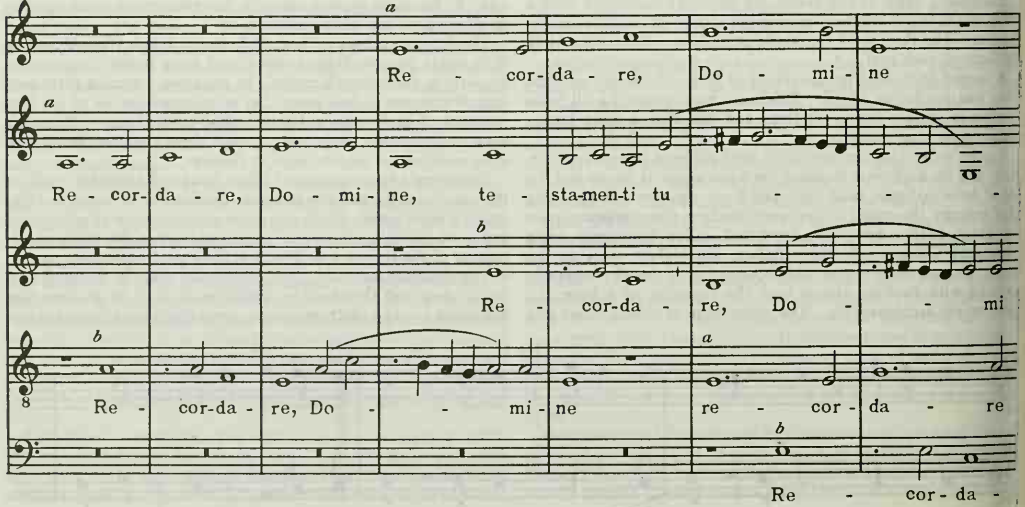
some dissonance, and the entries of different voices will produce movement.

Multiple Counterpoint.—From the problem of providing a second part as countermelody and from that of providing the second entry of a fugal subject arose the idea of double counterpoint, a device much used in the late 16th century, especially by William Byrd. In the following example themes (*a*) and (*b*) are interchangeable in voice position, so that whatever voice sings (*a*), another voice may sing (*b*).

Apart from the obvious musical advantages in such a procedure there is the added possibility of using two distinctive themes in double counterpoint, each fitting its own phrase of the text. Such a technique was often used in vocal fugues by Handel and Bach. Double counterpoint is, of course, constantly used in instrumental fugues that have regular countersubjects.

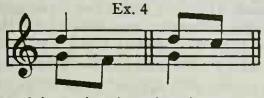
The technical problem involved in multiple counterpoint lies

Ex. 3



n the alteration of intervals between parts so inverted. Ex. 3 hows double counterpoint in the octave. Intervals inverted in he octave behave as follows: seconds become sevenths, thirds become sixths, fourths become fifths, octaves become unisons. Such inversions become reciprocal. This process can be expressed rithmetically, by subtracting each interval from nine, the result eing the inverted interval. Therefore, in such counterpoint dis- ords invert to discords and concords to concords, with the single xception of the concordant fifth, which inverts to become the dis- onant fourth. Hence fifths must be treated in some such manner s in Ex. 4, so that in inversion the dissonance is resolved.

Ex. 4

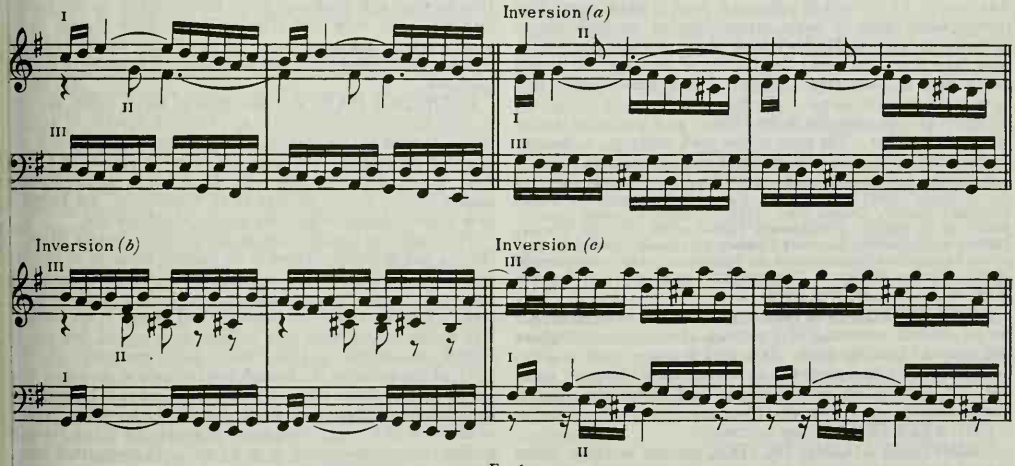


The problems of inverting in other intervals can be deduced rithmetically: inversion in the tenth, for example, by subtraction rom eleven, in the sixth by subtraction from seven and so on. The advantage of inversion at intervals other than the octave is he harmonic variety that can be so obtained. Some examples of nvertible counterpoint are shown in Ex. 5.

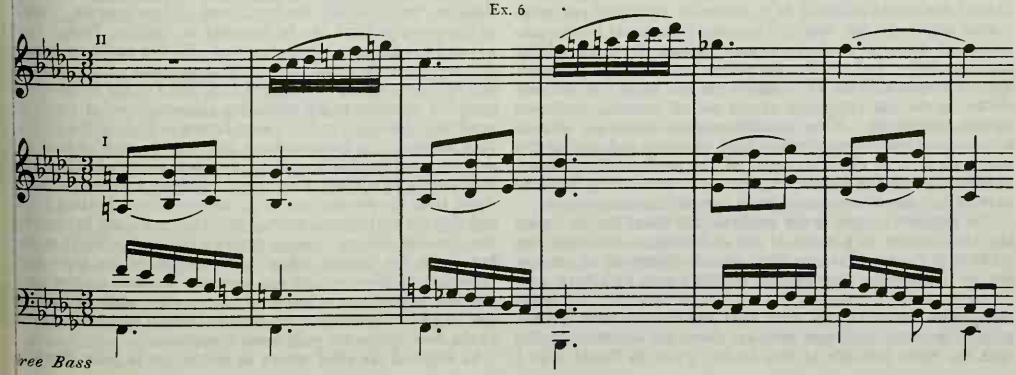
Note that the alteration in the form of shortened note values n the inner part in (*b*) is a matter of keyboard convenience and hat the rhythmic device in (*c*) is a purely artistic consideration. Exact inversion is possible in this instance, though generally in- ersions of triple counterpoint are often altered in details. The extract below (Ex. 6) shows an example of triple counterpoint at the 12th and incidentally at the ninth.

Ex. 6 is a tour de force as triple counterpoint, which is normally not possible in any interval but the octave because the changes of harmony involved in inversion at other intervals are too complex, and because such counterpoint would always involve incidental relationships. At the octave, triple counterpoint is quite common generally, and Bach found it particularly useful as a means of both linking and varying different episodes in fugues (as in Ex. 5). Quadruple counterpoint occurs quite often in Bach; even quintuple appears in his *Magnificat*. In the quintuple counterpoint of *Fecit Potentiam* in the *Magnificat*, a new free part is given to the vocal tenor that is actually invertible (over the given bass), though not so used by Bach. An independent bass does not so much remove the difficulty of inverting extended coherent passages of multiple counterpoint (*i.e.*, any more than quadruple) as it removes some of its pointlessness. First, the human ear is incapable of hearing many lines of counterpoint accurately; secondly, the very length of a movement required to use different permutations of extended multiple counterpoint makes its use pointless; thirdly, the harmonic constriction (which is less in very chromatic passages) that denies the normal use of the fifth would encourage dullness and thinness. In the finale of Mozart's "Jupiter" Symphony, K.551, the quintuple counterpoint occupies just less than two bars of *molto allegro*, $\frac{2}{2}$; however wonderful that finale may be artistically, the almost miraculous contrapuntal powers ascribed to Mozart on the strength of it are overrated,

Ex. 5



Ex. 6



especially in view of the fact that the themes concerned are such commonplace contrapuntal tags. But there can be few more perfect examples of contrapuntal writing than the fugal exposition occurring in bars 36–52 and the various stretti that occur later in the movement. Sextuple counterpoint occurs in Bach's Concerto in C for three harpsichords and in his cantata movement *Nun ist das Heil.*

Other Kinds of Inversion.—The word inversion is used also in an entirely different sense to mean the turning upside-down of melody. Total inversion of passages in several parts is described as "mirror" counterpoint, exemplified by Contrapunctus XII and XIII in Bach's *Die Kunst der Fugue.* Such a technique and that of crabwise movement (retrograde melody called cancrizans) have rarely been used with great artistic success.

It will be noted that this article ceased to be historical from the point at which multiple counterpoint was discussed. From the 16th century onward, counterpoint, as distinct from contrapuntal forms and devices, cannot be separated from harmony. The details of harmony are contrapuntal and are discussed in the article HARMONY. Musical style has been more or less contrapuntal according to circumstances and further information will be found in the articles CANON, FUGUE, MADRIGAL, MOTET, etc. The 20th century has seen a renewed interest in contrapuntal forms. But contrapuntal methods have varied with harmonic methods and it would be impossible to discuss details of style within the confines of this article.

Strict Counterpoint.—This is an entirely academic type of study that originated after the great polyphonic age of the late Renaissance but purports to embody the stylistic principles of that period. Its methods of using *canti firmi,* to which were added counterpoints, were to some extent founded on 16th-century methods, as Thomas Morley's book shows, though most of its rules bore little relation to the practice of that age. It is still widely used in contrapuntal studies. "Free counterpoint" is a name given to an academic study that is so vague in its stylistic principles as to be reducible to the whim of each particular teacher or textbook author. The term is also used, properly, to describe nonrecurring countermelodies in fugue and other forms.

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COUNTERPOISE, in radio engineering, an artificial ground for an antenna, consisting of a network of wires elevated above and insulated from the earth. It is used in places where it is difficult to obtain a good ground (*e.g.,* where there is extremely rocky soil). A combination of counterpoise and buried-wire grounds is also possible. *See* ANTENNA (AERIAL).

COUNTERTENOR: *see* SINGING.

COUNTERVAILING DUTIES, customs or excise duties (taxes) the object of which is to neutralize unwanted and unintended effects of other duties. They may be imposed for the protection of domestic producers against foreign rivals not subject to excise duties, and also for the protection of foreign producers against domestic rivals whose goods are not subject to customs duties, or for the protection of one set of domestic producers against another set. When customs or excise duties are adopted or increased solely for revenue-raising purposes and not for the encouragement or discouragement of the production or import of certain goods, the government imposes countervailing duties to prevent any unwanted consequences outside the fiscal sphere.

The principle became firmly established in Great Britain during the 19th century as a result of the endeavour to reconcile free trade with the need for providing revenue by means of customs duties. Such duties were adopted regularly even by Liberal governments on the assumption that, so long as countervailing excise duties were adopted at the same time, the customs tariff did not protect domestic producers and was therefore not incompatible with the basic principle of free trade. Prior to World War I this practice was a general rule. For each fiscal customs duty there was a countervailing excise duty, even on the negligible British tobacco production. For a long time British wines escaped countervailing duties, but as a result of the increase in their production a nominal duty of 1*s.* per gallon was imposed in 1927, which was gradually increased almost to the level of the preferential duty on Commonwealth wines.

It was the usual practice to fix customs duties slightly above the countervailing excise duties in order to compensate home producers for the inconvenience caused by the imposition of the excise duties. For instance, there was originally a difference of 2*d.* per proof gallon of spirits under the trade agreement of 1860 with France. This difference was subject to changes and was raised to 2*s.* 10*d.* after World War I.

When excise duties were adopted for fiscal purposes, countervailing customs duties were applied in order to protect domestic producers against their foreign competitors. Countervailing duties were also adopted in some instances to protect one domestic industry against another when products not subject to excise duty could easily be substituted for those that were taxed. For instance, in 1928 a countervailing duty was imposed in Britain on mechanical lighters to offset the duty on matches and since 1950 petrol (gasoline) substitutes have been made subject to countervailing duties which are adjusted to accord with changes in petrol duties. The term countervailing duties is sometimes interpreted as applying to customs duties imposed for the prevention of unfair competition by foreign rivals enjoying the advantages of a strongly organized industry, unduly cheap exchange rates, sweated labour or subsidies. Thus countervailing duties were levied in Canada in 1904 on steel rails produced in the United States on the grounds that these rails were sold at prices below those charged in the home market. But such duties are now better known under the term of antidumping duties and are frequently resorted to in many countries. (P. EG.)

COUNTRY DANCE. This type of social dance, regarded as deriving from the carole (*q.v.*), is for a number of couples, though there is historical evidence of performance by women only as a skill *sui generis.* The term was narrowly applied to a social dance practised by gentlefolk from the mid-16th century onward; similar dances, usually referred to as "traditional," are known to have existed contemporaneously among countrypeople.

The origin and precise meaning of the term "country dance" is obscure and disputed. There is no positive evidence of rusticity and the sources of knowledge concerning structure, movements and music are of urban, even courtly, origin: Italian (15th–16th centuries), English (16th–19th centuries) and French (18th century). The Italian *contra-passo* may perhaps be accepted, but not the French *contredanse* (a 17th-century gallic rendering; *cf.* "rosbif"), as the source of the English word already in use about 1560.

The country dance exists in three main forms: (1) circular for an indefinite number, such as the English 15th-century "round" or hornpipe (*q.v.*); (2) "longways" or double-file for an indefinite number, either processional or in a "set"; (3) geometrical formations or "sets" usually for two, three or four couples. Insofar as the country dance can be regarded as rustic or "folk," forms (1) and (2) are found in that context; the few rustic examples of (3) are generally considered to be derivations of the quadrille and the "set-running" of eastern U.S. and Canada to be a compound of doubtful origin exhibiting characteristics of carole and quadrille. Both (2) and (3) were known in Italy in the 15th and 16th centuries, in England from the 16th century onward and as a supposed English invention, (2) was re-exported to Europe as *contredanse* (*q.v.*) and *Kontratanz,* enjoying a prolonged vogue. Apart from the processional (*e.g.,* the well-known Helston Furry) carrying the participants over an extended route and its modification "square dancing," which disposes the double-file in an endless circle, the country dance "set" remains in the same place. "Figures" in great variety are executed between couples or individuals opposite or adjacent to one another, while in "progressive longways" continuous interchange brings a new leading couple to the head of the set with every repetition.

In England the chief source of instruction is John Playford's

English Dancing-Master (1651; recension by M. J. Dean-Smith, 1957), which was continued in 18 enlargements and additional volumes until 1728 and was succeeded by numerous imitations. In the early 19th century Thomas Wilson (*An Analysis of Country Dancing*, 1808, etc.) gave a new aspect to the country dance, but the revivifying effect was soon quenched by the introduction of the quadrille. A 20th-century revival of country dancing was brought about by Cecil Sharp, founder of the English Folk Dance Society (1911–32).

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(M. J. D.-S.)

COUNTY, in the United States, is the principal geographic and political subdivision of the respective states. (For the county in Great Britain and the commonwealth, *see* below.) Counties exist as geographic areas in all states, except Alaska (although they are called parishes in Louisiana), and are organized as governmental units in all except Rhode Island and Connecticut. Although organized county government blankets most of the nation, some local areas, in addition to Rhode Island and Connecticut, are without county government. Most numerous among these are certain cities, principally in Virginia but including also St. Louis, Mo., and Baltimore, Md., which are independent of the surrounding or neighbouring counties, and whose governments perform within their boundaries both city and county functions. In 1960, 3,059 organized county governments existed in the United States, the number in individual states ranging from 3 in Delaware to 254 in Texas.

The principal organ of county government is usually an elective board of commissioners or supervisors, whose members are chosen in some instances from county subdivisions or districts, and in others from the county at large. Three-member and five-member boards are most common; but where provision is made for representation of townships, board membership ranges upward to 50 and more. The term of members varies from a single year to eight years with the four-year term most common, and terms are frequently staggered. The county governing board is vested with both legislative and administrative powers. Foremost among its legislative powers are those of taxing, appropriating and borrowing money on behalf of the county, although bond issues frequently require voter approval. In addition to these fiscal powers, boards commonly possess some legislative authority of a regulatory nature, such as power to license and regulate retail liquor establishments and various forms of commercial amusement in unincorporated areas of the county. In some states county boards have zoning authority. Administrative powers usually include control and supervision of county institutions and property, letting of contracts, settlement of claims against the county, and appointment of various county officers and employees.

Elective county offices, in addition to membership on the governing board, most commonly include those of sheriff, treasurer, clerk, coroner, assessor, superintendent of schools, surveyor or engineer, and recorder or register of deeds. The local prosecutor, though in legal contemplation a state officer, is often elected from the county. Certain other county officers, such as highway commissioners, health directors and welfare superintendents, are more commonly appointed by the county board than elected. Also frequently included in the governmental organization are various special-function boards and commissions operating in such fields as agriculture, assessment, elections, hospitals, libraries and planning.

A few U.S. counties in the second half of the 20th century had managers patterned after the city managers found in many municipalities; a somewhat larger number had appointed executives with administrative authority less extensive than that of orthodox managers; and a few had elective executives similar to city mayors. The great majority of counties, however, were entirely without any single executive officer charged with general oversight of county administration, such supervision as existed being provided by the multimember board of county commissioners or supervisors.

Major county functions are law enforcement, judicial administration, construction and maintenance of roads, provision of public assistance to the needy, and the recording of legal documents. In some states, principally in the south, the county plays an important role in school administration. Other services and institutions provided by some counties include health protection, hospitals, libraries, parks, weed control, predatory animal control, fire protection and agricultural aid.

County government is financed for the most part from local property taxes and state-aid funds, although fees and fines constitute minor revenue sources; and occasional counties levy sales taxes or other nonproperty taxes, or operate public enterprises of a revenue-producing nature.

See Clyde F. Snider, *Local Government in Rural America* (1957) and bibliography therein. (C. F. S.)

Great Britain and the Commonwealth.—In the British Isles the county (or shire) is the principal subdivision of the country for political, administrative and other purposes. Before the Norman Conquest the shire was used as a unit of government, with two principal officers—the *ealdorman* or alderman, and the *scirgerefa* or sheriff. After the Conquest, under the name of county, the shire was administered by the sheriff and the county court; but these gradually gave way to the rising power of the magistrates in quarter sessions, who by the 18th century were the real rulers of the county. It also became the constituency for the election of knights of the shire, or county members of parliament.

In 1888 the Local Government act established county councils to take over the administrative duties of the magistrates and other functions. These councils consist of a number of county councilors (usually between 50 and 100) elected by universal adult suffrage, together with one-third of that number of aldermen chosen by the councilors, and a chairman elected by the councilors and aldermen together. They are responsible, in accordance with acts of parliament and under the supervision of central government departments, for a wide range of administrative duties, including education; services for children and old people; town and country planning; health services; maintenance of some roads; and fire brigades. The standing joint committees which administer county police forces are composed half of members of the county councils and half of county magistrates. Other services (*e.g.*, sanitation and housing) are provided by the councils of the county districts (urban and rural districts and municipal boroughs).

Apart from the county council and its officers, the chief officials of the county are the lord lieutenant and the sheriff (*q.v.*), but in both cases their functions had become by the 19th century greatly, though not entirely, ceremonial and social.

The county is also of importance as the unit for the territorial army, for sports (particularly cricket) and for the quarter sessions.

Every part of England and Wales is within a county, but for administrative purposes many of the larger towns form county boroughs and are excluded, providing their own local government services. Also, some of the counties are divided into two or three units (*e.g.*, the North, East and West Ridings of Yorkshire; East and West Suffolk); and so, while there are 52 geographical counties, there are 62 administrative counties (including the county of London) and 83 county boroughs. There are also some towns (*e.g.*, Norwich, Gloucester and Nottingham) which have been granted the status of counties in themselves and are known as counties corporate. This makes little difference in practice, and they do not necessarily have the status of county borough.

Scotland is similarly divided into 33 counties, with county councils generally resembling those of England except that they include members appointed by and from the councils of burghs within their area. County councils are also found in Northern Ireland and in the Republic of Ireland, where an adaptation of the U.S. system of council-manager government has replaced the English model.

Outside the British Isles the system of county government was adopted with variations in most of the countries settled from

Britain, including (besides the United States) Canada, New Zealand, Australia, Natal and Trinidad; in 1955 an experimental county council was established in Tanganyika. In Canada the system never became universal; where they exist, the county councils are generally much smaller than in England. New Zealand has had county councils since 1876, and by a process of subdivision the number had increased to 126 by the late 1950s. In Australia the administrative unit is generally called the shire, though the name county is used for larger areas.

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COUNTY AGENT. As commonly used in the United States and in some other countries, the title "county agent" refers to the county agricultural representative of the agricultural extension service. In some states, this representative is known as the farm adviser or county extension director, while the title agricultural adviser is more widely used in Europe and Asia.

In countries where it is organized, the agricultural extension service is a government-supported educational service for farmers and their families. Its purpose is to keep farmers informed on the latest research-proved farming methods so that the level of agricultural production and farm family living can be improved through the adoption of these methods.

The extension service in the United States is called the cooperative extension service in agriculture and home economics, since the program is co-operatively financed and administered by the U.S. department of agriculture and the land-grant agricultural college in each state. Local funds for supporting extension work in the counties come from county tax funds or grants from farm organizations. This means that the county agent is jointly employed by the U.S. department of agriculture and the state agricultural extension service of the land-grant college in his state.

In most other countries, the extension service is administered directly by the ministry of agriculture at the national level through a system of state or provincial offices. Major religious groups contribute funds for support of the extension service in the Netherlands, while major farm organizations give similar support in the Scandinavian countries.

Regardless of the particular administrative framework of the agricultural extension service, the job of the county agent or agricultural adviser is similar in all countries. That job is to keep the farmers in his district informed about new and improved farming methods. The county agent is probably the most important local source of agricultural information. His sources of information, in turn, are the national and state agricultural experiment stations as well as private agricultural research organizations.

Nearly all county agents are graduates of an agricultural college and have had a number of years of practical experience before being employed as agents. For the most part, they have a general background in agriculture rather than a specialized background. It is not uncommon, however, for assistant county agents to be employed as specialists in a particular field. This is more usual in Europe than in the United States.

The county agent makes use of nearly all means of communication in getting current information to the farmers in his county. County meetings, tours and demonstrations are most common. In addition, the county agent prepares articles for local newspapers, appears on local radio and television programs and prepares special exhibits and displays. *See* also AGRICULTURAL EDUCATION AND RESEARCH; AGRICULTURAL ORGANIZATIONS. (HY. RD.)

COUNTY CLERK, in the United States, the chief clerical official of the county in slightly more than half the states. The clerk usually is chosen by popular election for a term of two or four years. His primary duty is that of serving as secretary to the county board of supervisors or commissioners. In this capacity he prepares the agenda for board meetings; attends meetings and keeps minutes thereof; records ordinances, resolutions and other forms of board action; and is custodian of the board's records. Where there is no auditor or controller, the clerk commonly examines claims against the county; makes recommendation to the board concerning their payment or nonpayment; and when claims have been allowed, draws warrants upon the treasurer for their payment. In some states the county clerk serves also as clerk of one or more of the county's courts of record. Other duties assigned to his office in some states include supervision of elections; acting as registrar of voters; recording deeds and other legal documents; and issuing various licences, such as those for hunting and fishing, marriage licences and permits for the operation of commercial amusements outside municipalities. In some instances the clerk prepares the county budget and acts as county purchasing agent. As a result of his relation to the county board and the wide variety of his duties, the clerk's office tends to serve as a general clearinghouse for county business. Where his clerical and fiscal duties are most extensive, the clerk's position approaches, in some measure, that of a chief administrative officer in the county government. (C. F. S.)

COUNTY COURT. The most frequent use of the term county court in the United States is to designate county-wide courts of limited jurisdiction in contradistinction to courts of general, or unlimited, trial jurisdiction whose powers in the less populous areas extend to a group of counties. In this sense county courts exist in somewhat less than half the U.S. states. Actually the official legal designation is not in all cases "county court," but the territorial jurisdiction of such courts is generally coterminous with the county, and hence they are all referred to as county courts.

In some states they are courts of record; that is, they have a clerk and keep a regular docket and a systematic record of the disposition of cases.

The jurisdiction of these courts varies widely in the several states. In civil cases it ranges from a few dollars to approximately $2,000, and in criminal cases from misdemeanours to more serious offenses carrying a stipulated penalty. In some states they have no criminal jurisdiction. In some states county courts perform nonjudicial functions along with judicial functions, and in still other states they perform only nonjudicial functions. In Kentucky and Tennessee, for example, the county courts handle administrative as well as judicial functions; and in Arkansas their powers are entirely administrative and financial.

Later county-court systems set up in Virginia, Maryland, New Jersey and Missouri, and under consideration during the 1950s in several other states, were designed as a means of escaping the evils of the generally inexpert and incompetent justices of the peace courts. The first state to take this step was Virginia in 1934. There the justices of the peace courts were in effect abolished by eliminating their trial jurisdiction and establishing for each of the counties of the state a trial justice court with jurisdiction substantially broader than that formerly accorded the justices of the peace.

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England.—In England, a county court is a local court of civil jurisdiction. While the county court has ancient origins, dating from before the Norman Conquest, the institution of courts of assize under Henry II led gradually to its supersession, and the court in its modern form derives from the County Courts act 1846.

The main feature of the county courts is that they provide justice at a reasonable cost and with a comparatively simple procedure, administered by judges whose work brings them into close contact with ordinary people in the localities for which they are responsible. It was anomalous that there was until 1955 no appeal from them, unlike from judges in the high court, on questions of fact. Section 12 of the County Courts act, 1955, which has in substance been re-enacted in s. 109 and 110 of the County Courts act, 1959, authorizes appeals on questions of fact in broadly speaking, the more important cases.

The original limit of the jurisdiction of the new courts was £20; n 1850 this was extended to £50 in actions for debt, and in 1903 o £100.

The organization and jurisdiction of county courts are now gov- erned by the County Courts act, 1934, as amended by the Admin- stration of Justice act, 1938, and the County Court acts of 1955 nd 1959. The City of London court, though not strictly a county ourt, has the same jurisdiction (County Courts act, 1867, and . 185 of the act of 1888); it was amalgamated with the mayor's ourt by the Mayor's and City of London Court act, 1920. The ounty courts proper are organized into circuits, to which one or nore judges are allotted; circuits are divided into districts in each of which there is a court, with a registrar and bailiffs. The regis- rar is almost invariably a solicitor and hears the smaller cases as well as interlocutory matters and matters referred to him by the udge. The ordinary jurisdiction of the county court is (pecuniary imit of jurisdiction in parentheses): actions of contract or tort where debt demand or damage claimed does not exceed £200); ctions for recovery of land (where neither the value of the land nor the annual rent exceeds £100); actions in which the title to any hereditament comes in question (if the value of the land over which the easement is claimed or its annual value does not ex- eed £100); equity jurisdiction (£500); admiralty jurisdiction, except salvage (£300); salvage (£1,000); probate jurisdiction £200 personalty or £300 realty); interpleader transferred from igh court (£500); actions assigned to the queen's bench division of the high court, with written consent of both parties (unlimited); ounterclaims, unless plaintiff gives written notice of objection unlimited).

For a list of the acts on which this (not exhaustive) statement is ounded see the *Yearly County Courts Practice*. (W. T. Ws.)

COUP D'ÉTAT, a French phrase (literally translated as "blow" or "stroke of state") denoting a sudden action by which an individual or group, usually employing limited violence, cap- tures positions of governmental authority without conforming to the formal requirements for changing officeholders, as prescribed by the laws or constitution. Representative examples in French history include the overthrow of the Directory by Napoleon on Nov. 9, 1799 (18 Brumaire), and the dissolution of the assembly of the second republic by Louis Napoleon on Dec. 2, 1851. Broadly construed, the term not only describes Oliver Cromwell's forcible dissolution of the Long parliament (April 20, 1653) in England, but also applies to the Fascist march on Rome, led by Benito Mussolini, on Oct. 27, 1922; the Nazi political maneuvers of March 1933, engineered by Adolf Hitler in Germany; the ermination of the third republic of France by "constitutional mendment" and its replacement by the Vichy regime with Mar- hal Henri Philippe Pétain as head of state in July 1940; and he Communist elimination of centres of opposition in Czecho- lovakia (Feb. 1948). In a more restricted sense, a *coup d'état* nerely results in the abrupt replacement of leading governmental ersonnel; but, unlike a revolution, neither alters basic economic nd social policies nor significantly redistributes power among ompeting political groups. This occurrence (known in Spain as *golpe de estado*) is a regular one in Latin America, and accounted or the displacement of more than 30 presidents in South American nd Central American republics between 1945 and 1960.

(M. Kg.)

COUPER, ARCHIBALD SCOTT (1831–1892), Scottish hemist best known for his work in organic molecular structure, was orn at Kirkintilloch. He was a student at Glasgow and Paris, and ecame an assistant at Edinburgh. Through C. A. Wurtz, Couper ubmitted a paper to the French Academy entitled "On a New hemical Theory," which developed the quadrivalent character of the carbon atom and the ability of the carbon atom to unite with itself. Because Wurtz was not a member of the Academy, he presentation was delayed until June 14, 1858. Meanwhile, on March 16, 1858, the same revolutionary basic theory was presented by Kekulé von Stradonitz. Although Couper's paper was less biased by preconceived ideas and was the first to contain formulas which pictured molecular structural relationships by continuous or dotted lines, it was ignored. As Kekulé became famous, Couper's life, blighted by lack of recognition, became tragic. The board of lunacy of Scotland records two entrances and discharges from a mental institution. He lived in retirement, cared for by his mother, until his death March 11, 1892. A plaque placed on the house at Kirkintilloch commemorates his classic contribution.

(V. Bw.)

COUPERIN, the name of a French family that produced a succession of musicians from the early 17th to the mid-19th cen- tury and achieved its greatest fame through two composers of genius who were court musicians to Louis XIV.

Louis Couperin (*c.* 1626–1661), born at Chaumes in the prov- ince of Brie, was the first of the many Couperins to become or- ganist at the church of St. Gervais in Paris; he also played the viol and violin in the ballet music of the court. He was a brilliant harp- sichordist, and contemporary accounts suggest that his vigorous style of playing revealed the same qualities as his harpsichord compositions, which are distinguished by an almost aggressive use of dissonance and of baroque ornamentation. At the same time he had command of a sturdy contrapuntal technique recalling the French organ school of the 16th century. At times his tonal architecture, built on Italian models, and his *bel canto* melodies suggest Handel. It is significant that his finest compositions should be conceived in the transitional convention of the chaconne or passacaglia, for as a composer he is both reactionary and progressive. He died in Paris on Aug. 29, 1661.

François Couperin (1668–1733), Louis' nephew, known as "Le Grand," was born in Paris, Nov. 10, 1668. His father, Charles Couperin, who had succeeded Louis as organist at St. Gervais, died in 1679; François inherited the post, although he did not take it up until 1685 or early 1686 and was meanwhile educated in music by an uncle, also François Couperin (1631–1701), and by the famous organist Jacques Thomelin, who gave him a thorough grounding in counterpoint. Like his uncle Louis, François is re- membered mainly for his keyboard pieces, though the *Oiseau Lyre* edition of his works (1933) reveals that his chamber music and church music are also important. His first published works were two organ Masses, composed *c.* 1690, and long erroneously ascribed to his uncle François. In 1693 he succeeded Thomelin as one of the organists of the royal chapel and in 1694 was appointed to teach the royal children. He was ennobled in 1696 and from about 1701 performed the functions of director of music at the court, although not officially succeeding to the appointment until 1717. He kept his position as organist at St. Gervais until 1723 and his offices at court till 1730, being succeeded in both by other members of his family. He died in Paris, Sept. 12, 1733.

The personal voice beneath the traditionalism of Couperin's Masses becomes unmistakable in the succession of harpsichord pieces that he published, in four exquisitely engraved volumes, between 1713 and 1730.

Although the plan of Couperin's movements is conceived har- monically, his music marks a transitional stage between polyphony and homophony in that it usually includes a dialogue between treble and bass. Implied polyphony exists alongside the ripest development of tonal harmony, and Couperin is thus, among the late baroque composers, the nearest to Bach; this is evident in his fine trio sonatas (especially "L'Impériale" and "L'Apothéose de Corelli") and in many of the movements from the *Concerts Royaux* (*c.* 1714–15), which he composed for the king's Sunday evening entertainments. In his church music, as in his chamber music, Couperin achieves a fusion of the French and Italian styles, as illustrated in the early *Motet de Ste. Suzanne* (1698), which is at once voluptuous in its brilliant Italian cantilena and virginal in its harmony, rhythms and textures.

Couperin's last and greatest liturgical work, the *Leçons des Ténèbres* (1715), brings to the linear subtlety of the French vocal style and the pathos of Italian harmony a quality of ecstatic mysticism that has no parallel in French or Italian music of the period. Bach's well-attested admiration for Couperin was not fortuitous.

Couperin also wrote an important, if somewhat ambiguous and obscure, theoretical work, *L'art de toucher le clavecin* (1717).

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François Couperin and the French Classical Tradition (1950); P. Citron, *Couperin* (1956). (W. H. M.)

COUPERUS, LOUIS MARIE ANNE (1863–1923), one of the most famous of modern Dutch novelists. Of aristocratic family, he was born on June 10, 1863, at The Hague, to which he returned after living for a time in the Netherlands East Indies. After failing as a poet, he became known in 1889 through his naturalistic novel *Eline Vere* (Eng. trans., 1892). This was followed by *Noodlot* (1891; Eng. trans., *The Footsteps of Fate*, 1891) and *Extase* (1892). Two Balkan romances—*Majesteit* (1893; Eng. trans., 1894) and *Wereldvrede* (1895)—were less successful but were praised for their evocation of atmosphere. The fairy tale *Psyche* (1898; Eng. trans., 1908) showed a new aspect of his talent, but with *De stille kracht* (1900; Eng. trans., *The Hidden Force*, 1922) he returned to realism.

Meanwhile Couperus had settled in Italy where he wrote his masterpieces—*De boeken der kleine zielen* (1901–03; Eng. trans., *The Small Souls*, 1914) and *Van oude menschen de dingen die voorbijgaan* (1906; Eng. trans., *Old People and the Things that Pass*, 1919)—describing life as he knew it in the decadent society of The Hague. His surroundings inspired him also to write a group of historical novels conveying the combined joy in living and flourishing decadence of the ancient world. These included *De berg van licht* (1905) and *Antiek Toerisme* (1911; Eng. trans., *The Tour*, 1920). During World War I he returned to The Hague and later traveled through Africa and eastern Asia, describing his journeys in a series of impressionistic newspaper sketches. His later work included, as well as many short stories, the great novels *Xerxes* (1919; Eng. trans., *Arrogance*, 1930) and *Iskander* (1920), about Alexander the Great. He died at Arnhem, July 16, 1923.

Couperus had a refined and delicate pleasure in life, but his ideas and his writings were dominated by a pessimistic determinism. His fame is based on his great narrative gifts and his precise and convincing delineation of character.

See H. van Booven, *Leven en Werken van Louis Couperus* (1933). (Gd. W. Hs.)

COUPLET, a pair of lines of verse, which are welded together by rhyme. In rhymed verse two lines which complete a meaning in themselves are particularly known as a couplet. Thus, in Pope's *Eloisa to Abelard:*

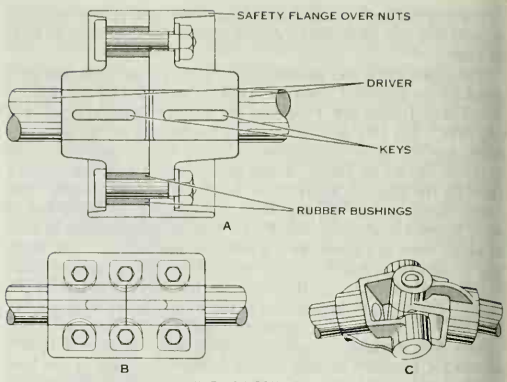
> Then share thy pain, allow that sad relief;
> Ah, more than share it, give me all thy grief.

In French literature the term *couplet* is not confined to a pair of lines, but is commonly used for a stanza. A "square" couplet in French, for instance, is a strophe of eight lines, each composed of eight syllables. In this sense it is employed to distinguish the more emphatic parts of a species of verse which is essentially gay, graceful and frivolous, such as the songs in a vaudeville (*q.v.*) or a comic opera. In the 18th century Le Sage, Piron and even Voltaire did not hesitate to engage their talents on the production of couplets, which were often witty, if they had no other merit, and were well-fitted to catch the popular ear. This signification of the word *couplet* is not unknown in England, but it is not customary; it is probably used in a stricter and a more technical sense to describe a pair of rhymed lines, whether serious or merry. The normal type, as it may almost be called, of English versification is the metre of ten-syllabled rhymed lines designated as a heroic couplet. This form of iambic verse, with five beats to each line, is believed to have been invented by Chaucer, who employs it first in *The Prologue to the Legend of Good Women,* the composition of which is attributed to about the year 1386. That poem ends with the couplet:

> And therefore may I seyn, as thynketh me,
> This song in preysing of this lady fre.

This is an absolutely correct example of the heroic couplet, which ultimately reached majesty in the works of Dryden and brilliancy in those of Pope.

COUPLING. When lengths of shafting are to be joined up, in factories or ships, couplings are employed, as they are also to connect a prime mover to a machine. Usually the coupling



TYPES OF COUPLINGS

(A) Flange flexible coupling, which is keyed onto each shaft; (B) split muff coupling, with key and clamping bolts; (C) universal joint coupling, providing free horizontal and vertical movement

connection is permanent; if frequent disconnections are required, a clutch (*q.v.*) has preference. Flange couplings are the most often used, the end of the shaft being forged into a flange, or a flange being keyed on and united to a companion one by bolts. Split muff couplings fit over each end of the shaft and are contracted by bolts, while the split compression type is also quick to apply and remove, being tightened by three bolts. These draw hoods together over the tapered exterior of a split sleeve, causing the latter to grip the shaft ends and drive without need for keys. When one shaft has to assume various angular relations, a universal joint coupling is preferred, having two pivots located at right angles, and connected either through a steel member or a composition plate (*see* Automobile). Huge universal couplings of a rather elaborate kind are needed in rolling-mill drives, to compensate for the varying heights of the rolls.

Flexible couplings on shafts are extensively utilized. They protect engines, electric motors or machines against the shocks due to variations in the driving power or in the loads; and their flexibility also allows for slight irregularities in the alignments of shafts. A favourite class is the flange coupling mentioned above, but with leather or rubber bushings surrounding the bolts in one flange, and sometimes with soft washers interposed between the faces of the flanges. Another kind has rims with interlocking lugs; these do not touch, but the drive is transmitted by rubber blocks, or a long leather belt is interwoven between the lugs so as to take the drive flexibly without any metal-to-metal contact occurring. These also electrically insulate the motor from the machine which is coupled to it. Steel springs in some instances perform a like service. A coupling is employed to join up the ends of hose, being either a screw type with nut turned by a spanner, or a hand instantaneous grip, for fire hose or the brake hose of trains. The railway carriage and wagon coupling is either of hand-tightened screw type, or automatic in action.

COURANTE (Latin *currere,* "to run"), a running dance in 3/4 time attributed to 16th-century Italy. The musical corrente consisted chiefly of running passages of eighth notes.

The court courante originated in 17th-century France. Much in vogue for almost two centuries as a slow, grave dance, it contained, despite its nobility, some gliding and springing steps. The music was in moderate 3/2 time with occasional measures in 6/4 for rhythmic interest. Composers used both types in the suite, where it followed the allemande (*q.v.*), with which it contrasted in rhythm and tempo. (L. Hr.)

COURANTYNE (Dutch Corantijn), a river which flows between Surinam and British Guiana, South America. The boundary runs along the British bank and British nationals have free navigation but no fishing rights. The Courantyne rises in the Acarahy mountains and flows 475 mi. to the Atlantic near Nickerie. Its upper course, called the Coeroeni, is a lesser stream than the

New river which joins it. Large vessels may ascend 60 mi. to the first rapids at Orealla, and there is boat navigation above, but the whole basin is undeveloped and largely unexplored forest with some savanna near the headwaters. (G. LN.)

COURBET, GUSTAVE (1819–1877), French painter and leader of the 19th-century Realist movement, was born on June 10, 1819, at Ornans (Franche-Comté) where his father was a prosperous farmer. In 1841 he went to Paris to study painting, nominally at various teaching studios, but more effectively by study in the Louvre of the works of Rembrandt, Hals, Velázquez and others. Some of his first paintings, especially self-portraits, are romantic in flavour, but after the mid-1840s he was painting landscapes and naturalistic figures notable for their sense of weight and tangibility. He visited Holland in 1847, which no doubt fortified him in his intention of painting, aggressively and on a large scale, subjects which to the academic eye would appear commonplace, vulgar and even subversive.

After exhibiting the huge "Burial at Ornans" (now in the Louvre) at the Salon of 1850, he became the acknowledged leader of the Realist movement, being supported by the critics J. Champfleury (for a few years) and Charles Baudelaire. He also received patronage from the comte de Morny, who in 1852 bought his "Village Girls" (Metropolitan Museum of Art, New York city). For the Exposition Universelle of 1855 he prepared "The Artist's Studio," described as a realist allegory, in which figures and objects pertaining to his own career and beliefs are solidly bodied forth. When this and the "Burial at Ornans" were refused by the jury, Courbet set up his own Pavilion of Realism containing 40 of his paintings near the exhibition palace.

He now became the rallying point of a new generation, and in the ensuing decade he was to exert a powerful influence on the work of Manet, Monet, Renoir, Camille Pissarro and Cézanne. Through his short-lived tutelage of Whistler, Courbet's influence spread even to Great Britain where, however, pure academism had already been abandoned. Courbet's other important works of 1850–60 include the "Portrait of P. J. Proudhon" (1853; Petit Palais, Paris); "The Meeting" or "Bonjour, M. Courbet" (1854; Musée Fabre, Montpellier); and the "Girls on the Bank of the Seine" (1856; Petit Palais). There are also some powerful marines and a group of rocky landscapes constructed with a grave and massive architectural sense.

After 1860 his subject matter became less doctrinaire and more sensuous and relaxed. He painted many portraits as well as flower and fruit pieces in which deep and glowing colours supersede the earthy tones of his early works. His studies of calm and raging seas are a contribution to the sea images of the romantic artists, poets and musicians of this period, while his strange groups of female nudes such as "Sleep" (1866; Petit Palais) are both sensuous and profound. By now he had overcome official opposition and was a regular Salon exhibitor. In 1871, as a dedicated Socialist, Courbet found himself an official of the Commune, and was charged with the demolition of the column in the Place Vendôme. After six months in prison he was forced by the threat of a huge fine to leave for Switzerland where, though despondent and in failing health, he continued to paint until his death at La Tour du Peilz on Dec. 31, 1877.

COURTESY OF THE METROPOLITAN MUSEUM OF ART, GIFT OF HARRY PAYNE BINGHAM, 1940

"VILLAGE GIRLS" BY GUSTAVE COURBET; *c.* 1852. IN THE METROPOLITAN MUSEUM OF ART, NEW YORK CITY

See G. Riat, *Gustave Courbet, peintre* (1906); G. Boas, *Courbet and the Naturalistic Movement* (1938); Gerstle Mack, *Courbet* (1952). (D. C. T. T.)

COURBEVOIE, an industrial suburb of Paris in the Seine *département*, is situated in the Gennevilliers loop of the Seine 9 km. (5½ mi.) N.W. of Notre Dame cathedral. Pop. (1954) 58,699. The Avenue du Général de Gaulle, the chief feature of the suburb, is a continuation of the Champs Elysées. Courbevoie manufactures dyes, biscuits, gauze and cars, and fruit preserving and laundering are carried on. Formerly the garrison of the Swiss guards (the barracks were built by Axel Guillaumot in 1756–65), it was occupied during World War II by the Germans on June 14, 1940. Damaged in air raids in 1943–44, it was liberated on Aug. 25, 1944. (H. DE S.-R.)

COURCHEVEL, a town of southeastern France, *département* of Savoie, is situated high on the south side of the Isère valley, about 70 km. (44 mi.) S.S.E. of Chambéry. The permanent population (1954) was 170. Courchevel is a rapidly developing winter resort, divided into five settlements at different heights: St. Bon 3,600 ft., Le Praz 4,260 ft., Courchevel (lower) 5,100 ft., Moriond 5,400 ft. and Courchevel (upper) 6,100 ft. There are several types of mechanical lifts for skiers. A motor road reaches Courchevel, and the railway station of Moutiers Salins is 25 km. (15½ mi.) away.

COURCI, JOHN DE (d. 1219), Anglo-Norman conqueror of Ulster, was a member of a celebrated Norman family of Oxfordshire and Somerset. Sent to Ireland with William FitzAldelm by Henry II in 1176, he immediately led an expedition from Dublin to Ulster and in 1177 seized its capital, Down (now Downpatrick). He subsequently gained effective control of eastern Ulster and his firm rule there was responsible for the early prosperity of the area.

John de Courci had a perennial feud with the de Lacys, another Anglo-Norman family adventuring in Ireland, and the younger Hugh de Lacy took and held him prisoner for a short while in 1204. De Courci, perhaps by a refusal of homage, had angered King John, who in May 1205 granted Ulster to Hugh with the title of earl. De Courci, with his brother-in-law, Reginald, king of Man, laid siege to the castle of Rath (possibly Dundrum) but was routed by Hugh's elder brother, Walter de Lacy, lord of Meath. He disappeared until 1207, when he received permission to return to England. He accompanied King John to Ireland in 1210 and seems thereafter to have retained his favour. He died probably in Sept. 1219.

Both John de Courci and his wife Affreca were benefactors of the church and founded monasteries in Ulster. John replaced the secular canons of Down priory with Benedictine monks from St. Werburgh's abbey, Chester.

See G. H. Orpen, *Ireland Under the Normans*, vol. ii (1911). (A. Gw.)

COURIER, PAUL LOUIS (1772–1825), French Hellenist and political satirist who opposed the centralization of power under the restored Bourbon monarchy, was born in Paris, Jan. 4, 1772. He was brought up on the family estates in Touraine and early acquired a love for the classics. Courier was destined for a military career and in 1784 was sent to Paris to study mathematics and science, but he continued to devote his leisure to Greek. He entered the army in 1793 and was posted to the army of the Rhine, but his determined disrespect for authority made him an indifferent soldier and, after failing to appear at his post at Wagram (1809), he left for Italy without leave. He subsequently resigned his commission and remained in Italy until 1812.

While serving in the Italian campaigns (1798–99 and 1806–07) he had pursued his classical studies in Italian libraries and had published *Éloge d'Hélène* (1803), a free imitation of Isocrates, and

an edition and translation of Xenophon's treatises on the command of cavalry and horsemanship (1807). In 1809 he discovered a manuscript of Longus' pastoral *Daphnis et Chloé*, containing a passage previously unedited, in the Laurentian library at Florence and published an edition and translation into a French full of archaic idiosyncracies in 1810. Its value was later the subject of controversy, because an ink blot he had made on the manuscript obscured part of the passage and made his version unverifiable.

After his return to France, Courier settled on his estate at Véretz (Indre-et-Loire), with frequent visits to Paris. His earlier *Lettres de France et d'Italie* (1787–1812) had revealed a keen sense of irony, fixed opposition to the empire and an original and lively style. He then developed these in a series of political pamphlets, beginning with the *Pétition aux deux chambres* (1816). In this he made local resentment at the tyrannies of the restored bureaucracy in Touraine the occasion for a vigorous attack on the Bourbon monarchy, typically invoking political principle in a personal cause. His *Simple Discours de Paul Louis . . .* (1821), a powerful plea against the proposal to purchase the estate of Chambord for the duke of Bordeaux, is in the same vein. It led to a brief imprisonment; his subsequent account of his trial achieved great success. A series of letters to the *Censeur Européen* (1819–20) advocated a liberal monarchy; Courier's conception of liberalism was based on a strong sense of individual prerogative. Other pamphlets included *Livret de Paul Louis* and *Gazette du village* (both printed anonymously in Brussels, 1823) and *Pamphlet des Pamphlets* (1824). Courier was found shot in the forest of Larçay near his home on April 10, 1825, and the murder, long unsolved, was eventually brought home to his own servants.

Courier is chiefly valued for the trenchancy with which he expressed a typical Gallic attitude to political affairs, for the brilliance of his satire and for his polished, incisive style, erudite but never obscure.

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COURLAND (Latvian KURZEME), the land of the people known to medieval chroniclers as Curi or Cori (in Latvian: Kursi); namely, the southwestern part of Latvia, to the south of the river Daugava (Duna, Dvina), on the west extending over the main part of Latvia's seashore on the Baltic. The Curi are first mentioned in Rimbert's *Vita S. Anskarii* (*c.* 875). At that time they already possessed a comparatively large territory with several organized subdivisions and a royal capital and had withstood Swedish expansion (early in the 7th century). Later they launched their own raids, menacing the Danish and Swedish shores (according to Nordic sagas). If forced at times to accept Swedish sovereignty, they shook it off. Adam of Bremen (writing *c.* 1075) describes them as rich, powerful, merciless, and possessing some important religious centres. Saxo Grammaticus (*c.* 1150–*c.* 1220) tells stories about several of their kings, and Henricus de Lettis (early 13th century) gives a colourful description of the fierce attack of the Curish fleet on the newly built town of Riga. In the 13th century, however, German crusaders subjugated the country. The last Curish king, Lammekinus, sought to elude direct pressure from the Knights of the Sword, otherwise known as the Livonian Order, by submission to the papal legate Baldwin of Aulnes in 1230.

Another warlike Latvian tribe was that of the Zemgali or Semigallians (called Simkala in a runic inscription of about 1040), who inhabited the fertile valley of the Lielupe river (the Kurländische Aa). Contemporary chronicles describe how they struggled for three generations to free themselves from the Order, but information about their earlier history is scant. Two facts, however, must be stressed. First, the Hypatian (Ipatiev) chronicle describes the heavy defeat suffered by the princes of Polotsk at the hands of Semigallians in 1106. Secondly, Henricus de Lettis relates how the western invaders had to beg Pope Innocent III to excommunicate those who traded with the Semigallians by the way of Portus Semigallorum (on the estuary of the Lielupe). Thus on the one hand the Semigallian state was strong enough to stop Russian penetration, while on the other its Baltic trade jeopardized certain ambitions of the newcomers from the west.

On the dissolution of the Livonian Order (1561), its last master, Gotthard Kettler, preserved the independence of Courland as a duchy under the formal suzerainty of Poland (1562), which ended with the third partition of Poland in 1795. The conditions under which the Latvian peasantry lived were rather hard, but the existing social order was vital enough to achieve extraordinary progress under Gotthard's grandson Jacob, the ablest of all the Curish dukes (sole ruler 1642–82). Jacob developed local industry, fostered foreign trade and created not only a sizable merchant fleet but also a navy of warships. He moreover acquired two colonies: the island of Tobago in the West Indies (1645) and Gambia, at the mouth of the Gambia river, on the West African coast (1651). Development was cut short, however, by the Swedish-Polish war of 1655–60, during which Jelgava (Mitau), the capital of the duchy, was stormed and pillaged by the Swedish army. The duke himself was made captive, but he returned to Courland and resumed his reign after the peace of Oliva.

Trouble came with the dynasty of the Birons (1737–95). Ernst Johann Biron (*q.v.*), who was elected duke on the extinction of the Kettlers in 1737, exercised great power in the Russian empire till court intrigues caused his downfall and long exile (1741–63), during which the duchy was governed by the ducal council and from 1758 by Charles of Saxony, a younger son of Augustus III of Poland. Restored to the duchy in 1763, Biron abdicated in 1769. His son Peter (d. 1800), the last reigning duke, founded the Academia Petrina in Jelgava (1775) but was dispossessed at the partition of Poland in 1795.

The Russian domination brought at first little change, as Catherine the Great strove to secure her rule over this frontier province (*gubernya*) and showered favours on its ruling class. Moreover, though the peasantry's situation was anything but splendid, Courland in the 16th and 17th centuries had already become known as a cultural centre, with such eminent writers as G. Mancelius, C. Furecker (Fuereccerus) and others. Similarly in the 19th century it was the cradle of the Latvian literary language and the homeland of Krisjanis Valdemars, promoter of the Latvian revival, and of many other Latvian political and cultural figures.

With the proclamation of Latvian independence in 1918, Courland became part of the new state; for subsequent developments *see* LATVIA.

See works cited under LATVIA; also A. V. Berkis, *The Reign of Duke James* [*i.e.*, Jacob] *in Courland 1638–1682* (Vaidava, Lincoln, Neb., 1960). (A. SP.)

COURNAND, ANDRÉ FRÉDÉRIC (1895–), French-U.S. physician and physiologist, co-winner of the Nobel prize in medicine in 1956, together with Dickinson W. Richards and Werner Forssmann, for work that opened a new era in heart research. Cournand was born in Paris, France, Sept. 24, 1895, and received his M.D. degree from the University of Paris in 1930. In the same year he settled in New York city to seek further training at Bellevue hospital in diseases of the chest. There he met Richards, with whom he collaborated for the next 25 years in studies of diseases of the lungs and heart. It was necessary for them to develop new techniques in order to increase the precision of their measurements of lung and heart function. They learned of Forssmann's experiment in which he passed a tube through a vein into his own heart and adapted this direct approach to measure the amount of blood the heart pumped and the pressures under which it performed. As a result of their perfection of this technique, now termed cardiac catheterization, it became possible to study the conditions under which the human heart laboured in disease and to make more accurate diagnoses of the underlying anatomic defects. Cournand became a member of the Columbia university college of physicians and surgeons in 1934 and held the rank of professor after 1951. He became a naturalized citizen of the U.S. in 1941. (R. M. HY.)

COURNOT, ANTOINE AUGUSTIN (1801–1877), French economist and mathematician, was a pioneer in mathematical economics. He held teaching and administrative posts at several academies and universities and was French inspector general of studies. Cournot was the first economist who, with a competent knowledge of both subjects, endeavoured to apply mathematics to the treatment of economic questions. His *Researches Into the Mathematical Principles of the Theory of Wealth* (Eng. trans. by N. T. Bacon, with a bibliography of mathematics of economics by Irving Fisher, 1897) was published in 1838. The foundations of the mathematical treatment of economic questions laid by Cournot provided the essential basis of much of the work of later economists. He was concerned primarily with an analysis of partial market equilibrium based on the assumption that participants in the process of exchange are either producers or merchants whose end is the maximization of money profit. He therefore ignored the concept of utility. His most important contributions were his discussions of supply and demand functions and of the establishment of equilibrium under conditions of monopoly, duopoly and perfect competition; his analysis of the shifting of taxes, which he treated as changes in the cost of production; and his discussion of problems of international trade.

Although his chief contributions were in the field of mathematical economics, he was a fruitful philosopher. In this latter field he was pre-eminently a protagonist of the theory of chance occurrences.

See Irving Fisher, "Cournot and Mathematical Economics," *Quarterly Journal of Economics,* vol. xii, pp. 119–138 (1897–98).

COURSING, the pursuit of game by hounds hunting by sight and not by scent, was fully described about A.D. 150 by the Greek philosopher and historian, Arrian, in his *Cynegeticus* (trans. by W. Dansey, 1831). Dogs bearing a strong resemblance to the modern greyhound are shown in carvings, paintings and inscriptions found in the tombs of the early Egyptian kings, and excavations in Mesopotamia date domesticated greyhounds prior to 5000 B.C. The New York Metropolitan Museum of Art has a wall painting from an ancient Egyptian tomb showing greyhounds hunting gazelles. The greyhound was bred by the Egyptian kings to hunt the wild are also, much like the coursing of the same breed of dogs with ares in Great Britain, the United States, Australia and in other arts of the world. Coursing is known as one of the most ancient f British sports, purportedly introduced into Britain by the hoenicians during early trading voyages or by the Cretans about 00 B.C.

The sport became very popular in England, Ireland and Scotland uring the reign of Queen Elizabeth I (1533–1603), and in this eriod the first known set of rules was drawn up by the duke of orfolk. The "laws of the leash," as they were called, laid own the principles upon which the sport has since been based, nd established coursing as a series of competitions between two eyhounds at a time pursuing one hare. The dogs are judged on erformance, as well as on their success in catching the hare; oints are awarded for outracing the other dog and catching up ith the hare, for turning it at a right angle, for wrenching (turng it at less than a right angle), for tripping the hare and for kill.

The first known coursing club came into existence in 1776 at waffham, through the enterprise of Lord Orford. Progress of the ort led to the creation of the National Coursing club in 1858, it by that time the Waterloo cup, the Derby of coursing, had en well established. It started in 1836 and is held annually Altcar, the estate of the Earl of Sefton, near Liverpool. It as named for the Waterloo hotel in Liverpool, where the first omoters met. Originally there were only 8 entries, since doubled 16, then 32, and finally 64. The *Greyhound Stud-Book* was stituted by the National Coursing club in 1882. (A separate ud book was established by the Irish Coursing club in 1923.)

Coursing was taken to the United States early in the 19th century and led to organization of the American Coursing board, which overned the sport from 1886 to 1906, when the National Coursing sociation (N.C.A.) came into being. Spring and fall coursing eetings are held by the association in Abilene, Kan. The American Field cup was established in 1886, followed by the Columbus cup in 1893, and the National Waterloo cup in 1895, named for its British counterpart and still contested annually.

The N.C.A.'s *Greyhound Stud Book,* established in 1906, also is the stud book for the sport of greyhound racing with a mechanical lure, the outgrowth of coursing. *See* also Dog Racing.

See H. Edwards Clarke, *The Modern Greyhound* (1947); E. C. Ash, *The Book of the Greyhound* (1954). (G. C. Mo.)

COURT, ANTOINE (1695–1760), minister of the French Reformed Church who restored Protestantism in his country after its proscription by the revocation of the Edict of Nantes (1685), was born in the province of Vivarais. By 1700 the Huguenots were disorganized, their ministers were exiled or dead and the revolt of the Camisards and the persecution of the Dragonnades had turned the leaderless Protestants to religious fanaticism. In many places Protestants turned despairingly to attending Mass, though afterward praying together secretly. The young Court determined that disorder, religious fanaticism and apostasy must be rooted out. He traveled in Languedoc and Vivarais preaching order and restraint. His purposes were to instruct people through religious assemblies, to combat fanaticism by introducing healthier religious ideas, to re-establish the consistorial discipline of the Reformed Church and to train young ministers. He began with a small gathering at Monoblet, Gard, in Aug. 1715—the first provincial synod of the Reformed Church of France since 1685. The synod decided that wherever congregations were re-established elders should be elected to oversee them, to assist ministers by finding safe refuges and guides and to collect money for the poor and prisoners. Also the synod decreed that women must not preach, that Scripture must be the only rule of faith and that aid was to be forbidden to those who rushed blindly into danger; these rules clearly rejected fanaticism. Court was ordained in Nov. 1718 by his coadjutor Pierre Corteiz, himself ordained the previous year in Switzerland. Other synods followed, and after 1724 their increasing activity brought determined persecution. Court steadfastly refused to rebel and withdrew several times to Switzerland, where eventually he settled at Lausanne, acting, until his death there on June 12, 1760, as director of a seminary for training ministers for the "Church of the Desert," the Reformed Church in France. He wrote *Histoire des troubles des Cevennes ou de la guerre des Camisards* (1760) and left a large correspondence and other materials in manuscript, preserved in the public library at Geneva.

See E. Hugues, *Memoires d'Antoine Court* (1885); E. and E. Haag, *La France Protestante,* vol. iv (1884). (B. H.)

COURT originally denoted an enclosed place and is still used in this architectural sense. It is aptly used as a term for judicial tribunals, which originally were enclosures within which sat the judges and their officials, while counsel, attorneys and the general public stood outside the bar of the court. In England the expression "called to the bar" is applied to barristers upon qualifying to practice. Similarly, senior barristers or queen's counsel are permitted to come "within the bar of the court." At first these enclosures were temporary structures in the open field; later, fixtures in a large room or hall.

In Europe, in the early middle ages, before the separation of judicial from legislative and administrative functions, the king and his chief councilors sat in his palace for the exercise of all these functions, and so the household of the king was also called "the court." Since all judicial authority was derived from the king, his presence was assumed in all the specialized courts, each of which was regarded as the *curia regis* ("king's court") itself.

Under the influence of feudalism, some institutions, originally public or royal, fell into private hands and finally became the property of a lay or ecclesiastical magnate who would preside, in person or by deputy. The owner was not, however, a judge: he conducted the proceedings and announced the result, but the court of suitors (*i.e.,* certain landowners who, because of their holdings, owed "suit of court" and were obliged to act as its judges) itself decided by what ordeal the case should be tried. When appellate proceedings ensued, it was sometimes difficult to say who had been responsible for a "false judgment," the court

and its suitors or the presiding officer, who might be a local official, a sheriff, count or margrave, or the owner of a seigniorial court. (*See* COURT BARON; COURT LEET.)

From the 12th century onward the increasing number of university-trained civilians and canonists created a recognized legal profession, and it became the rule for bishops and others to commit their judicial powers to their "officials" and to appoint "delegates" to review their decisions. The English kings appointed professional "justices," and the church's highest central court, the rota, was formed of professional lawyers. Many Italian cities conveniently accessible to university graduates in law took the opportunity to use these professionals to man their own courts and even incorporated them as a "college of justice." This term was employed when a somewhat similar court was set up in Scotland in 1532. The rise of the legal profession also determined the gradual separation of judicial from administrative functions. Thus, in England, many of the considerable powers of the justices of the peace in quarter sessions were transferred to the new county councils as late as 1888, by which time it had become an anomaly for an essentially judicial institution to levy tax rates, for example.

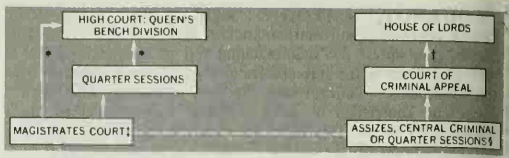
ENGLAND

England's oldest courts, those of manors, hundreds, counties and even the house of lords, seem to have consisted of suitors who in the course of time were replaced by their clerks (1846 in the new county courts; 1876 by professional judges added to the house of lords). The history of courts in England is one of steadily growing specialization, sometimes along lines of subject matter, sometimes of procedure. It might be too much to say that all the modern courts sitting in England may be traced back to a common origin, but the higher courts are all offshoots from the *curia regis*. (*See* COMMON PLEAS, COURT OF; EQUITY; EXCHEQUER; HIGH COMMISSION, COURT OF; PRIVY COUNCIL, JUDICIAL COMMITTEE OF; QUEEN'S BENCH, COURT OF; STAR CHAMBER.)

The courts exercising jurisdiction in England are divided by certain features which may be briefly indicated. A distinction may be made first between superior and inferior courts. Superior courts are the court of appeal and the high court of justice (comprising the chancery division, the queen's bench division and the probate, divorce and admiralty division), in which must be included the courts presided over by the itinerant commissioners of assize who are usually judges of the high court, specially commissioned for each assize (*q.v.*). There are also the court of criminal appeal, the courts-martial appeal court and the central criminal court. The inferior courts are the local or district courts; namely, county courts and magistrates' courts (*see* below). Superior courts are also known as courts of record because their proceedings are enrolled and definitive.

Secondly, courts may be distinguished as civil or criminal (*see* below). A third distinction is to be made between courts of first instance and courts of appeal. In the former the first hearing in any judicial proceeding takes place; in the latter, judgment of the first court is brought under review. Of the superior courts, the high court of justice, except as mentioned below, is a court of first instance. Over it is the court of appeal, and over that again the house of lords. The queen's bench division of the high court of justice also exercises powers of reviewing the decisions of the vast variety of statutory tribunals which make decisions affecting the rights of the subject. This is done by orders of prohibition, which restrain these tribunals from acting, orders of mandamus, which order these tribunals to act, and certiorari, which bring up the decisions of such tribunals and quash them in proper cases. The divisional court is also concerned with appeals from magistrates' courts. It will be convenient to take the division into criminal and civil courts and to outline the principal tribunals in each category.

Criminal Courts.—*Magistrates' Courts* are courts of summary jurisdiction, presided over by justices of the peace or, in London and a few of the larger towns, by legally qualified stipendiary magistrates. These courts deal with all criminal offenses except those which warrant serious punishment. An appeal lies from



*Appeal only on a point of law
†Appeal only on attorney general's certificate of a point of law of public importance
‡Summary trial, no jury
§Trial by jury on indictment after committal for trial by magistrate's court

FIG. 1.—FLOW OF CRIMINAL CASES IN ENGLISH COURTS

the decision of magistrates' courts by way of rehearing to quarter sessions or by way of case stated on a point of law to the divisional court of the queen's bench division. (*See* MAGISTRATES' COURTS.)

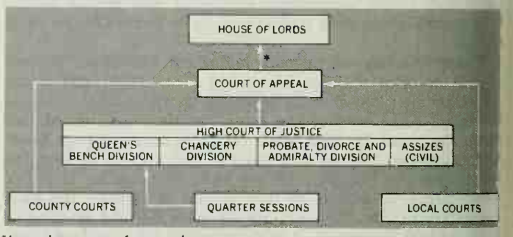
Courts of Quarter Sessions.—Apart from the appellate jurisdiction referred to above, quarter sessions have an original jurisdiction in most serious offenses and trial is by jury. The court is presided over by justices of the peace, whose chairman in effect exercises the powers of a judge and is usually legally qualified. For the purpose of the appellate jurisdiction of the court, the justices sit as an appeals committee. (*See* QUARTER SESSIONS, COURT OF.)

Courts of Assize.—Some of the most serious offenses, such as murder, can be tried only by the commissioners of assize. Trial before the assize courts is by judge and jury. The court of assize for London is the central criminal court, held at the Old Bailey.

Court of Criminal Appeal.—There is an appeal from courts of assize and courts of quarter sessions to the court of criminal appeal (*see* CRIMINAL APPEAL, COURT OF).

House of Lords.—On important points of law there is a further appeal from the court of criminal appeal to the house of lords, and also, under the Administration of Justice act, 1960, from any decision of a divisional court of the queen's bench division in a criminal cause or matter.

Civil Courts.—*Magistrates' Courts* have civil jurisdiction in a very few cases of small claims and also have very wide jurisdiction in cases of disputes between husband and wife.



*Leave is necessary for appeal

FIG. 2.—FLOW OF CIVIL CASES IN ENGLISH COURTS

County Courts have jurisdiction in civil disputes up to quite substantial amounts and also have jurisdiction in matters such as bankruptcy and by virtue of various special enactments (*see* COUNTY COURT).

The Supreme Court.—Such civil cases as are not within the jurisdiction of magistrates' courts and county courts can only be tried by the high court of justice, which here includes commissioners of assize. The supreme court of judicature consists of the two permanent divisions already referred to, namely the high court of justice and the court of appeal. By the effect of the Judicature acts the former inherits the jurisdiction of the court of chancery and the common-law courts, the courts of probate and divorce and admiralty, and the court of pleas at Lancaster and Durham. (*See* also COURT OF APPEAL.)

The House of Lords.—As already mentioned, there is an appeal by leave from the court of appeal to the house of lords, the juris-

iction of which in appellate matters is exercised by the law ords. These consist of salaried lords of appeal in ordinary, on hom life peerages are conferred on appointment, and other mem- ers of the house of lords who hold or have held high judicial office. he appellate jurisdiction of the house of lords extends to appeals rom the inner court of session in Scotland, to appeals from the ourt of appeal in Northern Ireland, as well as to appeals from he court of appeal in England and Wales. The law lords and cer- ain other judges also sit as the judicial committee of the privy ouncil to advise the sovereign upon appeals from parts of the ommonwealth and from various domestic tribunals.

(P. E. L.; X.)

UNITED STATES

The structure of court organization in the United States re- ects the division of functions characteristic of the federal form f government. Each state has its own independent, compre- ensive system of courts, capable, as a whole, of adjudicating al- most every conceivable controversy, and subject, ordinarily, to o higher judicial authority. At the same time, there exists a ystem of national courts, established to perform distinctively ational functions. To a considerable extent the state and na- onal (or federal) courts exercise concurrent jurisdiction; but in ertain cases the federal courts have exclusive jurisdiction, and n matters of national law they exercise the supreme judicial ower.

Federal System.—Two short sections of the U.S. constitution rovide for the establishment of a federal system of courts and efine the federal judicial power. The judicial power is vested in one supreme Court, and in such inferior Courts as the Congress ay from time to time ordain and establish." The judges are ppointed by the president, with the advice and consent of the enate. They hold office "during good Behaviour"—*i.e.*, they can e removed only by impeachment—and their compensation cannot e diminished during their continuance in office.

The federal judicial power extends to nine classes of cases: (1) ll cases, in law or equity, arising under the constitution, the laws f the United States, and treaties made under their authority; 2) all cases affecting ambassadors, other public ministers and onsuls; (3) all cases of admiralty and maritime jurisdiction; (4) ontroversies to which the United States is a party; (5) contro- ersies between two or more states; (6) controversies between a ate and citizens of another state; (7) controversies between itizens of different states; (8) controversies between citizens of he same state claiming land under grants of different states; nd (9) controversies between a state, or the citizens thereof, nd foreign states, citizens or subjects.

The power granted with respect to the 6th and 9th classes of ases was narrowed in 1798 by the 11th amendment, which with- rew from the federal courts jurisdiction of suits against a state y citizens of another state or by foreign states and their citizens r subjects.

The supreme court has original jurisdiction of all cases affect- ng ambassadors, other public ministers and consuls, and of cases which a state is a party. In the other enumerated cases, its urisdiction is appellate and is subject to congressional regula- on.

In addition to the courts thus provided for, congress has power o establish courts with plenary jurisdiction for the District of olumbia and other federal territories.

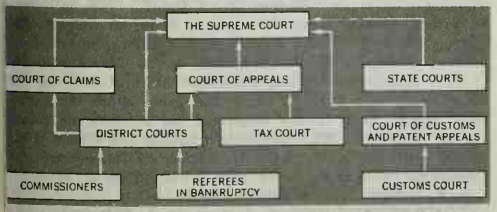


FIG. 3.—FLOW OF CASES IN U.S. FEDERAL JUDICIAL SYSTEM

Implementation of the judicial article of the constitution was a major task of the first congress in 1789. After providing that the supreme court should consist of a chief justice and five associate justices, that congress made the historic decision to establish a system of inferior courts instead of relying entirely on the state courts, in the first instance, to decide cases within the federal judicial power. The supreme court has been continuously in exist- ence, its membership varying from six to ten, but since 1869 it has been composed of a chief justice and eight associate justices. The plan for inferior courts has undergone changes from time to time, notably in 1891, when circuit courts of appeals were estab- lished, and in 1911, when the old circuit courts, which shared origi- nal jurisdiction with the district courts, were abolished. Under the organization in existence in the early 1960s, the court of first instance was the district court, the country being divided into 88 districts. The districts are grouped into 11 judicial circuits, in each of which is a court of appeals with jurisdiction to review decisions of district courts within its territory. The membership of the courts of appeals varies from three to nine judges. The supreme court opens its term in the District of Columbia on the first Monday in October of each year, exercising the original juris- diction vested in it by the constitution, a limited jurisdiction to review directly the decisions of district courts, a largely dis- cretionary jurisdiction to review decisions of the courts of ap- peals and a limited jurisdiction, also largely discretionary, to review decisions of state courts. Since 1925 the supreme court has been able to limit its appellate work to cases which are im- portant to the national interest or to the administration and de- velopment of the law.

Congress has also established certain specialized courts, such as the court of claims, the customs court, the court of customs and patent appeals and the tax court.

Contrary to popular supposition, the supreme court is not the court of last resort on all questions of law. It is only when some provision of the federal constitution, or an act of congress, or a treaty is involved, or some right under federal law is asserted, that the supreme court has power to review decisions of state courts. Even this limited power of review, though it was estab- lished in the first Judiciary act (1789), was repeatedly challenged by the states during the 19th century, despite the supreme court's definitive decision upholding its constitutionality in *Martin* v. *Hunter's Lessee*, I Wheat. 304 (U.S. 1816). In the great majority of cases, which involve only questions of common law or local statute, no appeal lies to the United States supreme court.

In a typical year in the early 1960s the supreme court disposed of more than 1,000 cases. In most of these it declined, after study of the records, to exercise its power of review. About 200 cases were disposed of on the merits, roughly half with full writ- ten opinions by one or more justices. Only a few original cases were involved. Of those in the appellate category, slightly more than half came from the federal courts of appeals and slightly less than half from state courts; the remainder came directly from district courts and from specialized federal courts.

In the same year, the 11 courts of appeals disposed of almost 3,000 cases, consisting primarily of appeals from district courts but including also appeals from certain administrative agencies and a few original proceedings. The district courts disposed of more than 110,000 cases. The largest single category consisted of prosecutions for violation of federal criminal laws (about 37,000); the second largest (32,000) consisted of bankruptcy cases (bank- ruptcy being one of the subjects concerning which the federal congress exercises legislative power). In some 20,000 cases the United States or a federal officer was a party. In the remaining category of private civil litigation (21,000 cases), about 60% were controversies between citizens of different states, about 30% arose under federal law and about 10% were in admiralty (*see* also SUPREME COURT OF THE UNITED STATES, THE).

State Systems.—Comparison of the judicial establishments in the U.S. states yields a bewildering variety of arrangements and nomenclature, and any attempt to describe a "typical" system of state courts would be misleading. Nevertheless, basic similarity is sufficient to justify an abstraction which, while not faithfully

reflecting the judicial organization of any state, will serve to illustrate the common features of most. Occupying the central place in the system is the local court of general original jurisdiction, exercising substantially plenary judicial powers. This may be called the district, or circuit, or superior court, or by any one of half a dozen other names. Modeled generally after the English court of queen's bench or the court of common pleas, and usually combining also the jurisdiction of the court of chancery, it exercises a general civil jurisdiction in law and in equity, as well as a general criminal jurisdiction. At the apex of the structure is a supreme court, although it is not always so called, with jurisdiction which is almost exclusively appellate. In some states, intermediate appellate courts have been established, often with appellate jurisdiction distinct from that of the supreme court; but the supreme court usually has final power to review decisions of the intermediate court. Apart from the local court of general original jurisdiction, there are numerous special and inferior courts of first instance with limited jurisdiction, from which appeals lie, ordinarily, to the court of general jurisdiction: probate courts, criminal courts, county courts, justices of the peace, and so on. In the larger cities municipal courts have almost completely replaced justices of the peace, and special-purpose courts, such as those for the handling of juvenile offenders, family problems and small claims, are becoming common. In contrast to the federal practice, the prevailing method for the selection of state judges is popular election. (For the courts of particular states, *see* the *Government* sections of the individual state articles.)

Administration.—The multiplicity of courts within a state, often with vaguely defined jurisdictional differences, has been a source of wasteful litigation and sometimes of injustice. To a considerable extent the hardships have been ameliorated by laws providing for transfer to the appropriate court of actions improvidently filed. Other features of the system, however, have called for stronger measures of reform. State and federal courts alike have shared the basic characteristics of independence and localism. The courts of first instance have operated independently of each other and free from any central administrative control; they have operated, indeed, in ignorance of the volume, character and distribution of judicial business within each system. Modern reform measures have therefore been concentrated upon the elimination of jurisdictional differences, the establishment of central administrative control over the assignment of judges and the dispatch of business, the systematic study of the business of the courts and the related problem of the selection and tenure of judges.

Federal Reforms.—The first effective step in improving the administration of the federal courts came in 1922 with the establishment of the Conference of Senior Circuit Judges (later the Judicial Conference of the United States). In 1939 the administrative office of the United States courts was established to assist the Judicial conference in its task of surveying and expediting the business of the courts. In addition there are annual conferences of all the district judges in each circuit, and semiannual meetings of the Judicial councils, consisting of all the circuit judges within each circuit. The principle that federal judges should assume an executive responsibility for the work of the federal courts as a whole, although opposed in the 1920s, has become firmly established.

State Reforms.—Several states have taken similar action to bring efficiency into judicial administration. A striking advance was made in New Jersey with the adoption of the constitution of 1947, which simplified and modernized an antiquated judicial system, vesting important administrative and rule-making powers in the courts.

Despite progress of this kind in some quarters, and despite comparable progress in the simplification of judicial procedure, the major problem of the courts in the 1960s was that of delay in the administration of justice. Especially in metropolitan areas, and particularly in cases in which jury trial was required, calendars were typically congested to such a point that years rather than months elapsed between the commencement of an action and its trial. There remained a clear need for improvement in the organization of courts, in judicial procedure and in methods of selection and tenure which would ensure capable and efficient judges who would be removed from political influence.

See JUDICIARY AND COURT OFFICERS; APPEAL. For the courts of other countries, *see* the articles devoted to the law of particular nations, such as GERMAN LAW, SCOTS LAW, etc., as well as the *Administration* sections of the individual country articles. *See* also references under "Court" in the Index volume. (B. CE.)

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COURTAULD, the name of a British family of manufacturers. George Courtauld, of Huguenot descent, first introduced silk throwing (spinning) into Essex. His eldest son, Samuel (1793–1891), established a silk manufacturing firm in Essex in 1816. Brothers George and John joined the firm in 1825. Originally silk throwsters, the brothers became weavers of crepe and other silk fabrics. In 1891 the firm became Samuel Courtauld and Company, which later became the great firm of Courtaulds, Ltd. The Courtaulds acquired the British right to the viscose process for manufacturing rayon yarn and entered the artificial silk trade in 1904. They entered the rayon industry in the United States by founding the American Viscose company in 1909. Samuel Courtauld (1876–1947), a great-nephew and namesake of the principal founder, was chairman of the board of Courtauld's from 1921 to 1946, and founded the Courtauld Institute of Art. His cousin, Samuel Augustine Courtauld (1865–1953), was a director of the Courtauld firm for many years. (H. J. SG.)

COURT BARON, the *curia baronis* ("baron's court"), is a later lawyer's name for the medieval manorial court or *halimoot* which any lord could hold for and among his tenants. By the 13th century, the steward of the manor, a lawyer, usually presided; in origin, the suitors of the court, the doomsmen, acted as judges, but the growing use of juries rendered their function obsolete. In the 17th century Sir Edward Coke distinguished two forms of the manorial court: the court baron for free tenants, the customary court for the unfree. There is no more evidence that this distinction existed in the 12th and 13th centuries than that a court baron was at that time separately constituted from a court leet (*q.v.*). The manorial court might meet every three weeks and dealt with personal actions between its suitors. The lord had considerable power over his unfree tenants, but over the free he had only a civil jurisdiction, increasingly diminished by the growing use of royal writs. Much of the business of the court was to administer the "custom of the manor" and to admit copyhold tenants. The proceedings were recorded on the court roll. *See* also MANOR.

See F. W. Maitland (ed.), *Select Pleas in Manorial and Other Seignorial Courts* (1889); F. W. Maitland and W. P. Baildon (ed.), *The Court Baron* (1891).

COURT DE GEBELIN, ANTOINE (1725–1784), French scholar and author of *Le Monde primitif, analysé et comparé avec le monde moderne,* 9 vol. (1773–82), a half-finished study of language and mythology considered as the key to the understanding of antiquity. Born at Nîmes, Jan. 25, 1725, he followed his father, Antoine Court (*q.v.*), as a pastor of the Reformed Church. In spite of later literary preoccupations, he remained a tolerant champion of Protestantism, as in *Les Toulousaines* (1763); despite considerable Protestant hostility resulting from his standing with those at court, and even before fame and a royal appointment (1781) confirmed his position, he pleaded against injustices. With Benjamin Franklin and others he supported American independence in *Affaires de l'Angleterre et de l'Amérique* (1776 *et seq.*). He died in Paris, May 12, 1784.

See C. Dardier, *Court de Gibelin* (1890).

COURTEEN (COURTEN, or CURTEEN), **SIR WILLIAM**

1572–1636), English merchant and shipowner, was born in London, the son of a Protestant refugee who had come there in 1568. From an early age William acted as the agent in Haarlem for his father's silk and linen business. He became senior partner in the merchant house of Courteen and Moncy in 1606. His trade with Europe, Guinea and the West Indies brought him great wealth, and in 1622 he was knighted. One of his vessels discovered an island which he named Barbados and to which in 1625 he sent colonists. But James Hay, earl of Carlisle, claiming a lease of all Caribbean islands under deeds of 1627 and 1628, seized Barbados in 1629. This entailed heavy losses on Courteen, as did also large loans made to James I and Charles I. He also suffered trading failures in the East Indies and long, unsuccessful litigation over the estate with one of his partners. Though still wealthy, he never recovered his former prominence. Finally, two of his ships sent to China were lost. Courteen was twice married. He died in London in late May or early June 1636. (S. R. Bt.)

COURTELINE, GEORGES (real name Georges Victor Marcel Moineau) (1858–1929), French writer best known for his satirical comedies, was born at Tours, June 25, 1858, the son of a legal reporter who also wrote *vaudevilles* (light comedies). He served in a cavalry regiment and later worked at the ministry of religious affairs, beginning as a clerk, but left in 1894, having published several novels and short stories: *Les Gaîtés de l'escadron* (1886; dramatized, 1895), *Les Femmes d'amis* (1888), *Le Train de 8 h. 47* (1891), *Messieurs les Ronds-de-Cuir* (1893; Eng. trans. *The Bureaucrats*, 1930) and *Ah! Jeunesse!* (1894). He later published *Les Linottes* (1912) and *La Philosophie de Georges Courteline* (1917) and had many plays produced, including *Lidoire* (1891), *Boubouroche* (1893), *Un Client sérieux* (1896), *La Peur des coups* (1894), *Le Commissaire est bon enfant* (1899), *La Paix chez soi* (1903) and *La Conversion d'Alceste* (1905). Courteline's works present a most colourful and truthful picture of his day: he observed and portrayed barrack-room life, office life and the daily life of the average Frenchman with shrewdness and accuracy, though his powerful sense of humour often served to conceal his basic bitterness. He possessed a gift for creating real human characters (*e.g.*, Boubouroche, Captain Hurluret, Sergeant-major Flick, Old Soupe, etc.) and his style, of quite classic perfection, was rich, vivid and expressive. These qualities give his works a strong resemblance to those of Molière, with whom critics have often compared him. He was elected to the Académie Goncourt in 1926. He died in Paris, June 25, 1929.

See Béatrice Elliott, *Georges Courteline* (1928); Albert Dubeux, *La Curieuse Vie de Georges Courteline* (1958). (A. Dx.)

COURTENAY, the name of a famous English family, earls of Devon. French genealogists head the pedigree of this line with one Athon, who was lord of Courtenay in Gâtinais in about 1010. Elizabeth de Courtenay, who in about 1150 married Peter (d. 1183), youngest brother of the French king Louis VII, was the heiress of Athon's great-grandson Renaud. Their son Peter (d. 1219) was the founder of a short-lived dynasty of Latin emperors which ruled at Constantinople until 1261, and among their descendants were the lords of Champignolles, Tanlai, Yerre, Bleneau, La Ferté Loupière and Chevillon. Roger de Courtenay (d. 1733), *abbé* of Eschalis, was the last recognized member of this royal line. Joscelin I (d. 1131), count of Edessa, was a grandson of Athon de Courtenay and a notable crusader; his son Joscelin II (d. 1159) ruled the county until 1150.

In England a house of Courtenay flourished with varying fortunes from 1161, when Henry II gave lands at Sutton, Berkshire, to its founder, Reynold de Courtenay. One of his sons, Reynold, married in about 1178 Hawise d'Aincourt, heiress of the honour of Oakhampton, Devon, and their son Robert (d. 1242) married Mary de Redvers, daughter of William (d. 1217), earl of Devon. From that marriage the Courtenays derived their later claim to the earldom of Devon and in 1293 Robert's great-grandson Hugh de Courtenay (d. 1340) inherited part of the estates of his distant cousin Isabel de Forz, countess of Devon and Aumale. Hugh was summoned to parliament as a baron from 1299 and he was recognized in 1335 as earl of Devon. The marriage in 1325 of his heir, Hugh (d. 1377), with Margaret de Bohun (d. 1391), a granddaughter of Edward I and Queen Eleanor, gave later generations of their line the distinction of descent from the royal houses of England and Castile. However the Courtenays were an unlucky family and their earldom was one of the poorest in late medieval England. The eldest son of Earl Hugh II, Sir Hugh de Courtenay, died young in 1349; he had served at the battle of Crécy and at the siege of Calais and was one of the foundation members of the Order of the Garter. Earl Hugh was succeeded in 1377 by Edward (d. 1419), the son of his third son, Edward. Earl Edward is reputed to have become blind and took little part in public life. The 4th Courtenay earl of Devon was his second son, Hugh (d. 1422). In the Wars of the Roses Hugh's son Thomas (d. 1458), earl of Devon, and his sons supported Henry VI, but they were at first chiefly concerned with pursuing a private feud with William, Lord Bonville (d. 1461), and the outrages committed in the west country by the earl of Devon and his men did much to discredit the Lancastrian cause and led the commons to petition in parliament in Nov. 1455 that Richard, duke of York, should be made lord protector. Thomas, the 6th Courtenay earl, was captured by the Yorkists at the battle of Towton and beheaded at York on April 3, 1461. The earldom was granted by Edward IV in May 1469 to Sir Humphrey Stafford, who was executed during Robin of Redesdale's rising three months later. The main line of the Courtenay family was extinguished on May 4, 1471, when Earl Thomas' surviving brother, John, who had been restored to the earldom during the brief return to power of Henry VI, was killed in the battle of Tewkesbury.

Sir Edward Courtenay of Boconnock (d. 1509), whose grandfather had been a younger brother of Earl Edward, was created earl of Devon in Oct. 1485. Courtenay and his kinsman Peter, bishop of Exeter (afterward bishop of Winchester), had supported the rebellion of Henry Stafford, duke of Buckingham, against Richard III in 1483; after the failure of the rising they fled to France and were later attainted (1484). Sir Edward returned to England to fight for Henry Tudor at the battle of Bosworth Field in 1485 and the revival of the Devon earldom was his reward. He resolutely defended Exeter against Perkin Warbeck's rebels in Sept. 1497. His heir, William Courtenay (d. 1511), had married in 1495 Catherine (d. 1527), a sister of Henry VII's queen Elizabeth and a daughter of Edward IV. After Queen Elizabeth's death in 1503, William Courtenay was imprisoned on a charge of corresponding with the Yorkist exile Edmund de la Pole, earl of Suffolk, and he was attainted in Feb. 1504. On his accession in 1509, Henry VIII released his uncle, whose attainder was later reversed, and a month before his death in June 1511, Courtenay was made earl of Devon, the title having lapsed at his father's death. His son Henry (d. 1539) was also treated with favour in the early years of Henry VIII's reign and in 1525 was created marquess of Exeter. Later his royal descent and opposition to the religious changes led to his destruction. He became involved in correspondence with the exiled Reginald Cardinal Pole, was sent to the Tower of London with his wife and son and was beheaded as a traitor in Jan. 1539. His son Edward (d. 1556) was released by Queen Mary in 1553 and created earl of Devon; he was soon regarded as a possible consort for the queen by those councilors who opposed her plans for the Spanish marriage. Courtenay was a foolish man who ill repaid the queen's kindness to him. Fortunate to escape with his life after being implicated in Sir Thomas Wyat's rebellion in Feb. 1554, he was again imprisoned, was exiled at Easter 1555 and died at Padua, Italy, on Sept. 18, 1556. His heir male was a distant cousin, Sir William Courtenay (d. 1557) of Powderham castle, whose descendant, another Sir William, was created Viscount Courtenay in 1762, a few months before his death.

The earldom was revived in 1831 in favour of William (d. 1835), 3rd and last Viscount Courtenay, who remained in exile in Paris until his death. His heir presumptive, William Courtenay (d. 1859), clerk of the parliament, succeeded in persuading the house of lords that the Devon earldom created in 1553 was still in existence, on the grounds that the terms of the remainder—to Edward Courtenay and his heirs male forever—did not limit the succession to the heirs male of the body of the grantee. There

was no precedent for reviving a peerage for collateral heirs male and Lord Brougham's influence was responsible for this decision. Hitherto the title had been regarded as extinct, and the Courtenays of Powderham had made no claim or protest when the earldom of Devon was bestowed in 1603 on Charles Blount (d. 1606), Lord Mountjoy, and in 1618 on Sir William Cavendish, whose house continued to include that title among the peerage honours of the dukes of Devonshire. The 17th earl of Devon, CHARLES CHRISTOPHER COURTENAY (1916–), descended from William Courtenay, who succeeded to the title in 1835 by virtue of the house of lords decision of 1831.

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(T. B. P.)

COURTENAY, WILLIAM (*c.* 1342–1396), archbishop of Canterbury from 1381 to 1396, a resolute leader of the English church and a moderating influence in the political disputes of Richard II's reign, was the fourth son of Hugh Courtenay, earl of Devon, and a great-grandson of Edward I. He studied law at Stapledon hall, Oxford, and became chancellor of the university in 1367. He received prebends at Exeter, Wells and York, was consecrated bishop of Hereford (1370), translated to London (1375) and became archbishop of Canterbury (1381). Courtenay proved a careful and zealous pastor; he gave vigorous leadership in convocation, defended the lower clergy against both papal and royal taxation, visited his diocese (1382) and dared to rebuke the king (1385). While protesting against the second Statute of Provisors (1390) as a restraint upon apostolic power and ecclesiastical liberty, he did much himself to reduce traffic in benefices. He found it necessary to censure the works of John Wycliffe and to suppress Lollardy, obtaining from the king permission to imprison heretics (1382) and to seize heretical books (1388). These activities brought him into conflict with John of Gaunt, duke of Lancaster, who for some time protected Wycliffe. In secular politics Courtenay was trusted by various parties and often played the role of mediator. He was among the 11 commissioners chosen in 1386 to regulate the king's household, and by his tact persuaded the king to meet them in 1387. Courtenay died at Maidstone on July 31, 1396, and was buried in Canterbury cathedral.

COURTHOPE, WILLIAM JOHN (1842–1917), English literary critic whose six-volume *History of English Poetry* (1895–1910) is based on an idea of poetry as the expression of a nation's history and relates its development to the age in which it was written. Born at South Malling, Sussex, July 17, 1842, and educated at Harrow and Oxford, he entered the education office, becoming senior commissioner in 1892. His continuation of Whitwell Elwin's edition of Pope, which includes the *Life*, showed his scholarship and his preference for the classical tradition in literature, as did his life of Addison (1882). His own poetry reflects his love of the English countryside. He was professor of poetry at Oxford, 1895–1901. He retired from the civil service in 1907, and died near Whiligh, Sussex, April 10, 1917.

COURT LEET, an English petty criminal court for the punishment of small offenses. The word leet, denoting respectively a territorial and a jurisdictional area, was used in the entries relating to East Anglia in Domesday Book and in the quo warranto proceedings of Edward I. In the 14th century its use spread throughout England, and the term "court leet" came to mean a court in which a private lord held to his own profit jurisdiction otherwise exercised at the sheriff's turn (*see* HUNDRED). It was essentially a royal court, its president being the delegate of the king.

The court leet met twice a year, usually at Easter and Michaelmas, under the presidency of the lord's steward, who, by the end of the 13th century, was almost always a professional lawyer, and acted as judge. The court's two main functions were to hold view of frankpledge (*q.v.*) and to receive the presentment of malefactors made by the juries constituted in the Assize of Clarendon (1166). This latter function became the more important, although, as serious cases were increasingly reserved to itinerant justices, the rights of trial of small local courts became restricted to petty misdemeanour only and they normally only had cognizance of common-law offenses. From the 13th century onward, lawyers tended to apply regulations concerning the sheriff's turn to the court leet; hence originated the legal but historically inaccurate theory that the court leet had developed from the sheriff's turn. Sir Edward Coke, in the 17th century, held that a court leet could not imprison; it could fine or amerce, but as time went on its capacity to enforce its judgments became progressively weaker. After the 16th century the duties of courts leet were increasingly transferred to the justices of the peace. Lords retained the courts, however, for the sake of the profits; some boroughs, such as Norwich and Southampton, continued to use them in local government. But the importance of the courts declined steadily, although the Sheriff's act, 1887 (s. 40), expressly kept them up, and they were not totally extinct in 1960.

See F. J. C. Hearnshaw, *Leet Jurisdiction in England* (1905).

COURTLY LOVE, the name given to a species of romantic love in which the relationship between lover and lady most nearly approximated to that of vassal and lord in the medieval feudal contract. It made its first appearance in the elaborate court poetry of the southern French troubadours (*q.v.*) at the end of the 11th century, and, once established in European tradition, its influence was profound and widespread. Minor lyric and romance were affected, as well as the work of major medieval authors such as Dante (1265–1321), Petrarch (1304–74) and Chaucer (1340–1400). It constituted a revolution of thought and feeling, the results of which are still apparent.

The character of the love celebrated by early troubadour poets is dramatic in the extreme. The lover is always in a position of servitude; he must obey his lady's wishes, however capricious or unjust they may be. But it is his privilege, not his misfortune, to exist subject to her, for love, whether rewarded or not, is regarded as the source of all true virtue and nobility. Within marriage, such love is held to be impossible; the lover habitually addresses the wife of another, and secrecy is therefore one of the important conditions of any favour granted to him. The ritual which surrounded the whole situation was observed reverently and devotedly; as later developments make even clearer, the courtly lover often thought of himself in a semireligious context, serving the all-powerful god of love and worshipping his lady-saint.

Classical and Nordic cultures provide no precedent for such an exotic philosophy of love. Latin and Greek poetry had dealt with erotic adventure with varying degrees of cynicism and tenderness, with domestic happiness, and, in a few striking cases, with love as a ruinous passion which, far from ennobling, destroyed nobility (*e.g.*, the legends of Phaedra, Medea and Dido). Germanic and Celtic society showed itself even less favourable to the development of a romantic attitude to women; this was a world in which the most strongly valued human ties were those of lord and retainer.

Social and Literary Influences.—The circumstances which created the new sentiment, and made it an active force in late 11th-century France, are very various. Certain factors in its make-up are easily definable. Feudalism, with its binding obligations of loyal service to a lord upon whom all fortune depended, provided the general background and even, perhaps, some of the poetic vocabulary—the troubadours spoke often of the adored lady as "my lord" (*"midons"*). It may also be true that the conditions of life in the castle civilization of southern France at this time were favourable to the development of courtly love. Rich but isolated centres of refinement and culture, the castles contained many men but few women; to the lady of the castle the knight and squire may have felt themselves feudally inferior. The adulterous basis of such love is understandable in the light of medieval marriage conventions, and the attitude of the church to marital passion. Marriage was usually a business contract, involving property and military power but little sentiment; no

woman had freedom either to choose her husband or to prevent the annulment of the marriage for political or dynastic reasons if, as often happened, it was not a success. The teaching of the Church upon the relationship between husband and wife was ambiguous as far as passionate love was concerned; it could have done little to encourage the growth of romantic devotion. For these reasons the idealization of passion could not be based upon the marriage state; poets looked beyond it.

But certain specific literary influences were also at work. The first is the *Ars Amatoria* of the Roman poet Ovid (43 B.C.–A.D. 18), a textbook upon the arts of seduction which was well known in France in the early middle ages and provided advice for both men and women. Ovid treats love with an ironic reverence, the never making exaggerated obeisance to the god Amor and to the lady's slightest whims in order to achieve the gratification of his desires. The *Ars Amatoria* refers to extramarital intrigues, and it is clear that the troubadours drew upon it. The Ovidian lover is the slave of passion; he is pale, trembles, is unable to sleep or eat, swoons and is even known to die of love. Ovid's attitude to love, however, is mock-reverent; his adoration of the lady is an assumed pose, calculated to win purely sensual rewards. He is, for instance, willing to recommend force as a legitimate method if pleading fails, and he becomes, by turn, the servant and the master of the situation, indulging, if he pleases, in more than one liaison at a time. Although his book undoubtedly provided some of the material for the idea of courtly love, it could not have accounted for the wholly serious, idealistic outlook of its first medieval exponents.

Various sorts of explanation have been sought for this outlook. One view is that increasing veneration of the Virgin Mary helped to place the lady of the French poets in such an exalted position. Another view sees the matter as a clear case of the influence of religious heresy. Provence, during the years in question, was certainly a breeding ground for strange heretical beliefs which were not completely rooted out until the Albigensian crusades of the 13th century (1209–29) and it has been suggested that the earliest troubadours were inspired to write not by love of a real woman but by the mystical doctrines of the Cathari (*q.v.*). Its adherents were strong in Provence, and can sometimes be localized in those very castles where troubadours lived.

A rival claim has been made for the origins of courtly love in Arabic mystical philosophy; even if this is judged controversial, it is highly likely that the literature of Muslim Spain had a direct influence upon southern French poets. A treatise, the *Tawq al-hamamaw* (Eng. trans. by A. R. Nykl, *The Dove's Neck Ring,* 1931), written in 1022 by the Andalusian religious philosopher Ibn Hazm (994–1064), contains in detail most of the ideas which recur in all medieval treatments of courtly love from the troubadours onward. The *Tawq,* which draws upon many earlier eastern textbooks of love, and ultimately upon Platonic philosophy, contrasts strongly with Ovid's manual in that it seeks to discover spiritual significance in passionate relationships. While never denying the joys of union, Ibn Hazm approaches his themes in a refined, idealizing way, stressing, for instance, that love "is a reunion of souls in the original sphere of their higher world" and that to love properly requires the virtues of magnanimity, continence, loyalty and courage. Features of his doctrine which ring familiarly after reading of European courtly love literature are: the sovereignty of love, the conception of love as a delightful disease, the association of love with sleeplessness and lamentations, the necessity of secrecy and of faithful service, and the almost blasphemous nature of faithlessness.

Considerable evidence supports the idea that during the late 11th century and the 12th century troubadour poets such as Guilhem, count of Poitiers (William IX, duke of Aquitaine), Bercamon, Marcabru and Jaufré Rudel (*see* TROUBADOURS) imitated and adapted Hispano-Arabic poetry written to conform with these principles. Guilhem married Philippa, widow of the king of Aragon, in 1094, and it is very likely that among those she brought with her to Aquitaine were singers knowledgeable in the Arabic ways of making poetry. In spite of the opposition of Christian and Muslim in the crusade warfare of those times and later, there is good reason to suppose that Frenchmen could and did learn philosophies, stanza forms and melodies from their enemies.

Courtly love must therefore be regarded as the complex product of a number of factors—social, religious, philosophical, erotic—operating upon the privileged culture of Aquitaine and Provence in the 11th and 12th centuries. The expression given to it by the troubadour poets was varied and intricate; the finest of them, from Guilhem (1071–1127) to the later Bernart de Ventadorn (*c.* 1150–95) and Arnaut Daniel (fl. *c.* 1180–1210) made their strong personalities felt through extravagant modes of sentiment and metre.

The Tradition Developed.—*In France.*—But courtly love was not long confined to Languedoc, and as it spread to the north of France, England, Germany, Spain and Italy, it both developed and was modified. By the mid-12th century its themes were certainly in the hands of northern French poets. One of the decisive influences in this transmission was Eleanor of Aquitaine (*c.* 1122–1204), granddaughter of the early troubadour duke of Aquitaine. Married first to Louis VII of France, and then to Henry II of England, she inspired some of the best poetry of Bernart de Ventadorn; at her courts in France and in England she was a patroness of the new love poetry. Her daughter, Marie, countess of Champagne (1164–98), encouraged the writing of the most famous courtly love romance of the later 12th century: the *Lancelot* of Chrétien de Troyes (*q.v.;* fl. 1170) and possibly also the important textbook on the subject by Andreas Capellanus (André le Chapelain; *q.v.,* fl. 1200), the *De Arte Honeste Amandi.* Chrétien tells us at the beginning of *Lancelot* that Marie supplied him with both the content and the method of approach for his poem. Exactly how revolutionary her commands were is easily shown by a comparison of Chrétien's earlier poem, *Erec,* with *Lancelot.* In *Erec* the older view of women predominates—the heroine is a model of wifely patience and submissiveness in the face of harsh and unprovoked trials. In *Lancelot* we have, in the first place, an adulterous situation. The heroine, Guinevere, dictates imperiously to Lancelot, who obeys her in every unreasonable demand. The absolute sovereignty of love is recognized, and Lancelot approaches his lady's bed with the solemn reverence of a worshiper at a shrine. Chrétien's importance, in the present context, is that he was, as far as is known, the first to graft the theory of courtly love on to the old, originally Celtic narratives of Arthurian legend. It was a successful graft; others followed suit not only in France but also in Germany and England. From then on, Arthurian stories, such as those of Lancelot and Guinevere and Tristan and Iseult, were framed as typical courtly love situations, with the appropriate sentiment.

The contribution of Andreas Capellanus, writing late in the 12th century, was a textbook codification of the whole doctrine of courtly love, much on the lines of Ibn Hazm's *Tawq.* It consists of three books, two of which are devoted to such matters as the nature of love, methods of acquiring, retaining and increasing love, the signs of love and procedure to be followed in the event of one lover proving unfaithful. The initial definition given by Andreas could have come from the *Tawq:* "love is a certain inborn suffering." He stresses that love develops nobility, but also that it is the prerogative of the leisured and cultured classes. It would be inappropriate for a man to apply the rules of courtly love if he had the misfortune to fall enamoured of a peasant woman. In his specimen dialogues for lovers and his list of precepts, Andreas sums up the theory of courtly love as the high middle ages understood it. The impossibility of love between husband and wife is still maintained. Devotion to the lady's wishes and attention to secrecy are essential; the true lover is still subject to sleeplessness and violent agitation and is commonly pale through the "inborn suffering" he endures.

The fact that Andreas thought it wise to shape the third book of the treatise as a solemn exhortation to engage in the service of a higher love—that of God—should not lead us to doubt either the serious intent of the preceding books or their influence. Such palinodes are not uncommon in an age which was encouraged to see human affairs *sub specie aeternitatis* as well as from the viewpoint of the participant. Courtly love continued to enlarge its

dominions, sometimes retaining its original character, sometimes changing as it came into contact with new traditions of thought and literary forms. The long French allegorical poem of the 13th century, the *Roman de la Rose* (begun in 1237 by Guillaume de Lorris and finished before 1280 by Jean de Meun), took as its theme the story of the difficult progress of the courtly lover toward his goal, expressing it as a dream adventure within a walled garden; the lady's love is represented as a rosebud, enclosed by a thick thorn hedge. The dreamer, wounded mortally by the arrows of the god of love, becomes love's vassal and is instructed in his new duties with the familiar detail of the *De arte*. The rest of the Guillaume de Lorris section of the poem is taken up with the dreamer's triumphs and setbacks as he attempts to gain the lady's favour; he is in continual suspense, moving between happiness and despair in the way the middle ages had come to think natural to the lover's condition.

In Italy and England.—The 13th and 14th centuries saw courtly love pervading European literature; the romances and minnesinger lyrics of Germany are witnesses to its power, as are also the vernacular songs of Italy and England. But it is in the two last mentioned countries that it receives most interesting handling from great writers. Traditional contacts and exchanges had helped to make troubadour forms and doctrines well known to Italian poets, and as early as the 12th century their love poetry was imbued with courtly ideals. The essence of all the romantic material considered so far can be found in the lyrical and rhetorical verse addressed to Laura by Petrarch in the 14th century. More important still is Dante's fusion of courtly love and mystical vision. Beatrice is the idealized lady of his earthly devotion, who was, in fact, the wife of another. But she is also, in the *Divina Commedia* (1307?–21), wisdom, philosophy and spiritual guide to the mysteries of paradise.

English vernacular tradition had shown itself at home with many of the tenets of courtly love by the early 13th century. There are lyrics of this time which describe the blissful torments of the lover and the surpassing beauty of his imperious mistress. The extreme adulterous form of the convention, however, is not often represented. Courtly love was certainly a vital influential force upon medieval English literature, as can be proved by secular lyrics and romances, and also by religious prose treatises such as the *Ancrene Riwle* (*c.* 1180–1200) which portray Christ allegorically as the adoring suitor, petitioning his disdainful lady, the human soul. But it was adopted, on the whole, as a ritual of courtship rather than as an infinitely preferred alternative to, or compensation for, marriage. In one work, the late 14th-century romance, *Sir Gawain and the Green Knight*, the author goes so far as to have his hero reject the opportunity of a liaison with another man's wife because of his moral scruples. Sir Thomas Malory, in his great Arthurian compilation of the later 15th century, the *Morte d'Arthur*, does not change the outlines of the major courtly love narratives handed down to him from the 12th and 13th centuries, but reshapes, on occasion, a minor episode of this type to bring it more into harmony with an age which had begun to idealize marriage itself.

It is in the poetry of Chaucer, above all, that the most interesting developments of courtly love can be seen. Beginning his career with a translation of part of the *Roman de la Rose*, he adapts many of its elaborate procedures for the love situations of his minor poems. His first major work, *Troilus and Criseyde*, takes a story which is, in essentials, of the courtly mould, dealing with a secret love outside marriage and the consequent sufferings and transports of the lovers. But Chaucer's conception of this love is richly ambiguous. The union of Troilus and Criseyde, in the central part of the poem, is set against a background of pagan and Christian mythology; the dominant impression left with the reader is of sanctioned, not illicit, happiness. In spite of the bitter ending of the story—Criseyde unfaithful and Troilus dead—it is quite true to say that Chaucer has here "brought the old romance of adultery to the very frontiers of the modern . . . romance of marriage" (*The Allegory of Love*, by C. S. Lewis, Oxford University Press, rev. ed., 1951). Significant also is the fact that one of the later *Canterbury Tales*, that told by the Franklin, describes a relationship between man and wife which possesses all the most valuable elements of the courtly code while lacking its obvious social and domestic disadvantages.

Its Continued Influence.—The history of courtly love after the medieval period is part of the general history of European sentiment, and as such cannot be treated without reference to innumerable religious and philosophical issues and literary fashions. Sixteenth-century English poets, in their enthusiasm for Italian verse, and for that of Petrarch in particular, reinterpreted the old extravagant attitudes and phrases for the Elizabethan age; the haughty lady of their lyrics is descended, ultimately, from the lady of the troubadour songs. In the poetry of Spenser (1552–99) on the other hand, we see the continuance of the process already begun in the 14th century; *i.e.*, the absorption of courtly love into an ideal of marriage. It is this aspect of its development which has proved courtly love of greatest importance to western culture, although the imaginative appeal of the original stories of secret, unlimited passion has never failed to draw poets and musicians, and belief in the eccentric behaviour of the lover is a commonplace of popular tradition today.

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(EH. S.)

COURT-MARTIAL, a court for the trial of offenses against military, naval or air force discipline, or for the administration of martial law.

United States.—The extraordinary jurisdiction of courts-martial is conferred by the constitution, which makes the president commander in chief of the armed forces and empowers congress to make rules for the government and regulation of the land and naval forces. It also exempts from the requirement for presentment or indictment by a grand jury "cases arising in the land or naval forces, or in the militia, when in actual service in time of war or public danger." Courts-martial are not part of the federal judiciary but are a part of the executive branch of the government. The proceedings and sentences of courts-martial, acting within their judicial powers and in accordance with law, are generally free from control or revision by the civil courts.

The jurisdiction of U.S. courts-martial is wholly penal or disciplinary. The specific objective of the courts is to ensure discipline in the armed forces. The jurisdiction embraces members of the armed forces and in certain cases civilians closely connected with these services (such as wives and other dependents and retainers to the camp outside the territorial jurisdiction of the United States) or interfering with their operation (such as spies). With regard to most offenses, jurisdiction is not limited by the place of the offense or by the locality of the offender. The members of a court function generally both as judge and jury. As a jury they sift and determine the facts in a case. Where there is a law officer he is primarily responsible for the determination of legal questions, such as admission of evidence, etc. Where there is no law officer (as in special courts-martial) the court itself determines all of these questions speaking through the president or senior member of the court. When a conviction has been reached, the members collectively function as a judge in determining the proper sentence within limits prescribed by law and regulations.

Otherwise, courts-martial processes are patterned after civil tribunals, and are designed to safeguard fundamental procedural and substantive rights of accused persons. Among others, these include the right to a thorough and impartial investigation before trial; to a speedy trial by an unbiased court; to protection from double jeopardy, compulsory self-incrimination and unreasonable searches and seizures; to the same presumption of innocence as in

ederal courts; to the opportunity to be informed of the nature f the charges; to confront hostile witnesses; to the assistance f competent counsel, to be present in court throughout the trial, nd to present whatever evidence there might be in defense or itigation (including the right of compulsory process to obtain itnesses). Courts-martial are governed with respect to procedure nd punishments by special enactments of congress. Until 1951 ose applicable to the army and air force were called Articles of War, those applicable to the navy and coast guard, Articles for ne Government of the Navy.

In 1950 the United States congress enacted a law to become ef- ective May 31, 1951, called the Uniform Code of Military Jus- ce, which consolidated and brought up to date the former statutes elating to the army, air force, navy and coast guard.

The Uniform Code of Military Justice retained many of the ritish enactments and regulations after which the first U.S. Arti- les of War were patterned when enacted in 1775. On June 4, 920, the Articles of War were substantially amended and re- nacted. They were again amended and re-enacted June 24, 1948, ncorporating improvements based upon experiences to date—par- cularly as a result of analysis of courts-martial during World War I. The Articles for the Government of the Navy, in effect Dec. 1, 873, were codified as of that date as section 1624, revised statutes.

The Uniform Code of Military Justice provides three types of ourts-martial—general, special and summary. General courts- nartial are composed of not fewer than five members, plus a law fficer, a trial counsel and a defense counsel, each with assistants the law officer, trial counsel and defense counsel must be certi- ed lawyers). General courts-martial have jurisdiction over any erson subject to military law for any crime or offense made unishable by the Uniform Code and can impose any authorized unishment, including death, dismissal and dishonourable dis- harge. Special courts-martial are composed of not fewer than hree members, a trial counsel and his assistants and a defense ounsel and his assistants. Special courts-martial have jurisdiction ver all persons subject to military law and over all offenses not unishable by death. They may not adjudge sentences to dis- onourable separation from the service or to confinement in excess f six months, etc., but they may give a "bad conduct discharge." n accused enlisted man has the right to demand that at least one- hird of the membership of the general or special court-martial hich hears his case consist of enlisted persons from other than is own unit or organization. Summary courts-martial, consisting f one officer, are limited in jurisdiction to the trial of enlisted ersons. Such courts-martial may not adjudge sentences in excess f confinement for one month, etc. Until May 31, 1951, the navy ourts-martial were slightly different. The navy courts were ermed general courts-martial, summary courts-martial and deck ourts.

Courts-martial are of a transitory nature, called into being and issolved by the commanding officer empowered by statute to ppoint them. Such commanding officers are known as appointing r convening authorities. After trial the appointing authority cts as a reviewing authority and a sentence cannot be executed ntil it is approved and ordered executed by him, his successor n command or the commander for the time being.

Under the Uniform Code, all cases in which a punitive discharge as been approved by the convening authority will be reviewed by n appellate tribunal called a board of review, composed of three udge advocate officers or other legal specialists before the dis- harge may be executed. Any case in which the board of review ustains the punitive discharge, as well as certain other serious ases, may, under the Uniform Code, be appealed to the court of nilitary appeals, composed of three civilian judges appointed by he president.

In all services death sentences must be finally acted upon by he president. Also in all services clemency powers are afforded y the articles and regulations, including the power to restore to onourable-duty status servicemen sentenced to punitive discharge. *See* also MILITARY LAW.) (M. O. E.)

Great Britain.—The English courts-martial inherited part of ne jurisdiction of the *curia militaris,* or court of chivalry. The modern form was adopted by ordinance under Charles I and recognized by statute in the Mutiny act, 1689. This was superseded by the Army Discipline and Regulation act, 1879, and this in turn by the Army act, 1881, re-enacted annually by the Army (Annual) act, until 1955, when the Army act made a great constitutional change by dispensing with the need for an annual act. Part ii of this act deals with discipline, and sections 84–117 inclusive provide for courts-martial.

The salient feature of the court-martial, as contrasted with a civil court, is perhaps the position of the judge advocate. His main functions are to sum up the evidence and to direct the court, whose members are serving officers, on questions of law. When an accused officer or enlisted man is found guilty, the findings and sentence of the court are subject to confirmation or quashing by the commander in chief concerned, who is advised by a deputy judge advocate general, and ultimately by the secretary of state for war or air, as the case may be, who is advised by the judge advocate general of the forces. In accordance with a recommendation of the committee (1946–49) under Mr. Justice Lewis (Sir W. H. P. Lewis), the duty of advising on, and providing prosecuting officers for, the more important or difficult trials was taken away from the judge advocate general and transferred to legal departments of the war office and the air ministry.

Provision for martial law in its modern form dates for the navy as for the army from the reign of Charles I. The system rests on the Naval Discipline act, 1957, which repealed the previous act of 1866 and amending act of 1922 and, with the Army and Air Force acts of 1955, established a common code of discipline and of trial procedure for the three services. A naval court-martial may be ordered by the admiralty, or by an officer authorized by admiralty commission; it is composed of from five to nine officers (rank of lieutenant upward) with a president not below rank of captain. A judge advocate attends and the actual procedure is similar to that of an army or air force court, but the confirmation of the commander in chief or the admiralty is not required except for sentences of death; apart from capital cases, the board of admiralty has a general power of suspending, annulling and modifying sentences. All persons on board H.M. ships are subject to the Naval Discipline acts, including the Royal Marines, who are otherwise subject to the Army act.

In the Royal Air Force court-martial proceedings are governed by the principles laid down in the *Manual of Air Force Law* in compliance with the Air Force act, the Rules of Procedure and the Queen's regulations and are similar to those in the army.

Because courts-martial exercised very wide powers and were normally composed of persons with qualifications inferior to those of the high court, the absence of any provisions for appeals therefrom gave rise to increasing disquiet. To remedy this the Courts-Martial (Appeals) act, 1951, established a court broadly similar to the court of criminal appeal, except that there was to be no appeal against sentence. *See* also JUDGE ADVOCATE; MILITARY LAW. (W. T. Ws.)

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COURTNEY, LEONARD HENRY COURTNEY, 1ST BARON (1832–1918), British radical statesman and writer who gained wide recognition for his support of advanced radical causes, notably proportional representation, was born at Penzance on July 6, 1832, son of J. S. Courtney, a banker. Educated at St. John's college, Cambridge (he was second wrangler in the mathematical tripos), he was called to the bar in 1858, but worked as a journalist, becoming a leader writer on the *Times* in 1864. From 1872 to 1875 he was professor of political economy at University college, London. He stood unsuccessfully as member of parliament for Liskeard in 1874; he was elected two years later. He soon made his mark in the house of commons by his forthright

attack on the annexation of the Transvaal and vigorous support of women's suffrage and of the main concern of his career—proportional representation. In 1880 Gladstone appointed him undersecretary to the home office; in 1881 he was moved to the colonial office and in 1882 to the treasury, but he resigned in 1884 when he could not get proportional representation included in the redistribution bill. He did not support Gladstone on Home Rule for Ireland but was nevertheless made chairman of committees in 1886, filling the post with distinguished impartiality until 1892.

Courtney married in 1883 Kate Potter, Beatrice Webb's sister, and their home became a centre for the followers of John Stuart Mill, among whom he and his friend John Morley were pre-eminent. Courtney's strong opposition to the South African War lost him his seat in 1900, but neither his two failures to get re-elected nor his deteriorating eyesight interfered with his independent public work. He was made Baron Courtney of Penwith in 1906. During World War I he was as much out of step with the majority as in the South African War. Detesting militarism, he was an early advocate of a negotiated peace and a fearless defender of the conscientious objectors. He died in London on May 11, 1918. He wrote mainly for periodicals, but published two books, *The Working Constitution of the United Kingdom and Its Outgrowths* (1901) and *The Diary of a Churchgoer* (1904).

See G. P. Gooch, *Life of Lord Courtney* (1920). (M. A. H.)

COURT OF APPEAL (British). The court of appeal, one of the two major divisions of the supreme court of judicature, was created by the Judicature act, 1873. The master of the rolls is, in effect, its president. Its other permanent members are designated lords justices of appeal, but all high-court judges and holders or former holders of high judicial office are eligible to sit from time to time. It hears appeals from all three divisions of the high court and from the county courts, but not appeals in criminal matters, which are heard by the court of criminal appeal (*see* Criminal Appeal, Court of). It usually sits in three courts, and in most cases appeal lies to the house of lords by leave either of the court itself or of the house. *See* Appeal: *Great Britain and the Commonwealth;* Court: *England;* Judiciary and Court Officers. (W. T. Ws.)

COURTOIS, JACQUES (Giacomo Cortese) (1621–1676), French baroque painter, also called Le Bourguignon or Il Borgognone, was born at St. Hippolyte, near Besançon, in 1621. His father, whose pupil he became, was a painter. Toward 1640 he went to Bologna and studied under Guido Reni; then he proceeded to Rome, where he entered upon his own characteristic style of art, that of battle painting, in which he has been accounted to excel. Prince Matthias of Tuscany employed Courtois on some striking works in his villa, Lappeggio, representing the prince's military exploits. In Venice the artist also executed some battle pieces. In 1655 Courtois entered the Society of Jesus, and as a Jesuit painted many works in churches and monasteries of the society. He lived piously in Rome, and died there on Nov. 14, 1676.

His brother, Guillaume Courtois (1628–1679), was a painter and etcher, often assisting Jacques with his large compositions.

COURTRAI (Flem. Kortrijk), the industrial capital of West Flanders, Belg., is situated on the Lys (Flem. *Leie*) and the Lys-Scheldt canal, 44 km. (27 mi.) S.W. of Ghent by road. Pop. (1961) 43,606.

In spite of damage by fire and in war, many old buildings of distinction remain as witnesses to medieval prosperity. The Broelbrug (*c.* 1400) is characteristic of medieval Flemish military architecture. The 16th-century town hall, a flamboyant piece of Gothic architecture (restored 1846), contains two elaborately carved chimney pieces. The church of Our Lady (begun 1191) was damaged by air raids in 1944. The chapel of the counts was attached to the church in 1374 and contains restored frescoes of the counts and countesses of Flanders, as well as an elaborate miniature, a 16th-century statue of St. Catherine. The church contains Sir Anthony Van Dyck's "Raising of the Cross" (1632). Railways run to, among other places, Brussels, Ghent, Lille and Ostend.

The population, one of the densest in Belgium, is employed making Courtrai linen and in the wood, wire and weaving industries.

The Roman Cortracum was established there. St. Eloi erected a chapel about 650 on the site of the present St. Martin's church, a 15th-century structure which was restored after destruction by fire in 1862. The town gained freedom with its first charter in 1190 and developed as a textile and trade centre which reached its peak in the middle ages. The Courtrai area is the largest producer and exporter of linen fibres in western Europe. In World War I Courtrai was in German hands from Oct. 1914 to Oct. 1918 and in World War II from May 1940 to Sept. 1944.

Battle of Courtrai.—In 1297 French troops invaded the town as well as most of Flanders. On July 11, 1302, Courtrai entered medieval history as the site of the "battle of the Spurs," which resulted from the action of the French king in imprisoning and confiscating the estates of Guy of Dampierre, count of Flanders. His subjects rose in revolt, but as they could raise only a small proportion of knights, their army appeared easy to crush by the powerful French army under Robert of Artois sent against them. The Flemish army took up a position with the Groeninghebeke covering the front, the Lys guarding the left flank and marshy ground on the right. With Courtrai in the rear, the Flemings had no hope of retreat.

The French first line of cavalry made a frontal attack after a duel across the stream between the rival crossbowmen. The passage through their own crossbowmen, the stream and up the slope beyond, threw them into confusion and the heavy mass of Flemish pikemen drove them backward. Robert of Artois strove to check them by throwing in his second line, which was easily crushed. The Flemings gave no quarter and Robert of Artois himself was among the slain, with 63 nobles and 700 knights. The intact French third line and foot then fled. After the battle about 700 pairs of golden metal spurs collected on the field were hung in a church (later demolished) as a thank offering. In 1382 Charles avenged the French defeat by sacking the town. (R. M. An.)

COURT REPORTING, the recording of the course of proceedings in an open court of law. The reports may be verbatim, as in the United States, or selective and edited, as in Great Britain and most European countries. The process used is customarily the taking of shorthand notes by a reporter, although in some courts various mechanical devices are being utilized.

The demand for the right to report trials and legislative proceedings developed in the 18th century with the spread of democratic ideals. However, until recently, the burden of making all arrangements and paying for reporting proceedings was borne by interested parties. In the United States today, most state courts and all U.S. district courts are provided with official reporters, paid by the government, who keep verbatim records of all trials. The expense of obtaining transcripts for an appeal is still borne by the interested parties, except that the government pays in the case of indigents. Provision has been made in Great Britain for official shorthand notes to be taken of all oral evidence and judgments in witness actions in the high court and in criminal cases at the assizes and quarter sessions throughout the country. Official shorthand notes are also taken of the judgments in superior appellate courts, such as the house of lords, the court of appeal, the court of criminal appeal and the divisional court, and the original notes are retained for at least ten years. They are not transcribed unless copies are ordered by interested parties wishing to buy them. In Great Britain the term "reporter" denotes not the shorthand writer but a barrister-at-law whose function it is to decide what decisions or points of law are "reportable," that is, suitable for inclusion in the *Law Reports;* and from a transcript of the shorthand note of the judgment and his own notes of the argument he prepares a report. (*See* Law Reports.)

Although daily transcripts in U.S. courts are an important aid to the lawyer during a trial and to the judge in a nonjury case, the primary impact of court reporting is on U.S. appellate procedure, and it has contributed to making the appellate process a cornerstone of the U.S. legal system. When a case is taken from the trial court to a court of appeals, the trial record as prepared by the court reporter is the most important evidence available upon which the appellate court can base its decision. The insistence upon verbatim reporting is to ensure that the record will be

ree from prejudicial omissions so that the appellate court can adequately determine whether the rights of all parties were observed during the trial. In this way, the court reporter's transcript s a guard against arbitrary judicial power just as the judiciary erves as a check on the possible exercise of arbitrary legislative nd executive power.

The basic function of a court reporter is to attend and record uch court sessions or other proceedings as are specified by statute r rule, or order of the court. In the United States the reporter s required by statute to record all that is said during the trial, ncluding remarks of the parties and counsel out of hearing of the eneral public and jury. In cases other than criminal cases verbatim reporting may be dispensed with, but only upon the agreement of both parties and the sitting judge. Most reporters also ecord observations of expressions, tones of voices, threatening notions, etc., which occur during the trial. The reporter is free o interrupt the proceedings at any point to clarify a statement or pelling. In addition the judge may request the reporter to read rom his notes at any time during the process of the trial.

In U.S. courts the reporter is considered an independent court officer, whereas in Great Britain his summaries are subject to the approval of the judge. The U.S. court reporter takes an oath to perform faithfully the duties of his office, and the records and ranscripts to which he attaches his official certificate are considered prima facie correct when employed by the appellate tribunal. All original shorthand notes are filed with the clerk of the court and retained as records for at least ten years.

Although brief, rapid systems of writing to record the spoken word were developed by the Greeks and Romans and have been known throughout history, English court reporting came into its own with the development of the Pitman and Gregg shorthand systems in the 19th century. Court reporting in shorthand has become a highly skilled profession, and the reporter must possess great stenographic skill as well as quick perception and response. Handwritten shorthand systems remain the basis for court reporting today, although various mechanical methods for recording are also utilized by the reporter. These include stenotype or stenograph machines which have keyboards resembling those of typewriters and which produce a printed version of shorthand. The stenomask method by which the reporter repeats into a sound-recording device all words spoken during the trial is used extensively in military courts and adjudicatory proceedings of many state and federal agencies. In some courts sound-recording machines employing discs, wires or tapes are used, and their use is increasing with the development of more sensitive, high-fidelity recording equipment.

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COURTSHIP, ANIMAL. When we see a peacock spreading his beautiful train to the full, and, occasionally vibrating the quills to produce a rustling sound, turning from side to side before his mate, or a barn-door cock with drooped wing and special call circling close round a hen, we are witnessing familiar examples of animal courtship.

Courtship may be defined to include all forms of action executed by members of one sex to stimulate members of the other sex to sexual activity. Such actions include the display of bright colours, or adornments such as crests; special tactile contacts; dances or other antics; pursuit; music, vocal or instrumental; the discharge of scents and perfumes; and the presentation of prey or of inedible but otherwise stimulating objects.

It is unfortunate that "courtship" is the only term available to denote these activities, since in our own species courtship is usually taken to mean only such activities as occur before marriage, in other words those that conduce to the finding of a more or less permanent mate. In most animals, however, marriage (in the sense of the living together of one or more males with one or more females in sexual association for considerable periods of time) does not exist, and in many birds courtship displays do not begin until after the selection of mates has taken place. Courtship, in the biological sense, primarily leads up to the sex act; where some form of marriage exists, courtship may also, or even primarily, be connected with the choice of mates.

By no means all organisms show even the most primitive form of courtship. It is not present in plants, or in any of the lower groups of animals. A few instances of rudimentary courtship occur in annelid worms, but otherwise it is confined to the vertebrates, the mollusks and the arthropods. Even here it is absent from many of the lower subdivisions of these groups. This becomes intelligible when the function of courtship is more closely looked into. No organism without a nervous system and sense organs can be expected to show courtship. In other forms, the union of the sexual cells is either entirely a matter of chance; or of simultaneous ripening and discharge (as when all sea urchins over a wide area discharge eggs and sperm at one time); or of passive transference, as in flower pollination; or of purely reflex reactions. Courtship will be needed only where the active co-operation of the sexes is needed for fertilization to be effected; and this will be the case only where the eggs and sperms are not blindly discharged, but are economized, either by means of internal fertilization or by being discharged in close proximity. Further, courtship will not be required where the nervous organization is so simple that pairing is a simple reflex action but only when the reflex machinery of pairing is under the control of higher centres in the brain, and the nerve processes of these centres and their emotional accompaniments need to be stimulated in a particular way before pairing can occur.

Courtship of Invertebrates.—The most primitive type of action that can be called courtship is found in certain marine annelids (bristle worms) related to the common sandworm *Nereis*. At the breeding season these annelids gather together and the males indulge in extraordinary contortions. These actions, whether by sight, touch or smell, appear to stimulate the females to shed their eggs, upon which the males discharge their sperm. Certain land snails are among the few mollusks that show courtship; and this in spite of the fact that they are hermaphroditic. They possess a structure called the dart, or *spiculum amoris*, secreted by a special sac. This is discharged with some violence during the preliminaries of mating and appears to stimulate the other animal, whose skin it may pierce. It might be expected that the highly organized cephalopods would have a striking courtship, but in spite of their peculiar method of fertilization, the meagre reports available do not bear this out (*see* Cephalopoda).

Although almost all Crustacea have well-developed special sense organs and internal fertilization, pursuit and forcible capture is usually the only preliminary to mating. In the semiterrestrial fiddler crabs, however, the males have one enormously enlarged claw, often brilliantly coloured, and this is employed in a primitive form of courtship—not as at first surmised, in fights between rival males or forcibly carrying off females. In the breeding season, if a mature female passes near a sexually eager male, he stands on tiptoe and brandishes his claw in the air. As A. S. Pearse says, "the males appear to be proclaiming their maleness." The fiddler crab reacts to three main types of situation—feeding, danger and reproduction. The brandishing of the male's claw is to the female the visible symbol of the reproductive situation.

A similar proclamation of a "sexual situation" appears also to be the main function of the courtship of male spiders. This, in certain of the hunting spiders (*e.g.*, Lycosidae, Attidae), which possess good vision, consists in dances or contortions in which brightly coloured parts are prominently displayed. Web-spinning spiders, however, have poor vision; accordingly in some of them the courting male vibrates a strand of the web in a peculiar way. The importance to the males and to the race of inducing a sexual reaction in the female is here very great, since the female's normal reaction to any small animal would be to attack and devour it. The female does actually sometimes attempt to seize the male as prey, but gradually desists as the courtship proceeds. The male

spiders are occasionally devoured after fertilization. This appears to be the rule in scorpions, in which courtship takes the form of a dance with interlocked claws.

Insects.—In insects courtship is not infrequent. In many flies (*e.g., Drosophila; q.v.*) the male vibrates his wings in a special way. Some male butterflies, including the blues (Lycaenidae) have scent scales on their wings. The most remarkable of scent-producing courtships is that of *Hepialus*. Here the last pair of legs are transformed into organs rather like a powder puff, normally kept inserted in a pair of pouches lined with scent-producing glands. In courtship these organs are used to throw scent toward the female. The sound-producing organs of grasshoppers and crickets (interesting because they probably produced the first not merely accidental and functionless sounds in the history of life) serve mainly to bring the sexes together; but they doubtless also help to generate a sexual situation. The male of the tree cricket *Oecanthus* has a unique structure on his back, consisting of a gland capable of secreting a sweet liquid; during courtship he offers this secretion to the female.

Special food of a protein nature is needed by many female insects if their eggs are to undergo their final ripening. Accordingly a number of male insects present animal prey to the females as a part of courtship. In this way, two birds are killed with one biological stone. In some species of little flies of the family Empidae, the proffered prey is embedded in a "balloon" of glistening bubbles secreted by the male, and usually larger than himself, which renders him and his gift very conspicuous. In other species a strange modification of this habit has taken place. The balloon is still made and carried, but in place of the prey bright objects such as flower petals are placed in it—the flies will even avail themselves of coloured paper if this is provided. This utilization of foreign objects in courtship is paralleled elsewhere only by the bowerbirds and man.

Courtship of Vertebrates.—In vertebrates no courtship appears to exist in cyclostomes nor in the majority of fishes. Definite courtship, with striking adornments displayed by the males, is found only in a few fish species with internal fertilization or with peculiar breeding habits. In the cyprinodonts (top minnows and cave fish) fertilization is internal; and here the males are often brightly coloured and armed with special prolongations of ventral fin or tail; *e.g.*, in the swordtail (*Xiphophorus*) the handsome breeding males swim excitedly round the females, occasionally giving them a dig with their long tail.

In the sticklebacks there are violent combats between males for the possession of nesting territory, but it is not certain whether display of the bright colours assumed by breeding males has any sexually stimulating effect on the females.

In Amphibia the most specialized group (frogs and toads) have no display courtship, since the males' habit of embracing the females and waiting thus until the eggs are shed, when they discharge their sperm, renders it unnecessary. However, the meeting of the sexes is facilitated by the croaking of the males, which is often very loud owing to the development of huge vocal sacs. Here again possibly, though by no means certainly, the croaking has also a sexually stimulating function. If the chirping of male grasshopperlike insects was the first deliberate sound produced by life, the croaking of male froglike Amphibia was almost certainly life's first vocal music. In the urodeles, or tailed amphibians, fertilization is internal, and here courtship is not infrequent. It usually consists in the male's rubbing himself against the female, at the same time discharging the secretion of special scent glands. It reaches its highest pitch in the European newts—*Triturus* and related genera—where the breeding males are usually brightly coloured and dance round the females in striking postures while fanning scent from special glands upon them with their tails. The sexually stimulating function of this performance is here very definite. The males of these genera deposit their sperm in a packet, or spermatophore, and this must be actually picked up by the female for fertilization to occur. It has been shown that females are quite irresponsive to the presence of isolated spermatophores, but will pick them up when stimulated by the male's performance.

Of reptilian courtship comparatively little is known; its study, especially in the more active lizards and snakes, would be certain to yield many interesting facts.

Mammals.—The two remaining vertebrate classes, birds and mammals, differ considerably in regard to courtship, its frequency and duration being much greater among birds, whereas it is commonly completely or almost completely absent in the case of mammals. When courtship does occur in mammals it is not infrequently associated with male combat. The biological reasons for the rarity of courtship in mammals appear to be the following: first, most female mammals, owing to their special method of nourishing their embryonic young, have their reproductive activity very strictly controlled by means of hormones. At certain definite periods the uterus is ready for the embryo's implantation and one or more ova are shed from the ovary; simultaneously, the sexual instincts are strongly stimulated, and the female will readily mate with almost any male, at the same time becoming an object of the males' strong sexual desire owing to an odour specially produced at this period. In other words, the sexual attractiveness of the female and still more her readiness to mate are in the main chemically controlled, the intensity of sexual emotion during the period of "heat" or oestrus being in general very high. In birds, on the other hand, although the sex hormones produced in the breeding female predispose her to sexual emotion, their activity is neither so limited in time nor so intense, while in addition the males are more helpless than in most groups to enforce their desires on an unwilling female. (*See* REPRODUCTION: *Physiology of Reproduction.*)

In most mammals, the cyclical production of female sex hormones thus automatically ensures mating. As a result, both definite courtship and secondary sexual adornments are rare. Since female preference counts for so little, the winning of females by battle will secure them as mates, and consequently size and strength, as of the elephant seal, offensive weapons like stags' antlers or stallions' canines, and defensive weapons like the lion's mane or the baboon's "cape" of long hair are the chief secondary male characters.

In monkeys and apes there appears the tendency, which reaches its climax in civilized man, of emancipating the female's sexual emotions from the strict cyclical control of hormones, and allowing them free play at other times than at oestrus. The mating season is extended over more of the year, and the animals become ready to pair at other periods of the menstrual cycle than oestrus. In such circumstances it would be expected that stimulation by courtship and display would once more become of biological importance, and in point of fact primates do show a number of striking sexual adornments, such as beards, mustaches or whiskers; bright coloured hair on the face; or brilliantly coloured patches of bare skin on the face and buttocks. Detailed studies of simian courtship would be of great interest (*see* SEXUAL BEHAVIOUR). In man, of course, courtship is highly developed and obviously plays an important biological role; but it cannot be discussed in a purely zoological article.

The Courtship of Birds.—It is in birds that courtship is most universal and striking, and its details and its biological significance have been here most thoroughly investigated. Consequently, certain general rules can be laid down as regards the form that courtship takes in birds of different modes of life and reproduction.

1. The racial function of the male bird may be confined to fertilization (ruff, black grouse); or he may also mount guard during the female's incubation (most ducks); or may also share in feeding the young (most perching birds and hawks); or also in incubation (grebes, herons, etc.). The more duties he executes for the good of the offspring, the greater is what may be called his racial value. To kill a male ruff immediately after fertilization has no deleterious effects on the next generation, whereas the death of a male grebe or heron at the same period seriously imperils the chances of the eggs and young.

2. The "marriage systems" of birds vary from permanent monogamy (parrots, ravens) through monogamy for one season (most monogamous birds) or one brood (some wrens) to polyg-

amy of the "small harem" type (jungle fowl, many pheasants) or of the promiscuous type (ruff, blackcock, probably some birds of paradise).

3. The need for protection by means of protective coloration and inconspicuous habits varies considerably. Birds that nest gregariously, in general, need less protection at the nest site than do birds nesting solitarily.

4. The need for a continuous supply of food to the naked young of most perching birds has resulted in the adoption by species of the system of "food territory" in which the male and later the pair defend from intruders an area of some extent round their nest. (*See* BIRD: *Breeding.*)

Courtship is modified in various ways with reference to these facts. In general, the less the share of the male in the care of eggs and young, the greater the difference between the sexes in plumage, and the more striking the (exclusively male) courtship behaviour. This is owing to the greater need for sober colouring and inconspicuous behaviour in the female, on whom the whole fate of the brood depends, and the lesser need in the male.

The greater the degree of polygamy, the greater in general the intensity of courtship and the exaggeration of display characters. This is due to the fact that with polygamy the successful males transmit their characters to many offsprings, while the less successful do not transmit their characters at all. Thus the premium on success in mating is greater. On the other hand, where the male plays a part closely similar to that of the female in incubation and care of the young, both sexes tend to be similar in plumage, and often both develop display characters (crest of crested grebe, plumes of herons).

Mutual courtship is often prolonged until the young are no longer under parental care (divers, egrets, grebes, albatrosses). In such cases it is probable that courtship, in addition to its function in raising the level of sexual emotion, has a secondary function as an emotional bond that helps to keep the pair together for the sake of the young.

Then, the greater the need for protection, the less will be the development of bright colours and display characters. In extreme cases, as in European warblers, the sexes are practically identical in coloration, although the male alone displays in courtship.

In solitary birds with concealed nests, it is rare for courtship to take place near the nest, for fear of revealing its site. When this danger is not of importance, courtship may occur at the nest (*e.g.*, in the rook). It is especially noticeable in gregarious birds with mutual courtship (*e.g.*, pelicans, herons); a joint ceremony is often performed when one bird relieves its mate on the nest.

Finally, where food territory exists, many sexual activities are related with the territorial system and not, as was originally thought, with true courtship. For instance, the song of all our common singing birds is mainly an advertisement to females of the presence of a male in possession of territory, and a warning notice to other males to keep out.

There is often a renewed activity of courtship in a mild form in early autumn when the birds are released from family cares and are still warm and well fed. In some gregarious forms this appears to blend with the remarkable social performances of this season (*e.g.*, stone curlew). In the oyster catcher, the same performance is employed both in courtship and to demonstrate sexual or territorial jealousy. When these two motives reinforce each other, this performance may be joined in by a number of birds and assumes in a rudimentary way a social character, as of a human dance.

In courtship, grebes and divers present weeds to their mates; penguins, stones; herons, sticks; warblers, twigs or leaves. In all such cases the objects presented constitute nesting material; it appears that some association occurs between the two pleasurable breeding activities of nest building and courtship.

Occasionally nonsexual actions are incorporated in courtship. Grebes often give a useless (one might say "ritual") imitation of preening their wings during courtship, and swans behave somewhat similarly. The psychological explanation of this is not easy.

An interesting psychological transference has been noted in the Adelie penguin. The males may present nesting material (stones) not only, as is normal, to the females as part of courtship but to other organisms that interest them, such as explorers and dogs.

Another type of transference has been observed in a captive male Argus pheasant. The courtship of this species is given to a stationary female. The female with which this male was confined belonged to another species and would not stand still. The male, after repeated attempts to display before the female, gave up and proceeded to display before his water trough.

Almost as a matter of course, the mode of life is reflected in courtship. As part of courtship, the males of the fast-flying falcons fly straight at their mates; the golden-eye drake raises a jet of water with his feet; grebes, divers and various diving ducks use their diving powers to appear from below the surface in striking display poses close to their mates and so forth.

Bowerbirds.—In some ways the most remarkable courtship known is that of the bowerbirds (*q.v.*). These birds clear playgrounds, in which special bowers (quite unlike nests) are constructed by some species. In the playground (if a bower is made opposite its entrance) is deposited a collection of bright objects. The objects differ with the species; they may include silvery leaves, flowers, shells, berries, bones, etc. When the female visits the playground, the male pursues her amorously round it (through the bower, when present). Here it appears that the bright objects collected serve instead of the brilliant plumage of other male birds to stimulate the female.

The details of courtship vary enormously from species to species. They all have in common two facts. First, the display presents the bird in an unusual aspect; and presumably stimulates by its very unusualness. Secondly, when bright colours or special plumage exist only in one sex, or only during the breeding season, these are in the great majority of cases made specially conspicuous in courtship. Often such characteristics are normally concealed, but made visible only by display.

A great deal still remains to be discovered about courtship, and amateur naturalists can render considerable service to biology by recording the results of intensive observation of the whole courtship period even of quite common species. *See* BIRD; SELECTION. *See* also references under "Courtship, Animal" in the Index volume. (J. S. H.)

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COUSIN, VICTOR (1792–1867), French philosopher, the exponent of systematic eclecticism, educational reformer and historian, was born in Paris on Nov. 28, 1792. At the age of 18 he passed from the Lycée Charlemagne to the École Normale. There, in 1811, he came under the influence of Pierre Laromiguière, who introduced him to the philosophy of Locke and the abbé de Condillac. This influence, however, was soon supplemented by that of P. P. Royer-Collard, the political leader of the Doctrinaires and the champion of Scottish philosophy; and by that of Maine de Biran. Furthermore, after an early period of teaching at the École Normale and, as Royer-Collard's assistant, at the faculty of letters in the university (1815–16), Cousin went to Germany to familiarize himself with contemporary philosophy there, meeting Hegel, Schelling and Jacobi (1817–18).

In the reaction against liberalism that followed the assassination of the duc de Berry, Cousin was deprived of his assistantship at the faculty of letters (1820); the École Normale was closed in 1822; and, on another visit to Germany, Cousin was arrested in Dresden on a political charge and held prisoner for about six months in Berlin (1824–25). In this period of official disgrace, however, he had the leisure not only to produce the important *Fragments philosophiques* of 1826 but also to complete editions of Proclus

(1820–23) and of Descartes (1824–26) and to begin his translation of Plato (1822–40). Reinstated at the university in 1828, he embarked on a series of lectures on philosophy that enjoyed an unprecedented popularity. His influence was enormous.

The principles of the July revolution (1830) coincided well enough with Cousin's political inclinations. He became a member of the council of public instruction (1830), of the Académie Française (1831) and of the revived Académie des Sciences Morales et Politiques (1832), a peer of France (1832), director of the École Normale (1834) and, in Adolphe Thiers' government, minister of public instruction (1840). Guizot's epoch-making reform of primary education (1833) was inspired by Cousin, who in 1831 went on a mission to Germany to study the system obtaining there (*see* his influential *Rapport sur l'état de l'instruction publique dans quelques pays de l'Allemagne et particulièrement en Prusse*, 1833; Eng. trans., London, 1834; U.S. digest, Albany, N.Y., 1836). It was Cousin who drafted the bill as presented by Guizot.

In the following years, apart from his new official duties, Cousin, no longer lecturing, found time for the revision of his past lectures, for the completion of work already begun and for new literary pursuits. This activity he continued during his retirement from public life after the fall of the July monarchy. His publications include *De la Métaphysique d'Aristote* (1835), *Cours de philosophie professé . . . pendant l'année 1818 . . . sur le fondement des idées absolues du vrai, du beau et du bien* (1836; many subsequent editions); *Cours d'histoire de la philosophie morale au XVIIIe siècle*, 4 vol. (1839–42); *Des Pensées de Pascal* (1843); *Leçons sur la philosophie de Kant* (1844); editions of Abelard (*Ouvrages inédits*, 1836, and *Opera*, 2 vol., 1849–59) and of Maine de Biran (1841); and a series of studies on 17th-century women, *Jacqueline Pascal* (1845), *Madame de Longueville* (1853), *Madame de Sablé* (1854) and *Madame de Chevreuse et Madame de Hautefort* (1856). Cousin died on Jan. 13, 1867, at Cannes.

His philosophy was based on the psychological observation and analysis of the facts of consciousness and on inferences made from the observed facts. This method was the unifying factor of his eclectic system. Consciousness he saw to comprise two necessary or impersonal elements, sensation and reason, and the contingent or personal and individual element of will (in which secondary or reflective volition must be distinguished from primary or spontaneous volition, the original liberty actuating all the processes of consciousness in the individual). Cousin's presentation of reason as a psychological fact, a component of consciousness independent of the will rather than a function of the mind, enabled him to evade the subjectivism of Kant; and on the principles of reason he claimed to establish the ontological reality of the two causally interdependent substances, the *me* and the *not-me*, the consciousness and the phenomenal world, which together, being correlative, must have God as an absolute and self-sufficient cause. His eclecticism was the application of his method to the history of philosophy: the several systems (sensualism, idealism, skepticism and mysticism) were facets of a total truth discernible in the composition of their positive aspects, this synthesis being a converse process to his analysis of consciousness.

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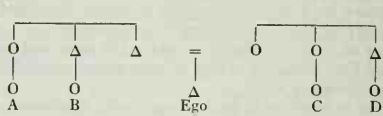
COUSIN MARRIAGE. Whereas sex relations between man and his sister or half-sister are almost universally regarded as incestuous, the corresponding rules governing the relations between first cousins show extreme variation. There are societies which treat sex relations between a man and any female first cousin as incestuous and others which consider marriage between first cousins an ideal to be sought by all. Others again permit marriage between certain categories of first cousin only. There is no evidence that any of these different rules have any genetic consequence, and the common belief that the children of a first-cousin marriage are likely to be physically or mentally defective is only the reflection of a sentiment which associates such marriage with incest.

For purposes of technical discussion, anthropologists distinguish the different types of first cousin as follows: in relation to any Ego, cousins on the father's side are patrilateral, those on the mother's side matrilateral; the children of two sisters or of two brothers are ortho-cousins (parallel cousins); the children of a brother and a sister are cross-cousins. The diagram thus distinguishes four types of female first cousin in relation to the male Ego.



A = a patrilateral cross-cousin
B = a patrilateral ortho-cousin
C = a matrilateral ortho-cousin
D = a matrilateral cross-cousin

Whereas the English word "cousin" covers all four of these relationships, many languages place the ortho-cousins and the cross-cousins in separate categories; in such cases the terms used to denote the ortho-cousins are frequently the same as those denoting brothers and sisters. A smaller group of languages places the ortho-cousins in one category but distinguishes the patrilateral cross-cousins from the matrilateral cross-cousins. Still another group of languages contains separate terms for each of the four female cousins. Many languages make further category distinctions which depend upon whether the girl in question is older or younger than the male Ego (*see* KINSHIP TERMINOLOGY).

Such variations of kin-term classification correlate in an approximate, but far from absolute, way with variations in the rules relating to cousin marriage (*see* table). In the classification of G. P. Murdock (1949) the tabulated linguistic usages are typed as IA Hawaiian, IB Eskimo, II Iroquois, III (i) Crow, III (ii) Omaha, IV Sudanese. For details *see* KINSHIP TERMINOLOGY.

Linguistic usage	Typical associated marriage rule	Example	Rough distribution of this type of rule
IA A, B, C, D, all classed together as "sisters"	Marriage preference for kinswoman of own generation including any cousin but excluding true sisters	Iban	Indonesia-Polynesia
IB A,B,C,D, all classed together but distinguished from sisters	Marriage with any first cousin tolerated but not preferred	English	Europe Arctic regions
II Ortho-cousins classed together as sisters but distinguished from cross-cousins who are classed together	Marriage with ortho-cousins forbidden. Marriage with cross-cousins (i) forbidden (ii) tolerated (iii) strongly approved	(i) Aranda (ii) Sinhalese (iii) Karikera	World-wide
III Ortho-cousins classed together as sisters but distinguished from cross-cousins who are classed separately, A by one term, D by another	Marriage with ortho-cousins forbidden Marriage with (i) A allowed but D forbidden (ii) D allowed but A forbidden	(i) Trobriands (ii) Kachin	World-wide
IV A,B,C,D, all distinguished by separate terms	Marriage with any first cousin approved, especially with B	Bedouin	North Africa Western Asia

While there is a certain rough correlation between the pattern of linguistic usage and the type of marriage rule, other fundamental elements in the total social structure of the society are relevant. Thus, irrespective of marriage rule, most societies which emphasize a principle of unilineal descent (matrilineal patrilineal or both) also make the linguistic category distinction between ortho-cousin and cross-cousin. Again, in the table, systems of type III (i) are usually matrilineal while those of type II (ii) are usually patrilineal. But there are many exceptions to all such generalizations: *e.g.*, the Tikopia (Polynesia) are patrilineal, class all first cousins as sisters and tolerate any form of first-cousin marriage; the Sinhalese distinguish ortho-cousins from cross-cousins, forbid marriage with the former, but do not have a system of unilineal descent. It is erroneous to think that mar

riage rules can be directly inferred from a study of kinship termiiologies.

Strong moral approval of first-cousin marriage does not necesarily imply a high incidence of such marriages. Thus B. Malinowki reported that the Trobrianders considered marriage with the ather's sister's daughter to be ideal, but actual instances of uch marriage among these people appear to be rare. On the other and it was reported of a community of Kurds that nearly 60% of all marriages were of the preferred type—in this case with the ather's brother's daughter. The literature on such matters is often misleading. Thus the Kachin were said to have a rule requiring marriage with the mother's brother's daughter, but in act the rule requires marriage with a relative of the class *nam*, which includes a wide variety of women of whom the matrilateral ross-cousin is only one.

Special interest in cousin marriage first arose from attempts to establish an absolute correlation between marriage rules and systems of kinship terminology and from a belief that the varieties of marriage rule reported from different parts of the world represent an evolutionary series. L. H. Morgan supposed that the rules governing the marriage of near kin were critical markers of the stages of human social development, and modifications of his doctrine by later writers, notably W. H. R. Rivers, produced a mass of intricate *a priori* reasoning concerning the supposed origin of various marriage rules and kin-term systems. A. R. Radcliffe-Brown (1931) demonstrated that the exceedingly intricate systems of kinship terminology and marriage regulation among Australian Aborigines might result from a practice of sister-exchange marriage between closely related males. But the significance of any particular marriage rule in any particular society will depend upon the circumstances of that society, especially upon the associated customs regarding succession, inheritance and residence. As a consequence, following Malinowski, later anthropological work was more concerned with the implications of different types of marriage regulation under special local circumstances and much less with speculation about the historical origins of particular customs.

In the *Bibliography*, items dating from 1949 onward reflect this new approach. The arguments, often highly technical and hotly disputed, are concerned not only with the significance of particular configurations of custom but with why some patterns *e.g.*, III [ii]) occur much more frequently than other similar patterns (*e.g.*, III [i]). In this group of writings the work of C. Lévi-Strauss deserves special attention.

See also KINSHIP; MARRIAGE, PRIMITIVE.

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COUSINS, SAMUEL (1801–1887), English mezzotint engraver, pre-eminently the interpreter of Sir Thomas Lawrence, was born at Exeter on May 9, 1801. During his apprenticeship to J. W. Reynolds he engraved many of the best among the 360 little mezzotints illustrating the works of Sir Joshua Reynolds. In the finest of his transcripts of Lawrence, such as "Master Lambton," his brilliancy and force of effect in a high key corresponded exactly with qualities of the painter. After the introduction of steel for engraving, about 1823, Cousins and his contemporaries were compelled to use it because the soft copper employed for mezzotint plates did not yield enough fine impressions for commercial competition with line engraving. Because of the hardness of steel, the painterlike quality of mezzotints of the 18th century was wanting in Cousins' later works. The labour of scraping was so augmented that Cousins resorted to using stipple engraving and etching processes. To this mixed style, he added heavy roulette and rocking-tool textures. The effect of these prints was mechanical, but their phenomenal popularity kept alive a form of mezzotint during a critical phase of its history. Cousins died in London on May 7, 1887.

See Alfred Whitman, *Samuel Cousins* (1904). (H. Es.)

COUSTOU, the name of a family of French sculptors.

NICOLAS COUSTOU (1658–1733), whose style continued the academic grand manner of the Versailles sculptors with some slight concession toward the freedom of the rococo, and his younger brother, GUILLAUME I (1677–1746), were born at Lyons. Both were brought to Paris by their uncle, Antoine Coysevox (*q.v.*), under whom they studied. After four years in Rome (1683–87), Nicolas was elected an academician (1693) and received a large number of commissions from the crown, particularly for garden sculpture at Versailles (Trianon) and above all at Marly, where he executed, among numerous other works, "Le Seine et le Marne" (1712). Among his religious works the most important was the "Descent From the Cross" (1725) for the high altar at Notre Dame. Guillaume I went to Rome in 1697 where he worked with Pierre Legros, whose extremely baroque style influenced him strongly. He became an academician in 1704 and was chiefly employed to provide garden sculpture for the various royal palaces, notably part of the "Compagnie de Diane" (1712–13) at Marly, but his most celebrated works were the "Chevaux de Marly" (1740–45) designed to replace Coysevox's horses which they now confront across the Place de la Concorde in Paris. His work for Parisian churches included the "Vow of Louis XIII" in the choir of Notre Dame (1713–15) and, in addition, he did some portrait sculpture. His work has a picturesque character and is closer to the rococo than his brother's, as emerges when Guillaume's "Marie Lesczinska en Junon" is compared with its pendant "Louis XV en Apollon" by Nicolas.

GUILLAUME II COUSTOU (1716–1777), son and pupil of Guillaume I, also provided much sculpture for the gardens of the royal palaces, for Mme de Pompadour, etc., but his style displays a further development of 18th-century taste. His later work, particularly his masterpiece, the tomb of the dauphin in Sens cathedral (1766–77, after designs by C. N. Cochin) is already neoclassic in feeling.

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COUTHON, GEORGES (1755–1794), French revolutionary who was closely associated with Robespierre and Saint-Just during the period of the Terror, was born at Orcet, in Auvergne, on Dec. 22, 1755. Brought up in the house of an attorney at Riom, he became a poor people's advocate at Clermont-Ferrand, where he was appointed president of the tribunal in 1790. Elected a deputy to the Legislative Assembly (1791), he opposed La Fayette and spoke in the Jacobin club (over which he presided in November) in support of the "patriot" soldiers who rose against their officers. Having lost the use of his legs as the result of an illness, he had to be carried about on another man's back or in a wheelchair. Elected to the Convention in 1792, he proposed the proclamation of the sovereignty of the people and voted for Louis XVI's death without reprieve. Despite his infirmity he was sent on missions to Loir-et-Cher in Nov.–Dec. 1792 and to the principality of Salm in March 1793. A bitter opponent of the "federal" movement, he procured the arrest of the Girondin deputies in their homes on June 2, 1793. He became a member of the committee of public safety on July 10 and was sent on Aug. 21 on a special mission to the army which was besieging Lyons. With the help of volunteers whom he raised in the Puy-de-Dôme he hastened the taking of the town, but he could not bring himself to carry out the decrees of the Convention ordering its destruction. Of a conciliatory nature, he loathed useless violence, but approved of energetic action against dissidents. An ardent patriot, he frequently intervened in the debates on the army and, on Dec. 21, 1793, was elected president of the Convention. Sharing

the egalitarian ideas of Robespierre and Saint-Just, he first, on Jan. 26, 1794, proposed the confiscation of the property of suspects and then, in February, approved the decrees envisaging the distribution of this property among poor citizens. He took an active part in bringing about the downfall of the Hébertists and of Danton and carried the famous law of 22 Prairial (June 10, 1794), which speeded up the work of the Revolutionary tribunal. During the crisis preceding the Thermidorian reaction he managed to stay in Paris (ignoring decrees which would have sent him away on special missions) and gave his full support to Robespierre. Arrested with him on 9 Thermidor (July 27, 1794), he was taken to the prison of La Bourbe. Set free during the night, he was with Robespierre at the Hôtel de Ville when they were seized as outlaws on the following morning. They were guillotined before the day was over (July 28, 1794).

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COUTTS, THOMAS (1735–1822), English banker and founder of the banking house of Coutts & Co., was born on Sept. 7, 1735. He was the fourth son of John Coutts (1699–1751), lord provost of Edinburgh in 1742, who carried on a business in corn and negotiated bills of exchange. Soon after the death of John Coutts the business was divided into two branches, one carried on in Edinburgh, the other in London. The banking business in London was in the hands of James and Thomas Coutts, sons of John Coutts.

From the death of his brother in 1778, Thomas, as surviving partner, became sole head of the firm; and under his direction the banking house was firmly established. He died in London on Feb. 24, 1822.

See C. Rogers, *Genealogical Memoirs of the Families of Colt and Coutts* (1879); and R. Richardson, *Coutts & Co.* (1900).

COUTURE, THOMAS (1815–1879), French academic historical and genre painter, was born Dec. 21, 1815, at Senlis (Oise), and studied under Baron A. J. Gros and Paul Delaroche, winning a Prix de Rome in 1837. He was best known for his "Romans in the Decadence of the Empire" (1847) and his "Love of Money" (1844). Couture was very popular as a teacher; among his pupils were Manet, Puvis de Chavannes and the Americans William Morris Hunt and John La Farge. He died March 30, 1879, at Villiers-le-Bel, near Paris.

COUVADE (from the French *couver*, "to hatch") is the custom of the father going to bed at the birth of his child, complaining of labour pains, observing dietary restrictions or otherwise acting like a woman in confinement. In its extreme form, the mother returns to her work as soon as possible after giving birth, often the same day, and waits on the father; thus the roles of the sexes are reversed. The term is sometimes applied to examples where both parents of a newborn child are confined and restricted to about the same degree, and even to instances where the father is less restricted than the mother. However, because some restrictions on the behaviour of the father at the birth of a child are almost universal among primitive and ancient peoples, it is best to ignore minor tabus affecting the father and to label the confinement and major restrictions applied with about equal force to both parents the "half-couvade."

The full couvade was practised on the island of Corsica in the first century A.D., in later antiquity probably on Cyprus, and in Spain. It was reported in the 19th century on the Balearic Islands, among the Basque of the Pyrénées, in France, and as late as the early 20th century in the Baltic states and in Holland. In Africa, it has been reported for the Congo area in recent times. In Asia, it first appeared in Pontus, on the southern shore of the Black sea; in ancient times, was observed by Marco Polo in Chinese Turkistan; was found among the Maiotzu tribe of south China in the 18th century; and in the 19th century occurred among the Ainu of Japan and a number of peoples of India. In Oceania it was observed in the 19th century on the Nicobar Islands, the Moluccas and the Solomons. Among the North American Indians it occurred only among the California tribes, but was present in the West Indies and among South American Indians east of the Andes as far south as Paraguay.

W. R. Dawson favoured the theory of a single origin of the custom in the eastern Mediterranean and its subsequent dispersal by migration or diffusion to all other localities where it has been reported. A more representative mid-20th century view is that the couvade originated independently a half dozen or so times in each major area of occurrence and subsequently spread to neighbouring peoples. Its social function is to emphasize the role of the father in reproduction, but those primitive societies which lacked the couvade were not ignorant of biological paternity, as some 19th century writers supposed.

Bibliography.—W. R. Dawson, *The Custom of Couvade* (1929); A. L. Kroeber, *Anthropology* (1948); E. A. Hoebel, *Man in the Primitive World* (1957). (H. E. D.)

COVARRUBIAS, MIGUEL (1904–1957), Mexican painter, writer and anthropologist, was born in Mexico City. He received little formal training. In 1923 he went to New York city on a government scholarship, and his incisive caricatures soon began to appear in *Vanity Fair* and elsewhere; a collection, *The Prince of Wales and Other Famous Americans*, was published in 1925. He illustrated numerous magazines and books, extending his interest to the study of racial types. In 1930 and 1933 he and his wife, a photographer, visited the orient, and subsequently he wrote *Island of Bali* (1937). In 1939 Covarrubias painted six mural maps illustrating the cultures of the Pacific area for the Golden Gate International exposition, San Francisco, published as *Pageant of the Pacific* (1940). Turning to Mexico, he wrote and illustrated an account of the Tehuantepec region, *Mexico South* (1946). His last book, *The Eagle, the Jaguar, and the Serpent* (1954), surveyed the cultures of the northern American Indians. Covarrubias also worked as a theatre designer, easel painter, print maker and teacher. His work reflects a flair for decoration, perceptiveness and thorough craftsmanship. He died at Mexico City on Feb. 4, 1957.

Bibliography.—H. C. Pitz, "Miguel Covarrubias of Mexico City," in *American Artist*, vol. xii, no. 1, pp. 20–24 (Jan. 1948); Justino Fernández, *Arte moderno y contemporáneo en México*, pp. 446–448 (1952); Augustín Velázquez Chávez, *Indice de la pintura mexicana contemporánea*, pp. 25–31 (1935). (D. W. S.)

COVELLITE, a mineral species consisting of cupric sulfide (CuS), although not a major ore of copper (*q.v.*), is found in many copper mines. Covellite, crystallizing in the hexagonal system, is of less frequent occurrence in nature than chalcocite (*q.v.*), the orthorhombic cuprous sulfide. Crystals are rare, the mineral being usually found as compact and earthy masses or as a blue coating on other copper sulfides. The dark indigo-blue colour is a characteristic feature, and the mineral was early known as indigo-copper. The name covellite is taken from N. Covelli, who in 1839 observed crystals of cupric sulfide encrusting Vesuvian lava, the mineral having been formed there by the interaction of hydrogen sulfide and cupric chloride, both of which are volatile volcanic products. Covellite is, however, more commonly found in copper-bearing veins, where it has resulted by the alteration of other copper sulfides, especially chalcopyrite. (L. J. S.)

COVENANT, an agreement made between two or more persons or groups. The word has various specific usages in history, the most important examples being the National Covenant of 1638 and the Solemn League and Covenant of 1643, and the covenant of the League of Nations; for these, *see* Covenanters and League of Nations. For the use of the word in law and in religion, *see* below.

In Law.—Covenant, in law, is a promise made under seal; *i.e.*, in a deed. The promise may be positive (to do something) or negative (not to do something); the deed may be a deed poll with no party to it other than the covenantor, or there may be two or more parties. In modern times certain enforceable promises not made under seal, especially those relating to land, are sometimes loosely referred to as covenants. (*See* Real Property and Conveyancing, Laws of.)

The effects of putting a promise under seal are various. At common law, an agreement made without valuable consideration is unenforceable unless made under seal. Again, under the

tatutes of limitation, lapse of time bars an action on a simple ontract sooner than an action on a covenant. In most cases, owever, a promise is put under seal not in order to secure the pecial consequences of a covenant but merely because the law equires the transaction to be effected by deed (as in the case of nost formal dealings with land), and so any promises in the docu- nent perforce become covenants.

Covenants are used for a wide variety of purposes. Frequently hey are merely incidental (though often important) parts of a ransaction under seal, *e.g.*, a lease, but sometimes they are of he essence. Thus it is common to find payments being made to ersons or associations under deeds of covenant. However, it is n relation to land that covenants have a special importance. Three categories call for special mention:

1. Covenants for title are covenants in a conveyance of land whereby the grantor undertakes to protect the grantee and his uccessors in title against defects in title. In their broadest orm, usually found in a warranty deed, they are against any lefect in title. In England, however, the traditional covenants xtend only to the acts or defaults of the grantor, of those claim- ng under him and of any predecessors in title back to the last urchaser for value; the benefit of all covenants for title runs with the land. In a quit-claim deed, no covenants for title are iven to the purchaser.

2. Leasehold covenants are covenants contained in a lease. At ommon law a contract is normally enforceable only against the ontracting party, but leasehold covenants which "touch and con- ern" the land are enforceable against the landlord and tenant or the time being, even though they are not the original lessor nd lessee. (*See* LANDLORD AND TENANT.)

3. Restrictive covenants, or "equitable servitudes," show a urther modification of the common-law rule. In *Tulk* v. *Mox- ay*, 2 Ph. 774 (1848), it was held that a covenant to maintain eicester square, London, uncovered with buildings would be nforced by injunction against a subsequent purchaser who bought with notice of the covenant. This decision lifted such covenants rom the sphere of contract to that of property; thereafter they vere equitable proprietary interests which bound all except a urchaser without notice. In the second half of the 19th century nd the first half of the 20th, such covenants were widely used ot only to protect individual plots of land but also to secure uni- ormity in the development of estates by means of schemes ubjecting all plots within them to uniform and reciprocal estrictions: *e.g.*, in prohibiting their use for any purpose save rivate residence, in securing a uniform "set back" and in pro- ibiting the erection of cheap buildings and unsightly outhouses. n many ways such schemes were the private equivalent of the ublic control subsequently imposed by town planning laws and oning ordinances, but the modern tendency, particularly in Eng- and, is to rely more on public control and less on private re- trictions.

The debate in the United States concerning covenants not to ermit members of a specified race to buy or use a parcel of land hould not obscure the usefulness of restrictive covenants as a onstructive tool in community planning. Racial covenants in he U.S. are now unenforceable under *Shelley* v. *Kraemer*, 334 .S. 1 (1948) and *Barrows* v. *Jackson*, 346 U.S. 249 (1953), which made judicial sanction of such covenants unconstitutional. n England the special rules for restrictive covenants apply only o negative covenants, but in the United States the courts have xtended the rules to positive covenants as well. Covenants some- imes hinder rather than help, for they remain enforceable in erpetuity, even if obsolete. However, the courts will not en- orce them if changed circumstances make this inequitable, and n England the Law of Property act, 1925, s. 84, provides also a tatutory procedure for modifying or discharging covenants in pecified circumstances. (R. E. My.)

In Religion.—The Hebrew word *berith*, translated as "cove- ant," denotes a relation between two persons or groups, be- ween God and man or between God and the created world. This elation is characterized as harmonious existence (peace), law nd order, reconciliation, mutual or unilateral protection, trust, etc. Covenant is established either unilaterally, by the gracious act of the more powerful of the two, or mutually, by two equals. Though the term is often used in the Old Testament to express a relation between two parties in the sphere of law, business, poli- tics, individual friendship and tribal intercourse, it is employed in a more important theological sense to express the nature and meaning of man's fellowship with God.

As a Form in Human Relations.—The covenant may be a bond of allegiance between friends like David and Jonathan (I Sam. xxiii, 18), a treaty between two chieftains like Jacob and Laban (Gen. xxxi, 44 ff.) or simply a business agreement (I Kings v, 12). This type of covenant is not entirely secular, however, but fre- quently has religious sanctions (Gen. xxxi, 49).

As a Religious and Social Institution.—The relation between God and his people is understood as covenant. Yet here the term has a different meaning from its use in human relations. In the sphere of religion, covenant is a means whereby the deity is represented as binding his worshipers to himself by a sovereign act of grace and calling them to obedient allegiance and faithful- ness. Among the Hittites and other peoples of the near east in the 2nd millennium B.C. there existed a form of political covenant which resembled the covenant between Yahweh and Israel. This is the so-called suzerainty treaty, in which the suzerain binds his vassals to himself unilaterally and makes stipulations which they are to observe. The suzerainty treaty, as well as other near- eastern types of covenant, has been adduced as evidence for the early age of the Old Testament covenant form. The covenant was the central institution which bound the tribes of Israel to- gether in both the political and the religious sphere. This ancient institution was radically changed when the monarchy became the central authority in the 10th century B.C.

Two covenant ceremonies are primarily noteworthy: the cove- nant at Sinai (Ex. xix–xxiv; xxxiv) and the covenant at Shechem (Josh. xxiv). In the Sinai covenant, Israel is inaugurated as Yahweh's people and exhorted to obedience to the stipulations of covenant (the Ten Commandments). (*See* EXODUS; DECA- LOGUE; ARK.) In the Shechem covenant, the tribes were united into a league which worshiped Yahweh as the God who led them out of Egypt. (*See* JOSHUA, BOOK OF.) In the covenant cere- mony the intermediary proclaimed God's gracious acts of salva- tion and exhorted the people to do God's will (Ex. xix, 4–6; xx, 1–17), and after the people's promise of allegiance (Ex. xix, 8; xxiv, 7) he presided at the sprinkling of the "blood of the cove- nant" and the sacred meal (Ex. xxiv). The intermediary of covenant—be he Moses, the priest or the king—represented the deity who bound his people to himself in the covenant rite. Dur- ing and after the Exile (and in the New Testament), the inter- mediary became an eschatological figure and a symbol of God's new order of salvation (Isa. xlii, 6–9; *cf.* Heb. ix, 15).

As a Symbol for the Promise of God.—The oath of Yahweh, promising protection and guidance to an individual who somehow represented the totality of the people, is termed covenant. The covenants with Abraham (Gen. xv) and with David (II Sam. vii, 8–17; Ps. lxxxix, 19–37) constitute symbols which are frequently used in biblical tradition to denote God's promise of eternal faithfulness to his people (Isa. lv, 3; Luke i, 72–73).

As a Symbol for God's Plan and Purpose in History.—The no- tion that there is a given order in which man exists, and a purpose to his life and to the life of the religious community, is some- times expressed by the term covenant. According to this view, God established an order of harmonious existence for all man- kind in primeval times in the covenant with Noah (Gen. ix, 8–17); he promised protection to the people of Israel in the covenant with Abraham (Gen. xvii, 1–14); and he revealed his will to his peo- ple in the covenant with Moses at Sinai. This series of covenants symbolizes the stages in the purposeful forward movement of history from the natural world (Noah) to the elect people (Abra- ham) and the revelation of law through Moses.

The "New Covenant."—Jeremiah reinterpreted the ancient covenant notion and coined the term the "new covenant." It was a symbol for the new life which God would establish for his people in the future (Jer. xxxi, 31–34). (*See* JEREMIAH.)

Theological Meaning in the Old Testament.—In its ancient usage, covenant symbolized the interrelation between God's grace and man's responsibility, between "gospel" and "law." It also stood for God's sovereignty as Israel's God. Although covenant was sometimes interpreted in a legalistic way (Deut. xxvi, 17–19), the institution of covenant presupposed God's forgiveness (Ex. xxxiv, 6, 7, 10; *cf.* Jer. xxxi, 34). In Jeremiah and Deutero-Isaiah, covenant becomes a symbol for God's entering upon the scene of history to create a new people unto Himself.

Covenant in the New Testament.—The life and death of Jesus is understood in terms of the new covenant which has replaced the old. The Last Supper is seen as a covenant rite in which the wine symbolizes the suffering of Jesus and the blood of the covenant (Ex. xxiv, 8; Mark xiv, 24; I Cor. xi, 25), Jesus being the intermediary of the new covenant (Heb. viii, 6; ix, 15). *See* Hebrews, Epistle to the.

Bibliography.—George E. Mendenhall, *Law and Covenant in Israel and the Ancient Near East* (1955); Edmond Jacob, *Theology of the Old Testament* (1958); J. Hempel and L. Goppelt, *Die Religion in Geschichte und Gegenwart: Handwörterbuch für Theologie und Religionswissenschaft*, ed. by Kurt Galling (1957). (T. K. T.)

COVENANTERS, the name given to Scottish Presbyterians who at various crises during the 17th century subscribed to bonds or covenants, notably to the National Covenant of 1638 and to the Solemn League and Covenant of 1643, pledging themselves to maintain their chosen forms of church government and worship. Private covenants for secular purposes had sometimes been made by Scots before the 16th century, but the fervour generated by the Reformation, and the dangers to which external threat and internal treachery constantly exposed the reformed church in Scotland after 1560, led its adherents to employ them for the safeguard of the new religion. After the first recorded religious covenant, the Bond of 1557, was made, the Scots circulated others at every time of danger.

It was in the 17th century, however, that the two most famous Scottish covenants were subscribed and that their adherents came to be known as covenanters. The National Covenant, first signed in Greyfriars' churchyard, Edinburgh, on Feb. 28, 1638, crystallized opposition to the attempt (1637) made by Charles I to introduce a new liturgy in Scotland. The Scottish assembly subsequently abolished episcopacy and in the Bishops' Wars of 1639 and 1640 took arms to maintain their religious liberty. The financial difficulties into which these wars brought the crown led to the summoning in England of the Long parliament (1640) and to the Civil War. Subsequently, by the Solemn League and Covenant (Sept. 1643), the Scots pledged their assistance to the parliamentarian party in England on condition of the "reform" of the Anglican Church. The covenanting army thereafter took part in the Civil War, receiving Charles I's surrender in 1646. However, by the terms of "the Engagement" of Dec. 1647, by which Charles agreed to the Solemn League and Covenant, the king secured military assistance from the Scots. They also fought, after Charles I's execution, for his son Charles II, who signed the covenant in June 1650. In both campaigns they were defeated by the English.

The religious settlement forced upon Scotland by Commonwealth rule failed to satisfy the more rigid Presbyterians; the restoration of 1660, however, far from giving them greater satisfaction, ushered in the covenanters' era of martyrdom. All the legal sanctions of Presbyterianism were removed, episcopacy was re-established, and covenants were denounced as unlawful oaths. For 25 years the adherents of extreme reform suffered brutal persecution: three rebellions (1666, 1679, 1685) were cruelly suppressed. Relief was eventually brought by the English revolution of 1688, but constant persecution had rendered some of the covenanters so embittered and fanatical that they were unable to accept the new ecclesiastical settlement, which re-established Presbyterian church government but did not renew the covenants. *See* Scotland: *History;* Civil War, English.

Bibliography.—D. H. Fleming, *Story of the Scottish Covenants* (1904); J. K. Hewison, *The Covenanters* (1908); G. D. Henderson, *Religious Life in Seventeenth Century Scotland* (1937). (J. M.; X.)

COVENANT THEOLOGY. While the covenant idea appears in the systems of many early Reformed theologians (*see* Beza, Theodore; Calvin, John), the covenant or federal theology proper became widespread in the 17th and 18th centuries in England, Germany, Scotland, the United States and the Netherlands. Two covenants are understood to have been made: the covenant of works concluded by God with Adam as the federal head of the human race, and the covenant of grace, revealed and mediated by Christ as the second Adam. The classic statement was formulated by Hermannus Witsius in his *De oeconomia foederum Dei cum hominibus* (1677). (H. Wa.)

COVENT GARDEN, a London square in which is situated the principal fruit, flower and vegetable market of England, lies north of the Strand in the city of Westminster. Originally a "convent garden" owned by the abbey of Westminster, from 1552 to 1918 it was the property of the earls and dukes of Bedford. During 1630–33 Inigo Jones designed the site for the fourth earl as a square bounded by vaulted loggias of which only a small portion survives on the north side. His church of St. Paul, in the Tuscan style, was rebuilt after a fire in 1795 by Thomas Hardwick. Grinling Gibbons, William Wycherley and Samuel Butler (author of *Hudibras*) are buried there and the ashes of Dame Ellen Terry are in a silver casket on the south wall. The market, established in 1671 under a charter of Charles II, was rebuilt during 1829–30. In 1961 the charter was revoked and ownership and control vested in a statutory authority charged with reorganizing and rebuilding the market by 1968. Contrasting with the bustling market, the dignified Royal Opera house (1858) stands to the northeast on a site which has been occupied by a theatre since 1732.

See E. Beresford Chancellor, *The Annals of Covent Garden and its Neighbourhood* (1930). (Ja. E. F.)

COVENTRY, SIR JOHN (d. 1682), English politician, remembered for his connection with the "Coventry act" of 1671, was the son of Sir John Coventry (d. 1652), a royalist and member of the Long parliament, and the grandson of Thomas, Lord Keeper Coventry. He was knighted in 1660 and entered parliament as member for Weymouth in 1667. His uncles Sir William and Henry Coventry were leading figures at court, but Sir John associated himself with the parliamentary opposition. In Dec. 1670, during a debate on a playhouse tax, he hinted that the king's interest in the stage was confined to actresses. Subsequently, he was waylaid (Dec. 21) by some guards officers led by Sir Thomas Sandys and his nose was slit. The outrage angered parliament and delayed the course of business until the passing of the "Coventry act," declaring assaults accompanied by personal mutilation a felony without benefit of clergy. An attempt was even made to bar the royal prerogative of pardon which had been exercised to protect Coventry's assailants. The king's responsibility for the attack need not be assumed, but he was fortunate in being shielded from further repercussions by an organized court party majority in the house of commons. Coventry died in 1682. (H. G. Ro.)

COVENTRY, THOMAS COVENTRY, 1st Baron (1578–1640), English lawyer, lord keeper of England between 1625 and 1640, was born at Croome in Worcestershire and was educated at Balliol college and at the Inner Temple, where he fell under the influence of Sir Edward Coke. Despite Francis Bacon's opposition, Coventry became recorder of London in 1616 and solicitor general in 1617. Under the patronage of the duke of Buckingham, whose ambition to obtain the office of lord high constable Coventry was later to oppose, his star continued to rise; he was appointed attorney general in 1621 and lord keeper in 1625, succeeding the unfortunate Bishop John Williams (*q.v.*). Coventry, who was raised to the peerage in 1628, was loyal to his sovereign and a firm supporter of the royal prerogative on such issues as ship money. He was, however, more of a lawyer than a politician and he had but little influence in the inner councils of state. By nature a moderate man, he sought to mitigate the severity of the Star Chamber sentences and to prevent many of the court's illegal practices, such as the hanging of men for resisting press gangs. He cannot be wholly exculpated of responsibility for the excesses of the Star Chamber, but he was respected by the majority of his contemporaries and, as lord keeper, tried to remove many of the abuses of the court of chancery. He died

in London on Jan. 14, 1640, "in great honour, and much lamented by all the people." (G. H. J.)

COVENTRY, SIR WILLIAM (*c.* 1628–1686), English statesman, was one of the ablest and most respected figures in politics during Charles II's reign, and his failure to attain the highest offices of state can be attributed solely to his distaste for the vicious public life of his times. He was the fourth son of Thomas, Lord Keeper Coventry. He entered the Queen's college, Oxford, in 1642 but soon left to join the royalist army and later followed the court into exile. He returned to England in 1652 and by refraining from royalist activities survived unmolested to assist the Restoration. James, duke of York, made him his secretary in 1660 and he rode at the head of the royal procession into London in May 1660. He was elected member of parliament for Great Yarmouth in 1661 and at once interested himself in naval and commercial matters. He became a commissioner of the navy in 1662. His zeal and intelligence made him critical of the earl of Clarendon's leadership and it was ostensibly as an ally of Lord Arlington that he was knighted and made a privy councilor in 1665. Clarendon's account of him is consequently a jaundiced one, but they shared certain attitudes, notably their pessimism about England's capacity to fight out the naval war with the Dutch in 1665. Flimsy accusations of corruption made against Coventry and his growing sense of the government's inadequacy combined to depress his spirits, but in May 1667 he readily took office as a member of the treasury commission. In this post and as an outstanding speaker in the house of commons, he led a determined drive for administrative efficiency. Regarding Clarendon as an obstacle to this, he resigned from the duke of York's service in Sept. 1667, but he did not join in Clarendon's impeachment. Economies in expenditure became his principal concern during 1668 and the king's resentment at the restraints these imposed made it easier for the duke of Buckingham to secure Coventry's disgrace in 1669. Coventry was released after a short confinement in the Tower of London, utterly disillusioned with public service and determined never to take office again. Although his reputation made him a natural leader of the parliamentary opposition his independent spirit, breadth of mind and sense of moderation saved him from the grosser failings of partisanship. He shared many of the qualities and attitudes of his nephew the marquess of Halifax, but after assisting in the attack on the earl of Danby in 1675 he preferred retirement. Re-elected in 1679 he evaded serving in parliament after 1680. He died near Tunbridge Wells on June 23, 1686.

Coventry spoke out frequently against the French entanglement and during the exclusion crisis, when an attempt was being made to prevent the duke of York from succeeding to the throne, favoured the middle way of imposing limitations on a Roman Catholic king. Consequently he has been plausibly but wrongly credited with writing Pierre du Moulin's *England's Appeal From the Private Cabal at Whitehall to the Great Council of the Nation* (1673) and Halifax's *Character of a Trimmer* (1688). While in office Coventry earned the unstinted admiration of his subordinate Samuel Pepys, who saw "more real worth in him than in most men that I do know," but his principal satisfactions lay increasingly in the tranquil comforts of a country gentleman. Bishop Gilbert Burnet rightly estimated him "a man of the finest and best temper that belonged to the court" but "too honest to engage in the designs into which the Court were resolved to go." However, his career in opposition did not hinder his brother Henry from serving as secretary of state, 1672–80. (H. G. Ro.)

COVENTRY, a city and county borough of Warwickshire, Eng., 90 mi. N.W. of London and 10½ mi. N.N.E. of Warwick by road. Pop. (1961) 305,060. Coventry stands on undulating ground (highest point, 296 ft.). The Sherbourne and its tributary the Radford Brook meet near the centre, but are culverted along much of their course.

Two gates and some parts of the old city wall remain. During the violent German air raids of Nov. 1940 and April 1941 the centre of the town was laid waste and 50,479 houses were damaged. St. Michael's, the cathedral church, a fine Perpendicular building, was ruined except for the 295-ft. tower and spire. Likewise, all that remained of modern Christ church was the ancient spire of Grey Friars church, to which it was attached. These two, with the lofty steeple of Holy Trinity church, a Perpendicular cruciform building, still standing, are responsible for Coventry's being known as the "City of the Three Spires." The early 16th-century half-timbered Ford's hospital was seriously damaged, but carefully restored. Buildings that remain include St. John's or Bablake church (nearly a parallelogram on the ground plan, but cruciform in the clerestory), with a central tower; and St. Mary's hall, the centre of civic life since it was built by the Merchant Guild of St. Mary in the 14th century. The Great Hall, above a fine crypt, has a carved oak roof.

Work began in 1954 on the new cathedral, designed by Sir Basil Spence. The ruins of the old 14th-century cathedral have been incorporated in the whole cathedral plan and are used as a precinct to the new cathedral, as well as a Memorial Shrine of Reconciliation. Although contemporary in style, the new building harmonizes both with the old cathedral and modern buildings in the central area. Behind the high altar hangs a 70-ft.-high tapestry designed by Graham Sutherland. The ten 70-ft.-high nave windows face toward the altar: the five on the one side represent man's progress through life and the five on the other side God's revelation through history. On an exterior wall is Sir Jacob Epstein's bronze group of St. Michael and the Devil. Adjoining the cathedral is the Chapel of Unity administered jointly by Anglicans and Free churchmen. Elizabeth II laid the foundation stone in the new cathedral and the Chapel of Unity in 1956 and the cathedral was consecrated on May 25, 1962.

The ancient diocese of Lichfield and Coventry, formerly Coventry and Lichfield, was divided in 1836 when Coventry was included in Worcester diocese. The new diocese of Coventry was constituted in 1918.

Coventry (*Coventreu, Coventre*) owed its early fame to the foundation of a Benedictine monastery there by Leofric, earl of Mercia, and his wife Godgifu (famous in legend as Lady Godiva; *q.v.*) in 1043. Their estate in Coventry descended in part to the earls of Chester and to Robert de Montalt and from him the manor of Cheylesmore in Coventry passed to Isabella, queen of Edward II, and then to Edward, the Black Prince, as duke of Cornwall; it remained part of the duchy for more than four centuries. Randulf or Ranulf de Gernon, earl of Chester (d. 1153), granted the earliest charter to the burgesses. This was confirmed with further privileges by Henry II, probably in 1182, and by nearly every succeeding sovereign until the 17th century. In 1345 Edward III gave Coventry a charter of incorporation. It first sent two representatives to parliament in 1295. Charters to hold markets and fairs were obtained in 1218, 1348 and 1445.

The origin of the popular phrase "to send to Coventry" (*i.e.*, to refuse to associate with a person) is uncertain. Lord Clarendon (*History of the Great Rebellion*) states that the citizens of Birmingham rose against small parties of the king's supporters and sent the prisoners they captured to Coventry.

From its early trading in raw wool, Coventry turned to cloth-making at the end of the 13th century, and increased in prosperity to become, before 1400, the centre of the midland cloth industry and the third most important town outside London. It acquired a reputation for its dyeing and the expression "as true as Coventry blue" became proverbial. The craft guilds associated with weaving and other trades played an important part in the life of the town, including the performance of the famous miracle plays, one of four extant collections. At the end of the 17th century ribbon weaving began to replace the declining cloth trade and increased to become, with watch- and clockmaking, the basis of the economy until the latter part of the 19th century. The industrial era began with the manufacture of bicycles in 1868 and further developed with automobiles in 1896. In 1904 rayon spinning was introduced and shortly after this the making of telephone and other electrical equipment.

The most important among a wide variety of industries are motor vehicles, agricultural machinery, guided missiles and turbo-prop engines, aircraft, machine tools; telecommunication equipment, radio, television, motion picture and other electrical equip-

ment; synthetic fibres and woven labels and other ribbons.

King Henry VIII school for boys, now a direct-grant secondary grammar school (1545 charter), is in a Victorian building (1885), as is also an equally ancient foundation, Bablake school. There are two grammar schools for girls, eight comprehensive secondary schools, a technical college (a college of technology was opened in 1960) and a college of art.

A new city centre was built with a traffic-free shopping precinct occupying more than 100 ac. A feature of the central area plan is linked-rooftop car parking. The first full-scale theatre to be built by a civic authority in Great Britain was opened at Coventry in 1958. The city has many parks and open spaces totaling, with several commons, nearly 1,000 ac. The War Memorial park includes trees provided by relatives of the dead of two wars.

The boundaries of Coventry were several times extended between 1890 and 1932. Many street improvements were carried out, a bypass road was opened in 1939, and a city airport was established in 1936. A county of itself from 1462 to 1842, the city became a county borough in 1888. It now includes three parliamentary constituencies.

See William Dugdale, *The Antiquities of Coventre* (1765).

COVERDALE, MILES (1488?–1569) translator of the first printed English Bible and bishop of Exeter, was born at York and ordained priest in 1514(?) at Norwich. He became an Augustinian friar at Cambridge, graduating B.D., and under the influence of his prior, Robert Barnes, adopted first Erasmian then Lutheran opinions. Doubtless he met William Tyndale at the White Horse tavern, where the Lutherans gathered for discussion. When Barnes stood trial in London for heresy, and recanted in Feb. 1526, Coverdale accompanied him to help with his defense. Afterward he returned to Cambridge and devoted himself, with Thomas Cromwell's encouragement, to biblical studies. In 1528, however, he abandoned his convent, and clad as a secular priest began to preach in Essex against images and the Mass. In 1529, on Tyndale's invitation, he spent eight months at Hamburg helping him translate his Pentateuch, and then seems to have settled in Antwerp. In 1534 Coverdale translated into English J. Campensis' Latin paraphrase on the Psalms (1532), and was then employed by Jacob van Meteren, a Lutheran merchant of Antwerp, who did business with England, to translate the Bible. The book, dated Oct. 4, 1535, was printed by E. Cervicorn and J. Soter of Cologne, a city now safer for Lutherans than Antwerp. Coverdale wrote a dedication to the king, Holbein designed the frontispiece and the book was distributed, with Cromwell's support, by James Nicholson of Southwark, who himself reprinted it twice in 1537. Copies were installed in some churches, and Queen Anne Boleyn had one in her chamber. Nearly half its text (Ezra to Maccabees) was incorporated in Matthew's Bible (1537), which became the direct ancestor of the Authorized Version (1611). Being inexpert in Greek and Hebrew, Coverdale made his translation from five versions—Tyndale's incomplete version, Luther, the Vulgate, S. Pagninus' Latin (1528) and the Swiss-German (Zurich, 1534). Yet the result is surprisingly good, thanks to his modesty, judgment and easy style.

This task accomplished, Coverdale returned to England and threw himself into the cause of reform. He translated tracts by Luther and others, and compiled *The Concordance of the* [*i.e.,* Tyndale's] *New Testament* (1535). He also sought to placate the conversatives by translating from the Vulgate first the New Testament (1538) and then the psalter (1540). But his chief work was to edit the Great Bible, which by royal injunction was to be installed in every church. This was a revision of Matthew's Bible based on Sebastian Münster's Latin (1535) in the Old Testament and Erasmus' Latin in the New. It was printed at Paris by F. Regnault, and was nearly finished when the French inquisition intervened. Coverdale and his publisher, Richard Grafton, fled with the types and printed sheets, and completed the book in London in April 1539; and a revised edition followed in April 1540. The psalter of the Great Bible was printed in the Book of Common Prayer (1549), where it still remains, being considered smoother and more singable than that of the Authorized Version. (*See* also BIBLE, TRANSLATIONS OF.)

Then came the reaction. The Six Articles (1539) laid stringent penalties upon married priests and all persons who denied transubstantiation. In 1540 Cromwell was beheaded and Barnes was burned at the stake. Coverdale fled overseas with his wife, Elizabeth Macheson or Sutherland, whose sister married John Macalpine (Maccabaeus), afterward professor and royal chaplain at Copenhagen. For three years Coverdale made Strasbourg his headquarters, translating tracts, writing a defense of Barnes and graduating D.D. at Tübingen university. He also visited Copenhagen, and wrote a tract describing how the Danes use the Lord's Supper. But in Sept. 1543 he moved to Bergzabern, about 40 mi. from Strasbourg, to become for four years headmaster of the town school and assistant pastor of the church. In England his writings were denounced by proclamation and burned at Paul's cross in 1546.

After Henry VIII's death Coverdale returned to England about April 1548 and became almoner to Queen Catherine Parr, whose funeral sermon he preached in September. He was also royal chaplain and a notable preacher much in demand on important occasions. He contributed to the translation of Erasmus' paraphrases (1549) and at the duke of Somerset's request translated from German Otto Werdmüller's *Precious Pearl* (1550). In 1549 he accompanied Lord Russell's army against the Devonshire rebels, preached on the battlefield after the victory near Exeter, and remained to pacify the diocese. For these services he was appointed bishop of Exeter by letters patent, was consecrated on Aug. 30, 1551, and won golden opinions by his episcopal zeal. In London he was regular in his attendance at the house of lords and served on the commission (1552) to reform the canon law.

With Mary I on the throne Coverdale lost his bishopric and on Sept. 28, 1553, was put under sureties by the council. He was in extreme danger, and prepared himself for the fire. He was saved by the king of Denmark, whose intercessions prompted by Maccabaeus, persuaded the queen to grant him a passport to Copenhagen. Coverdale spoke no Danish and soon left Denmark; and after a brief ministry to the English at Wesel he returned to Bergzabern in Sept. 1555. In Aug. 1557 with his wife and two children he joined the English colony at Aarau in Switzerland, and in autumn 1558 migrated to Geneva, probably in order to advise on the translating of the Geneva Bible of 1560.

After Elizabeth I's accession Coverdale started for England in Aug. 1559, and became for some time preacher and tutor in the household of the Puritan duchess of Suffolk. On Dec. 17, 1559, he joined with three other bishops in consecrating Archbishop Matthew Parker in Lambeth chapel, but he steadily refused to resume his bishopric of Exeter. He was old and poor, and his Puritanism, strengthened by residence abroad, rebelled against the ceremonies prescribed. All preferments he declined save a brief incumbency (1564–66) at St. Magnus, London bridge, but he often preached, and his sermons were highly esteemed. In 1563 he had an attack of plague. In 1565 his wife, Elizabeth, died, and he married in 1566 one Katharine, who survived him. He died on Jan. 20, 1569, aged 81, and was buried in the chancel of St. Bartholomew by the Exchange. This church was demolished in 1840, and his bones were transferred to the church of St. Magnus. No authentic portrait exists and nothing is known of his children.

Coverdale's life of courageous and unsparing labour wins respect. In the story of the English Bible his name stands second only to Tyndale's, and the musical rhythms of his psalter have enriched the devotions of countless Anglican worshipers. Coverdale's translations are rather free. Nourished on the cadences of the Latin language, he desires an easy movement and to please the ear by varying the stresses. For example: "I became dumb and opened not my mouth for it was thy doing. . . O spare me a little that I may recover my strength, before I go hence and be no more seen" (Ps. xxxix, 9, 13; *cf.* the Authorized Version: "I was dumb, I opened not my mouth, because thou didst it. . . O spare me that I may recover strength, before I go hence and be no more") and "My soul is athirst for God, yea even for the living God" (Ps. xlii, 2; *cf.* A.V.: "My soul thirsteth for God, for the living God").

See the edition of Coverdale's works (letters, original writings and some of his translations of German or Latin tracts) by G. Pearson for the Parker society, 2 vol. (1844–46). *See* also J. F. Mozley, *Coverdale*

id His Bibles (1953), which gives all sources. (J. F. My.)

COVERLEY, SIR ROGER DE, in English literature, a ame taken by Richard Steele from the north country tune "Roger f Coverley." In the second number (March 1711) of the *Spec-tor* he is introduced as "a gentleman of Worcestershire of ancient escent, a baronet. His great-grandfather was inventor of that mous country dance which is called after him. . . He is now in s 56th year, cheerful, gay and hearty . . . rather beloved than steemed." But Joseph Addison (*q.v.*) soon took the character to his own hands and developed it with subtler observation and umour than Steele ever had at command. Of the 30 numbers of ie *Spectator* in which his character and surroundings are pictured,) are by Addison, eight by Steele, two by Eustace Budgell. In s courtesy and simplicity he shows some kinship with Don uixote (*q.v.*) but his politics and churchmanship, like his paternal tivity as master, landlord and magistrate, are native. The cre-ion of Sir Roger marks and probably assisted the evolution of the orish, hard-living Stuart squire into the benevolent, well-annered and cultivated country gentleman which was the 18th-ntury ideal. Squire Western and Mr. Allworthy in Fielding's *om Jones* show the two types in sharp contrast and the popularity Addison as a moralist may have contributed to the victory of ie more humane and more civilized way of life.

COVILHÃO (Covilham, Covilhã), **PEDRO DE,** Portu-ese traveler (late 15th–early 16th century) principally re-owned for establishing the Portuguese connection with Ethiopia. e left no written narrative of his travels, but part of the valuable formation in Francisco Alvarez' work is based on intelligence pplied by Covilhão. The dates of his birth (probably between 450 and 1460) and death (sometime after 1527) are not known. e was a native of Covilhã in the province of Beira, Port. In early 'e he had gone to Castile and entered the service of Alfonso, duke Seville, but with the outbreak of war between Castile and Portu-l he returned to his native country.

It was in 1487 that King John II of Portugal sent for Covilhão nd entrusted him, together with Alfonso de Paiva, with a mission hose aims were twofold: "to discover and learn about Prester ohn" whose Christian kingdom (in China, India or Abyssinia?) nd long aroused the curiosity of European rulers; and to establish where cinnamon is to be found, and the other spices which from ose parts went to Venice through the countries of the Moors." he quest of the country of Prester John was no doubt motivated the alarm which the Christian powers of Europe felt at the ex-ansion of Islam, while the commercial rivalry of the Venetians ade the diversion of the immensely valuable trade in spices, by rect route to Portugal, a highly desirable object. It appears om the account which Covilhão gave to Alvarez that earlier mis-ons had failed for lack of a knowledge of Arabic and that ovilhão possessed this knowledge even before setting out on his avels. While Paiva and Covilhão were proceeding eastward over-nd, Bartolomeu Dias (Dias de Novaes, *q.v.*) discovered the sea ute round the Cape of Good Hope. The two explorers traveled way of Barcelona, Naples, Rhodes and thence to Alexandria nd Cairo. There they joined a caravan of Moors and went on to or, Suakin and Aden, where they parted, Covilhão going to India, nd Paiva to Ethiopia. Nothing more is known of Paiva's move-ents (he probably died in Ethiopia), but Covilhão reached alicut whence he returned by way of Goa and Ormuz. After an pedition along the east coast of Africa as far as Sofala he re-aced his steps to Cairo. There he met two emissaries of the king Portugal bearing further instructions to look for Prester John. one of them Covilhão sent a detailed report about his travels us far. He then set out once more for Jidda (including, he claims, ecca and Medina) and, by a somewhat circuitous route, finally ached Zeila (about 1490) whence he penetrated into Abyssinia. e was well received by the king, was given lands and honours, arried an Abyssinian lady—but was not allowed to leave the untry. When, 30 years later, the Portuguese embassy under drigo de Lima (including Alvarez) reached Abyssinia (1520), ovilhão with his knowledge of languages, customs and country oved to be of great use. He was also "an honourable person of erit and credit."

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COVINGTON, third largest city of Kentucky, U.S., and seat of Kenton county, is on the Ohio river opposite Cincinnati. The Licking river, which empties into the Ohio, separates Covington from Newport. A 2,252-ft. suspension bridge, completed in 1866, spans the Ohio to Cincinnati; the Greater Cincinnati airport is located in adjacent Boone county. Commerce on the Ohio river was important in the early growth of the city and barges still operate the entire year. Population of the city of Covington, which is included in the Cincinnati (*q.v.*) standard metropolitan statistical area, was 60,376 in 1960 according to the federal census.

Located on a plain and partly surrounded by hills, the city has many fine attractions which include wooded Devou park, a 550 ac. recreational area with a natural amphitheatre seating approximately 40,000. Covington is the seat of a Roman Catholic bishopric; St. Mary's cathedral contains one of the world's largest stained-glass windows. Villa Madonna college (1921) and the University of Kentucky extension centre (1957), both located in the city, are but two of the institutions of higher learning in the Covington-Cincinnati area. The surrounding region specializes in tobacco, corn, hay and livestock. Numerous plants produce precision instruments, machine tools and dies, paper bags and cartons, electric equipment, canned fruits and meats, iron and steel products, fuels, building and road-surfacing materials, beverages and many other products.

The area was frequented by Daniel Boone and George Rogers Clark. The town was founded in 1815 and named after Gen. Leonard Covington of Maryland, a distinguished cavalry officer who fought and died in the War of 1812. The city was chartered in 1834.

A commission-manager form of government has been in effect since 1932. (J. C. Cr.)

COWARD, NOEL (1899–), English playwright and actor whose skilled dialogue and frank treatment of the period between World Wars I and II won him recognition as one of the most brilliant of the younger dramatists, was born at Teddington, Middlesex, on Dec. 16, 1899, and was educated privately. He made his stage début as a child and became a very good actor. Among his most successful plays were *Hay Fever* (1925), *Easy Virtue* (1925), *Private Lives* (1930), *Design for Living* (1932), *Tonight at 8:30* (1935) and *Blithe Spirit* (1941). *Cavalcade* (1931), a historical play, differed from most of his work and was one of his greatest successes. Coward's extraordinary versatility was further evidenced by the number of musical plays and revues that he wrote and in most cases composed; they included *This Year of Grace* (1928), *Bitter Sweet* (1929), *Words and Music* (1932) and *Pacific 1860* (1946). He made many successful films, notably *In Which We Serve* and *Brief Encounter*, and wrote two volumes of autobiography, *Present Indicative* (1937) and *Future Indefinite* (1954), as well as a collection of short stories, *To Step Aside* (1939). He played in some of his own films and also appeared in cabaret, proving still further his versatility and ability as composer, writer and entertainer. (W. J. M.-P.)

COWBANE: *see* Water Hemlock.

COWBIRD, the name given to the six species of the genera *Tangavius* and *Molothrus* in reference to their habit of associating with cattle in order to prey on ticks and, more especially, on insects that may be flushed from the vegetation. Cowbirds belong to the passerine family Icteridae, as do blackbirds, troupials and others. In most species the male is uniform glossy black and the female grayish brown. Like the old world cuckoos, they habitually lay their eggs in the nests of other birds. Young cowbirds, usually one to the host nest, customarily either displace competing nestlings or appropriate their food and may even exceed the foster parents in size. Some species parasitize many kinds of birds, but others utilize nests of only one or two kinds of orioles.

Best-known of the more northern species is the brown-headed cowbird (*Molothrus ater*) of southern Canada, the U.S. and northern Mexico. The bronzed cowbird (*Tangavius aeneus*) is found

from Arizona and New Mexico south to Panamá. The bay-winged cowbird (*M. badius*) of southern South America is unique in that it builds its own nest. (E. R. Be.)

COWBOY. "A boy who tends cows," the first definition sometimes given by standard dictionaries, is a statement of such profundity that it must be universally accepted wherever a boy performs that irksome chore. Such a one is not a cowboy, but a cow boy—two words. In North America, the word first cropped up in New York state during the American Revolution, and was there applied to a group of Tories who made a business of raiding the settlements that supported the American cause. This use of the term was both local and transient, passing with the termination of the Revolution. It is possible that the men who gathered cattle in the mountainous region of the south during colonial days were called cow boys, but proof of this is not available.

Indeed since the early days of the domestication of cattle, men have herded grazing cattle and driven them first from pasturage to pasturage and then from pasturage to market. Cortés used Aztecs enslaved as a result of his conquest as herdsmen. More than 200 years before the appearance of the cowboy in the U.S. in the 19th century, there were Mexican *vaqueros* (the Spanish and English words are virtually literal equivalents), whose relation to U.S. cowboys is explained below. The gauchos of South America appeared with the opening of the pampas to agriculture about 1850.

The cowboy—one word—is a product of the American west. His habitat, or range, began in the second tier of states west of the Mississippi, extended west to the Pacific, north into Canada and south into Mexico; in the U.S., it comprised 17 western states and covered about one-half of the United States. This western cowboy—the American cowboy—was not related in any way to the Tory raiders of New York or the colonial cattle gatherers of the south.

The Cowboy in Texas.—The American or western cowboy had his origin at the place where men began to handle cattle on horseback. It occurred where the five ingredients of open range cattle growing were found in juxtaposition: grass, water, cattle, horses and men. This combination was first made in extreme south Texas in an area shaped like a giant baseball diamond with San Antonio, the ghost town of Indianola, Brownsville and Laredo representing the four bases. The line from San Antonio southeast to Indianola separated the timbered country from the grassland, that from Indianola southwest to Brownsville was formed by the shoreline of the Mexican gulf, that from Brownsville northwest to Laredo followed the Rio Grande and separated Texas from Mexico. The fourth line, from Laredo northeast to San Antonio, bounded the vast plains and grasslands to the north and west, future home of the cowboy.

Here was open country where men could ride and grass grow; here was open climate where snow and ice come rarely; here were herds of wild horses, furnishing mounts for men hardy enough to ride them; here was the gulf where ships could anchor for cargoes of beef and hides; and here was enough fresh water for stock but not enough to grow trees or attract farmers. And here, as it turned out, were herds of cattle so wild and ferocious that only a man on horseback would or could approach them. All the elements were present except the American "boy who tends cows."

When the American "boy" came on the scene—1820–1836—he found this country already occupied, though sparsely, by Spaniards and Mexicans, and these had already perfected the art of handling cattle on horseback. The *vaquero* was already master of all the tools of the trade—horse, rope, saddle, spur, and branding iron (*see* Branding). In the revolution of 1836 which gave Texas its independence, the Texans took over the country north of the Rio Grande. They also took over the wild longhorns, the mustangs and all the techniques and tools that the Mexicans and their forebears had learned from the Moors and the Arabs before them. By the time the Texans had learned their lessons, Texas joined the union (1845) and the Texas cowboy took on the task of teaching what he had learned to his brothers north to Canada and west to the Pacific ocean.

It is difficult to say when the term cowboy came into use in Texas, but it was in use before 1842. In that year one Ewen (or Ewing) Cameron went on the Mier expedition into Mexico, was captured and executed in the following year. Prior to that time, but subsequent to 1836, he headed up "a bunch of wild-riding, reckless Texans . . . who spent their time chasing longhorns and Mexicans soon after Texas became a republic. To the Mexicans they became the symbol of calamity. Then came the real cowboy as we know him today. . . ." (Reprinted from *The Best of the American Cowboy*, compiled and edited by Ramon F. Adams. Copyright 1957, University of Oklahoma Press. Used by permission.)

As long as the cowboy was confined to south Texas he did not acquire national recognition. It has been estimated that by the end of the Civil War the cattle in south Texas had increased to 5,000,000 head, and for them there had been little market. In 1866 they swarmed out of south Texas, finding markets in the growing industrial cities of the booming north. This movement resulted in laying out the cattle trails to such railheads as Sedalia in Missouri, Abilene, Dodge City and Ellsworth in Kansas, and finally to all the grassy states to the north and west. The cowboys were dispersed with the cattle throughout the cattle kingdom, and this movement was complete by 1890. It was in this era of handling cattle on the open range that the cowboy became a national figure.

The Cowboy in the West.—As the cowboy spread over the west he varied his practices, techniques and equipment to meet local requirements, but the changes were slight. For example, in the brush country and in the mountains he used a short rope but in the open plains he could use a long one. There were corresponding slight modifications in saddles, bridles and methods of riding. Though always a cowboy, or cowpuncher, he came to be known by different supplementary names in different areas, such as "buckaroo," "waddie," "vaquero" or "broncobuster."

The cowboy can never be understood apart from the work he did. The first thing to note about him is that he was not a boy, and he did not tend cows. He was a man, though usually a young one, and he handled cattle on a horse that nobody but a man could manage and with a rope that only an expert could use. Though his profession was that of handling cattle, he was not a cattleman nor a cowman—terms reserved for owners of cattle. He received a wage, and a small one, but he never thought of himself as a hired man and was reluctant to do anything that did not pertain to cattle. His loyalty was to the "outfit" and not to the owner, and his mores were derived from those he worked with rather than those he worked for. His occupation imposed many of his qualities on him. He was usually single, lived in a male society where every member understood every other member. Such a society imposes great restraint on its members. Loquacity is not long tolerated by men who live constantly together. The cowboy spent much of his time alone with his horse, and he became accustomed to silence and adept in expressing his ideas in few words. In the presence of strangers his taciturnity could be embarrassing.

The cowboy's clothes seemed picturesque to those who did not know their uses, but there was a reason for everything he wore from the toe of his shop-made boots to the crown of his Stetson hat. The cowboy did most of his work on top of a 900-pound horse whose movements were at best varied and at worst uncertain —running, turning, stopping, stumbling, or bucking. From such an ever-changing platform the cowboy had to do his work, swing the rope, throw it, and know what to do when he made his catch, whether a small calf or a steer that outweighed man and horse. His boots, built to leave the stirrup when he left the saddle, protected his ankles and legs; his hat had to stay on his head, however violent the action or high the wind, and it had to be of such quality that the brim would not tend to cut off his vision. Between his boots and his hat almost anything went, but it had to fit snug so that he had free use of arms and legs. Everything was tied on or tied down as for a ship in a storm. His bandana around his neck was not for looks but for use if he needed it to screen the dust from his nostrils or the sun from his cracked lips. His saddle, spurs, and bridle had to be of the best quality because they were subjected to the hardest use, and for any one of them to fail could bring disaster.

The cowboy was so dependent on his horse that he had great ffection for him. Though the horses belonged to the ranch, a string" of eight or ten was assigned to the cowboy to ride in uccession, and nobody dared "tamper with his mount."

Two events in open range ranching brought the cowboy to the op of his performance. The roundup, one in the spring and nother in the fall, was like the harvest when the crops were athered. The long drive to Abilene, to Dodge City, or to a istant range or Indian reservation was the real adventure when nything could happen. At the end of the trail the cowboy was aid—maybe for a year's work—and he was likely to celebrate by pending all his money in a few days. After all it was his money, nd he had another year in which to make some more. It was his acation on these rare occasions that gave him the reputation of eing a rowdy character. To judge him here would be as unfair as o judge a student at a football game or a businessman at a distant onvention.

The End of an Era.—The era of the cowboy was closed by the oming of railroads to haul the cattle to market and of barbed ire to enclose the wandering animals. Together they ended the oundup of open range days and made the long drive impracticable nd impossible. On the largest ranches, in the big pasture country, me semblance of the old practices remains, but only a semblance. he improved breeds of cattle could not stand the rough treatment nat the longhorns flourished on.

Nobody knows how many cowboys there were at any given time. hey never numbered more than a few thousand because a few owboys could take care of many cattle and a great area. But of l the cowboys that rode the ranges from 1840 and after, nobody an name one as representative of the profession or trade. Among estern characters an individual stands out as the top "bad" man, - "good" peace officer, or scout, or mountain man, but no indi- dual can be cited as *the* cowboy. This namelessness may help explain why he has become an abstraction and a myth, more erfect and certainly more glamorous in the imagination than he er was in reality. He came on the scene at the very end of the oneer period, came on horseback and with clothes and gear that ade him seem romantic. He came so late that there were many view him and spin around him the stuff of which myth is made. The fiction writers picked him up, clothed him with silk, broad- oth and silver, put him on magnificent horses and sent him reening through a million pages of print, destroying evil and de- nding innocence and virtue, especially if these were wrapped up attractive feminine form. The motion pictures took him fresh om the range and perfected his glamour and improved his owess, and nightly this mythical cowboy rides to adventure and ctory on thousands of motion-picture and millions of television creens all over the world. But in the words of Ramon Adams, "he West . . . knows that he has always been 'just a plain, every- y bow-legged human,' carefree and courageous, fun-loving and al. . . . He has been called everything from a cowpoke to a dude angler, but never a coward." (Reprinted from *The Best of the merican Cowboy,* compiled and edited by Ramon F. Adams. opyright 1957, University of Oklahoma Press. Used by per- ssion.) The cowboy—real and mythical—became the subject the greatest volume of literature and legend pertaining to any nerican worker. *See* also Folk Music; Rodeo; Gaucho.

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COWDENBEATH, a small burgh in Fifeshire, Scotland, 6 mi. N.E. of Dunfermline by road. Pop. (1961) 11,918. Cowden- ath's principal industry is the mining of the Fifeshire coal field, th which its prosperity was linked. Peat is dug at Moss Morran, ath of the burgh. Meetings in connection with the adoption and omulgation of the Covenant were held in the old parish church Beath. Originally called Baith, the present form is said to ve first appeared in Queen Victoria's *Journal.*

COWELL, HENRY DIXON (1897–), U.S. composer who in his early years introduced numerous novel devices into the modern technique of composition, was born in Menlo Park, Calif., March 11, 1897. He was virtually self-taught. Seeking new piano sonorities, he used massive chords, which he named "tone clusters"; these were struck on the keyboard with the fist and forearm. He applied such effects in numerous piano works he composed, including a piano concerto (1930). With the Russian engineer Leon Theremin he constructed the rhythmicon, an electronic instrument capable of producing different rhythms simultaneously. Cowell founded the *New Music Quarterly* (1927), devoted exclusively to publishing ultramodern music. Later he adopted a less radical style, composing music based on folk tunes gathered on world-wide travels. He wrote 15 symphonies; the 13th, *Madras Symphony* (1956–58), employs authentic Indian modes and rhythms; his *Persian Set* for chamber orchestra (1958) is derived from Persian tunes. Other works include *Synchrony* for orchestra (1930), *Tales from Our Countryside* for piano and orchestra (1941), and a set of eight pieces, each entitled *Hymn and Fuguing Tune,* derived from themes by an early American composer, William Billings. Cowell published *New Musical Resources* (1930) and (with his wife) *Charles Ives and His Music* (1955). (N. Sy.)

COWEN, SIR FREDERIC HYMEN (1852–1935), one of the most versatile British composers and conductors of his day, was born at Kingston, Jamaica, Jan. 29, 1852. At the age of four he was taken to England and in 1860 began studying with Henry Russell, Julius Benedict and John Goss. He later studied in Leipzig and Berlin. After his return to England in 1868 Cowen established himself as composer, conductor and accompanist. His music, including operas, oratorios, cantatas, six symphonies (of which no. 3, the "Scandinavian" [1880], was the most successful), orchestral suites and many songs, though variable in quality, is graceful in style and skilfully written. Cowen was active as a conductor in London, Glasgow and Manchester and as an adjudicator at music festivals throughout the British Isles. He received a knighthood in 1911. He died in London on Oct. 6, 1935. (H. Ru.)

COWEN, JOSEPH (1831–1900), English orator, politician and journalist who was a highly individualistic champion of radical causes, was born at Blaydon, near Newcastle upon Tyne, on July 9, 1831. His father, Sir Joseph Cowen, was a Northumberland mine owner and proprietor of the Blaydon brick and fireclay works. Joseph Cowen was educated at Edinburgh university, where he made his name as an orator. From his student days he showed enthusiasm on behalf of advanced radicalism at home and national movements abroad. He sympathized with the Chartists, was an ardent parliamentary reformer and, though active in the family business, a supporter of trade unionism. He was the friend of Kossuth, Mazzini, Garibaldi and A. I. Herzen and of Polish exiles, and he made generous and bold efforts to help their conspiracies in Europe. Accordingly he was intensely antitsarist. He was a strong advocate of the North in the American Civil War and also of Home Rule for Ireland. In 1859 he bought the *Newcastle Chronicle,* which he made famous among provincial journals and through which he exercised great influence on opinion in the north of England. Cowen succeeded his father as member of parliament for Newcastle in 1874. He called himself a radical and was soon known for his independence of party. He championed, against Gladstone, Disraeli's policy toward Russia in the near eastern crisis of 1875–78 (*see* English History: *The Victorian Age, 1837–1901*), and he was a pioneer of imperial federation. In the 1880s he opposed the introduction of the closure into the procedure of the house of commons and campaigned against what he regarded as the interference of the National Liberal federation in his constituency. He retired from parliament in 1886, but continued to play an important part in northern politics. He died on Feb. 18, 1900. (D. E. D. B.)

COWES, an urban district and seaport in the Isle of Wight, Hampshire, Eng., is on the Solent (*q.v.*) 11 mi. S.S.E. of Southampton. Pop. (1961) 16,974. West Cowes is separated from East Cowes by the picturesque estuary of the Medina river, the two towns (combined as an urban district in 1933) lying on opposite

sides of its mouth at the apex of the northern coast of the island. A floating bridge connects them. The port between the two towns is the main port on the island.

The Royal Yacht squadron (founded 1815) has had its headquarters since 1856 at Cowes castle (1540), built by Henry VIII for coastal defense. There are six other yacht or sailing clubs and the annual regattas culminate in Cowes week (the first week in August). There are shipyards and aircraft, rope and sailmaking works. East Cowes castle (1799) was built by John Nash the Regency architect for his own residence. He died there and is buried in the churchyard of St. James close by. Osborne (*q.v.*), to the southeast, was the marine residence of Queen Victoria from 1845 until her death. On Nov. 22, 1633, two vessels, the "Ark" and the "Dove," carrying the founders of Maryland under Leonard Calvert left Cowes for America, an event commemorated by a tablet on Victoria parade.

COWL, JANE (Jane Cowles) (1884–1950), U.S. actress, was born in Boston, Mass., on Dec. 14, 1884. She made her stage debut at the Belasco theatre, New York city, in *Sweet Kitty Bellairs* in 1903. Her most important plays were *A Grand Army Man, The Easiest Way, Within the Law, Lilac Time, Information, Please,* and *Smilin' Through,* the latter three of which she was the co-author.

She died at Santa Monica, Calif., on June 22, 1950.

(S. W. H.)

COWLES, HENRY CHANDLER (1869–1939), U.S. botanist and one of the foremost pioneer investigators in plant ecology in America, was born in Kensington, Conn., on Feb. 27, 1869. He graduated from Oberlin college in 1893 and in 1898 he received the Ph.D. degree from The University of Chicago. He was instructor of botany at The University of Chicago from 1902 to 1907, assistant professor from 1907 to 1911 and associate professor from 1911 to 1915. In that year he was made professor, and in 1925 he became chairman of the department of botany. He made valuable researches in physiographic and comparative ecology, especially the ecological relations of dune vegetation. He also made important contributions on the floristics of the Chicago region and on trees as indicators of past topographic conditions. Cowles's writings include *Vegetation of Sand Dunes of Lake Michigan* (1899); *Plant Societies of Chicago* (1901); *Textbook of Plant Ecology* (1911); and *Plant Societies of Chicago and Vicinity* (1913). He was editor of the *Botanical Gazette*, 1925–34.

COWLEY, ABRAHAM (1618–1667), English poet and essayist, last of the Metaphysicals and first of the Augustans, was born in London, and educated at Westminster school and at Trinity college, Cambridge. On being expelled by the Parliamentarians in 1643, he moved to Oxford where he was a member of the Falkland circle. He followed the queen to France in 1645 and was appointed her cipher secretary, acting also as a royalist agent in various capacities. On returning finally to England in 1656, he became associated with the group of men who prepared the way for the Royal society. He wrote *A Proposition for the Advancement of Experimental Philosophy* (1661) and, though never a Fellow of the Royal society, was always considered a pioneer of the society's principles. After 1660 he retired to live a quiet scholarly life in the country, where he interested himself in horticulture, on which he corresponded with John Evelyn, and also in medicine. He died at Chertsey on July 28, 1667.

Cowley is the type of the transitional writer. Remarkably versatile and adaptable, he produced verse and prose, usually of good quality, in almost every style current in his lifetime. While still a schoolboy he wrote verse of a Spenserian kind in *Poeticall Blossomes* (1633) and also lyrics in a more natural style reminiscent of Ben Jonson. His prose shows a steadier development than his verse but, as one might expect, the metaphysical verse usually shows signs of decline and the newer work of immaturity.

The term "Metaphysical Poets" originated in Dryden's critical collocation of Cowley with Donne. Dr. Johnson later made a number of trenchant comments on his use of the conceit, yet he took him as not only the representative poet of this school but as "undoubtedly the best." Cowley's metaphysical poetry appeared mainly in *The Miscellanies* (1656) and *The Mistress* (1647 and 1656). His "Ode of Wit" discusses and exemplifies the spirit of this poetry. His work lacks the imaginative concentration and tension of the great Metaphysicals; his conceits tend to be decorative expressions of a simple theme rather than embodiments of subtle and passionate feeling. The language is close to speech and there is a noticeable air of social decorum. "On the Death of Mr. Crashaw" is the most emotional of Cowley's metaphysical poems. It is in couplets, the conceits are on a large scale and the grand style and organization of the poem suggest his neoclassical successors. *The Mistress* belongs with the Cavalier collections and is heavily indebted to Donne. Cowley sets out also to rival Edmund Waller. The best poems have a racy dramatic quality of some originality. "On the Death of Mr. Hervey" belongs with this work in date though not entirely in manner. It is a poignantly personal account of a friendship, informal in language and quiet in tone.

An unfinished epic, *The Davideis* (1656; written *c.* 1640) and the *Pindarique Odes* (1656; written in the early 1650s) have their links backward, particularly the former, where conceits make up a large part of the imagery, but their main interest is as precursors of the future. *The Davideis* is a landmark in the history of the couplet and is composed according to strict neoclassical principles. In the odes, Cowley began with "imitations" of Pindar's "way and manner of speaking" rather than translations, and went on to independent poems in irregular stanzas and conversational style which have considerable intrinsic interest. "To the Royal Society" (1667) is a powerful and dignified address. Cowley established the form in England.

Cowley's later and more decidedly neoclassical work is contained in *Essays in Verse and Prose* (1668). The essays in prose vary from Baconian and Brownean sentences to more extensive passages which, as Johnson says, are "easy without feebleness, and familiar without grossness." With Dryden's prefaces they mark the emergence of a modern prose suitable for most purposes. Cowley's theme is the Epicurean-Horatian ideal of a life of cultivated retirement in a "moderate plenty." He writes personally, with many literary allusions, but few references to the contemporary scene or to his own scientific interests. The verse essays, in the form of odes and sets of couplets, supplement the prose with mild satires on "the Great Vulgar, and the Small" and celebrations of the "old Plebean" in his "Sabine field."

Cowley was the leader of the literary world in later life and was widely read in the 18th century. Since then his reputation has gradually settled down to that of an important and representative minor writer with a limited number of achievements approaching greatness.

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COWLEY, HENRY RICHARD CHARLES WELLESLEY, 1st Earl (1804–1884), British diplomat who as ambassador to Paris from 1852 to 1867 played a crucial role in the diplomacy of the Crimean War period, was born in London, June 17, 1804. He was the eldest son of Henry Wellesley, 1st Baron Cowley (1773–1847), British ambassador successively in Spain, Austria and France; nephew of the 1st duke of Wellington; and brother of Gerald Valerian Wellesley (1809–82), dean of Windsor and confidant of Queen Victoria. He was educated at Eton and at Brasenose college, Oxford, and entered the diplomatic service in 1824, serving in turn at Vienna, The Hague, Stuttgart, Constantinople, Bern and Frankfurt. In Feb. 1852 Lord Granville chose him to succeed Lord Normanby as British ambassador at Paris.

The appointment, though unexpected, proved excellent. For many years the ambassador to Paris had changed with each change of government in London (Normanby's predecessor, in 1841–46, had been Cowley's own father), but Cowley proved so able and trustworthy that he held his post for 15 years, under eight ministries. Personally shy and even unsociable, he was absolutely straightforward and a master both of tact and firmness. Stror

s well as weak British foreign secretaries and the vacillating em-eror Napoleon III alike relied on his judgment and advice. He onducted with exemplary skill the delicate negotiations with the rench which resulted in the alliance that fought the Crimean War; eld the alliance together—no easy task—while the war went on; nd with his friend the 4th Lord Clarendon (*q.v.*) was a pleni-otentiary at the peace congress of Paris which concluded it in 856. Next year he was advanced to an earldom. It was largely ecause of Cowley's abilities and discretion that peace was pre-erved between England and France, both when French opinion as exacerbated over the Orsini affair in 1858 (*see* ORSINI, FELICE) nd when English opinion was exacerbated over the French annex-tion of Savoy in 1860. He helped to negotiate Richard Cobden's rade treaty of that year, and continued to exercise a pacific in-uence over the emperor for the rest of his time at Paris. He as created knight of the Garter in Feb. 1866, and retired in uly 1867. Cowley died in London on July 15, 1884.

See F. A. Wellesley (ed.), *The Paris Embassy During the Second Em-ire* (1928); Sir Victor Wellesley and R. Sencourt (eds.), *Conversations ith Napoleon III* (1934). (M. R. D. F.)

COWLEY FATHERS, the popular name for the SOCIETY OF T. JOHN THE EVANGELIST, the oldest Anglican religious com-unity for men, founded in 1866 by Richard Meux Benson (1824–915) at Cowley, Oxford. It combines an austere and profound ner life with preaching and missionary work. The society also as houses in the United States, Canada, South Africa, India and apan.

See P. F. Anson, *The Call of the Cloister* (1955); M. V. Woodgate, *ather Benson* (1953). (A. MACD. A.)

COWPEA, the name used in the United States for the culti-ated forms of *Vigna sinensis* especially, but also for *V. catjang*, wo legumes closely related to the ommon beans. In most other ountries the cowpea is known as hina bean or black-eyed bean; otanically it is a bean rather han a pea. The plants are ram-ling tender annuals, probably ative to India and Iran, but their ultivation extended to China at n early date.

JOHN H. GERARD

COWPEA OR BLACK-EYED PEA (VIGNA SINENSIS)

In the U.S. the cowpea is ex-nsively grown in the south as a ay crop, as a green-manure crop nd as shelled beans for human nsumption. More than 200 arities of *V. sinensis* have been cognized under the generic terms "black-eyed pea" and "corn-ld pea." (J. M. BL.; X.)

COWPER, WILLIAM (1731–1800), was one of the most idely read English poets of his time, and even today some of s hymns are sung throughout the English-speaking world. He ought a new directness into nature poetry; he wrote of the com-on joys of everyday life; he expressed the feelings of the hu-anitarian movement of his age. Yet the circumstances of his life d little to prepare him for his place as a popular and influential et, for he was a recluse and, at times, a madman and, like Wil-am Blake, was always at odds with the predominantly pragmatical hilosophy of his time.

William Cowper (who, like the rest of his family, pronounced is name "Cooper") was born at Great Berkhamsted, Hertford-ire, on Nov. 26, 1731. His father, who was rector of the parish, as a nephew of the first Earl Cowper; his mother, Anne, was re-ted to the family of the poet John Donne. After the death of s mother when he was six, an event which greatly affected the oung boy, Cowper was sent to a boarding school at the nearby vil-ge of Markyate or Market Street where the bullying he endured ought on a nervous inflammation of the eyes. He then moved on Westminster school in London where he seems to have been asonably happy. He left Westminster in 1748, and went to live 1750 at the house of Mr. Chapman, an attorney, with whom he udied law. He was admitted in turn to the two Inns of Court, the Middle and Inner Temple, was called to the bar in 1754, and took chambers in the Middle Temple in 1757. Cowper was obviously unsuited to a career in law, but his student days were important because it was then that he made friends with some of the young wits of the time (Charles Churchill, Robert Lloyd and the future lord chancellor, Edward Thurlow). It was then, also, that he got to know his cousins, Harriet and Theodora, daughters of Ashley Cowper of Southampton row, and fell deeply in love with Theodora. For a time there was an engagement between the two, but Ashley Cowper insisted that it should be broken off on the grounds that his nephew was without prospects and was showing signs of mental instability. William Cowper, indeed, was beginning to cause some anxiety to his friends. His father had died in 1756, leaving him no great fortune, and his family used their influence to obtain for him the offer of two administrative posts in the house of lords—that of reading clerk and that of clerk of the committees. Unfortunately the appointment entailed a formal examination at the bar of the house, the prospect of which so disturbed Cowper that he tried to commit suicide and had to be confined for 18 months in an asylum at St. Albans.

It was during this period of insanity that he began to be troubled by the religious doubts and fears which returned, intermittently, throughout his life. In a dream he saw himself shut out from the band of Christian worshipers and woke to believe that he was predestined to inevitable damnation. But if religion provided the chief horror of his madness, it provided also the comfort of his convalescence. In June 1765 he was able to leave the asylum, and his friends, who had contributed toward a small pension, arranged for him to live at Huntingdon to be near his brother Jack who was a fellow of St. Benet's college, Cambridge. At Huntingdon he made friends with the Unwins (the Rev. Morley Unwin, his wife Mary and their son and daughter) with whom he took lodgings in Nov. 1765. The Unwins were a pious, Calvinist, Church of England family, fervent supporters of the evangelical revival which was then a powerful force in English society. Cowper's two years with them were the happiest of his life and when, in July 1767, Morley Unwin was killed by a fall from a horse, it was arranged that the poet should take up residence with the widow and her children at Olney, in Buckinghamshire, in order to be near John Newton, curate of the parish, with whom he had become acquainted. Newton, one of the leaders of the evangelical movement, introduced Cowper to a life of hymn singing, sick-visiting and acts of charity, which was too vigorous for the poet's frail nervous system and led to a return of his doubts and melancholy, though it must be noted that it was not from Newton that he derived his delusions about damnation. To divert the poet from his melancholy Newton suggested that the two of them should co-operate in writing a book of religious verse which appeared eventually in 1779 as the *Olney Hymns*, Cowper's contributions being marked by a "C." The work of composition failed to revive his spirits and in 1773 he relapsed once again into melancholic near-madness, which put an end to any thoughts of marriage with Mary Unwin.

During this illness he stayed at the vicarage under Newton's care, and though by the summer of 1774 he was well enough to return to his own house, Orchard Side, he was greatly changed. He had lost all his religious fervour and sought distraction from fears of damnation by gardening and the keeping of tame hares. In 1780 Newton left Olney to become rector of St. Mary Woolnoth in London, and though his absence may have been something of a relief, it left Cowper with much spare time. He decided to occupy himself, therefore, with the writing of poetry and, Mrs. Unwin having suggested as a subject "The Progress of Error," he began composing the six moral satires which gave him valuable practice in versifying.

About this time he passed into a comparatively cheerful phase (as can be seen from two of the satires, "Conversation" and "Retirement") due largely to his friendship with Lady Austen, the sister-in-law of the vicar of the nearby parish of Clifton. It seems likely that Lady Austen, who was a widow, may have contemplated marriage with Cowper but this was unthinkable to him and the friendship cooled. In 1784 she left Olney and did not

return, but before leaving she had given Cowper the story which he made into the ballad "The Diverting History of John Gilpin," soon to be sung all over London, and also had playfully suggested that he should write about the sofa—an idea which grew into *The Task*. This latter, a long, discursive poem intended "to discountenance the modern enthusiasm after a London life, and to recommend rural ease and leisure, as friendly to the cause of piety and virtue," was published in 1785, together with "Tirocinium, or A Review of Schools," and was an immediate success. His fame brought him new friendships and a renewal of old ones. In particular, his cousin Harriet Cowper, now Lady Hesketh, spent much time at Olney and persuaded the poet to move to a larger house at Weston, a neighbouring village, where he could be near his Roman Catholic friends, the Throckmortons. He was at work by this time on his translation of Homer, a long laborious task, the revision of which continued to trouble him for many years after the publication, in 1791, of the first edition. His spirits and health began to break down under the strain, and there were occasional bouts of madness. In 1792, Mrs. Unwin had a second paralytic stroke from which she remained an invalid for the rest of her life. Cowper now began to compile an edition of Milton which he failed to complete. The work brought him the friendship of William Hayley, famous for his association with William Blake and George Romney, who was interested in the same poet. Largely through Hayley's efforts Cowper was awarded a pension of £300 a year, but his health continued to deteriorate, and in 1795 his cousin John Johnson ("Johnnie Johnson of Norfolk") took the poet and Mrs. Unwin to East Anglia where, in Oct. 1796, they finally settled at East Dereham. It was hoped that the change of scene would be of benefit to Cowper, but, after the death of Mary Unwin in Dec. 1796, he gradually sank into lethargy and despair from which he never emerged. He died on April 25, 1800, and was buried in East Dereham church.

Though Cowper's life was a sad one, his poetry is largely the poetry of pleasure. He celebrates not the rare and strange but things that are ordinary and even humdrum—the greenhouse, the garden, the fireside, the cup of tea. Some 18th-century poets (such as James Thomson) wrote of wild, romantic country, while others (such as Pope) wrote of parkland and well-managed estates, but Cowper was content to describe the unspectacular midland scene of hedges, lanes, ditches, rivers, haystacks and ploughland. In the long descriptive passages of *The Task* he seems not to be constructing a landscape but rather to be recalling his impressions in a series of vivid vignettes. His sketches of birds and other creatures are as lively as a woodcut by Thomas Bewick. From no poet before him and from few since can there be compiled so rich an anthology of the details and minutiae of nature accurately observed and felicitously worded. His style sometimes has a certain stiffness, for he often essayed a mock-Miltonic manner, but at his best he has a quiet, conversational ease and when moved by a subject which stirred him greatly (such as the slave trade or cruelty to animals) he could rise to a true eloquence. In his comparative simplicity of language, his feeling for nature and his sympathy with the poor and oppressed, he may be seen as one in revolt against the trend of much 18th-century verse and as a forerunner of Burns, Wordsworth, Coleridge and other romantic poets. He was no wit, but he had the saving grace of humour which gives charm to his slightest pieces, some of which, such as "The Colubriad," are excellent examples of light verse. "The Poplar-Field" and one or two other short lyrics reveal an ear for melody which might not have been guessed from a reading of his blank verse, while "The Castaway" poignantly shows the tragedy which was never far below the surface of his mind.

It is this same combination of poignancy and humour which makes Cowper's correspondence so attractive and puts him among the very best letter writers in the English language. The best of his hymns, too, are important. More personal in tone than is usual in a successful hymn, they evoke an imaginative response by their use of powerful imagery drawn from nature and from the Bible. "God moves in a mysterious way" and "Oh! for a closer walk with God" have become part of the folk heritage of Protestant England.

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COWPER, WILLIAM COWPER, 1ST EARL (*c.* 1665–1723), English lawyer and a leading Whig politician who was the first lord high chancellor of Great Britain, was the elder son of Sir William Cowper, 2nd baronet. Educated at St. Albans school, Cowper was called to the bar in 1688. Having promptly given his allegiance to William of Orange, he was made recorder of Colchester in 1694 and from 1695 to 1705 represented first Hertford and then Beeralston in the house of commons. He enjoyed the reputation of being the most distinguished Whig barrister and one of the most effective parliamentary orators of his generation.

Having survived the odium of a murder charge brought against his brother Spencer (the grandfather of William Cowper the poet), Cowper was appointed lord keeper of the great seal in 1705. In 1706 he succeeded to his father's baronetcy and was raised to the peerage as Baron Cowper. In 1707, after the union with Scotland, he was appointed the first lord high chancellor of Great Britain. He resigned in 1710. On the death of Queen Anne, he was made one of the lords justices for governing the country during the interregnum, and Cowper wrote a paper entitled *An Impartial History of Parties* for George I's guidance. He was reappointed lord chancellor in 1714, supported the impeachment of Lord Oxford in 1715 and presided, in 1716, as lord high steward at the trials of peers charged with complicity in the Jacobite rising of 1715. In 1718, shortly after receiving the titles Viscount Fordwiche and Earl Cowper, he resigned, probably because his intimacy with, and support of, the prince of Wales had incurred George I's enmity. He remained an active member of the house of lords until his death, at Colne Green, Hertfordshire, on Oct. 10, 1723.

Cowper was not a profound jurist, but he sought to remove many of the abuses of his court, refusing to accept the traditional new year gifts and attempting to expedite chancery procedure. A man of considerable personal charm, he was twice married. His son William succeeded to the family honours. (G. H. J.)

COWPER STOVE, an apparatus for preheating the air blown into a blast furnace (*q.v.*). One of the most important steps in successful and economical blast-furnace practice is accomplished by heating the air blast prior to its introduction into the furnace. While the general principle of the use of preheated air was originally employed by James Neilson in 1828 in Glasgow, Scot., it was not until 1860 that E. A. Cowper invented the first economical intermittent type of hot-blast stove. This is a vertical cylindrical steel shell lined with fire brick and with the interior separated into a chamber for the combustion of waste hot-blast furnace gases and a regenerative chamber filled with a checkerwork of refractory brick heated by the burned gas. After the checkerwork has been heated the gas is shut off and the air blast passes through the regenerative chamber to be preheated on its way to the blast furnace.

The efficiency and thermal capacity of the stove are governed by the surface area of the brick checkers and their mass. The brick, exposed on both sides to heating, is generally about 1½ in. thick. The normal air blast period is about 90 minutes with a

blast temperature ranging from 1,000° up to 1,800° F.

For another application of heat regeneration *see* CRUCIBLE STEEL. *See* also IRON AND STEEL INDUSTRY: *Blast Furnace Plant: Stoves.* (D. S. E.)

COWRIE (COWRY), a common name for a handsome, shelled marine gastropod mollusk of the family Cypraeidae, a great favourite with shell collectors because of its rich colouring and naturally polished shell. More than 160 living species are known. They live in shallow water, and are found principally in the Indo-Pacific region, though several species are found in warm American waters.

CARLETON RAY

COWRIE (CYPRAEIDAE) SHOWING MANTLE PARTIALLY FOLDED OVER EDGE OF SHELL

Cowries have a striking appearance when seen alive. The edges of the mantle are folded over the shell, covering a large part of its surface, and are provided with branched appendages. In the young cowrie the shell is like that of a normally coiled snail, the lip of the aperture being simple and the spire acute and prominent. In the adult the outer lip is very large, the shell is inrolled so that the spire is nearly hidden, and the internal wall between the various whorls is resorbed.

The shells of the money cowrie, *Cypraea moneta*, have been used by certain African tribes as currency (*see* CURRENCY, PRIMITIVE), and those of other species are widely employed as ornaments and charms against evil, sterility, etc. (*see* DRESS: *Origins*). *Cypraea aurantium*, the golden cowrie, is worn as a symbol of rank in the Fiji and the Tonga islands.

See also SHELLS AND SHELL COLLECTING. (W. K. E.)

COWSLIP, a common name for several herbs including a garden perennial, the primrose *Primula veris*, and a wild flower, the marsh marigold. *See* MARSH MARIGOLD; PRIMROSE; PRIMULACEAE.

COW TREE (MILK TREE), any of several tropical American trees whose milky latex, which flows out in quantities when a notch is cut in the trunk, is sweet and pleasant tasting. The group includes *Brosimum utile* (family Moraceae) native to Venezuela; and several species of *Couma* (family Apocynaceae) and *Mimusops* (family Sapotaceae). The milk tree of Brazil, *Mimusops huberi*, produces a latex having the consistency and richness of thick cream; it is used as a nutritive drink and as glue. The timber of this tree is valuable and the fruit is edible.

COX, JACOB DOLSON (1828–1900), U.S. army officer, political leader and educator, was born on Oct. 27, 1828, in Montreal, Que. He was reared in New York city, and studied in a law office in 1842–44. Working in a broker's office in 1844–46, he came under the influence of Charles G. Finney, whose daughter he afterward married. In New York city he also prepared himself for the ministry. He attended Oberlin college, Oberlin, O., and graduated in 1851, having given up his theological studies in rebellion against Finney's dogmatism. From 1851 to 1853 he was superintendent of schools at Warren, O. In 1853 he was admitted to the Ohio bar and in 1859 was elected to the state senate. Appointed by the governor of Ohio as one of three generals of militia in 1860, he studied tactics, strategy and military history.

During the American Civil War he raised troops for the Union service, enlisted himself in spite of poor health and a family of six children, and was commissioned a brigadier general, U.S. volunteers. He took part in the West Virginia campaign of 1861, served in the Kanawha region and was in supreme command there from the spring of 1862 until August of that year when his troops were ordered to join Burnside's IX corps in Virginia. During Antietam, Cox commanded the corps, and at the close of the campaign (Oct. 6, 1862) he was appointed major general, U.S. volunteers, but the appointment was not confirmed. In April–December 1863 he was head of the department of Ohio. In 1864 he took part in the Atlanta campaign, as a corps commander.

As governor of Ohio in 1866–67, he advocated colonization of the freedmen in a restricted area, sympathized with President Johnson's program of reconstruction and worked for a compromise between Johnson and his opponents. In 1868 he was chairman of the Republican national convention that nominated Grant. He was secretary of the interior in 1869–70; introduced the merit system in his department, and resigned in Oct. 1870 because of political pressure.

He took up legal practice in Cincinnati, became president of the Toledo and Wabash and Western railroad in 1873, and until 1877 was receiver of that company. In 1877–79 he was a representative in congress. From 1881 to 1897 he was dean of the Cincinnati Law school, and from 1885 to 1889 president of the University of Cincinnati. He died at Magnolia, Mass., on Aug. 8, 1900. A successful lawyer, and in his later years a prominent microscopist, he is best known as one of the great "civilian" generals of the Civil War. In 1874 he became military expert for the *Nation* and wrote extensively. Among his published works were *Atlanta* (1882) and *The March to the Sea, Franklin and Nashville* (1882), both in the "Campaigns of the Civil War Series"; *The Second Battle of Bull Run, as Connected with the Fitz-John Porter Case* (1882); and the valuable *Military Reminiscences of the Civil War* (1900), published posthumously.

COX, JAMES MIDDLETON (1870–1957), U.S. publisher, state governor and unsuccessful Democratic candidate for president, was born near Jacksonburg, O., on March 31, 1870. Leaving school at 16, he was a country schoolteacher for a few years before working in a printer's office. Later he became a reporter on the *Cincinnati Enquirer* and in 1898 bought the *Dayton News*. Eventually he purchased the *Dayton Journal Herald*, the *Miami* (Fla.) *News*, the *Springfield* (O.) *News*, the *Springfield* (O.) *Sun*, the *Atlanta* (Ga.) *Journal* and, in 1950, the *Atlanta* (Ga.) *Constitution*.

He served as congressman (1909–13) for the 3rd Ohio district (Dayton) and was governor of Ohio (1913–15 and 1917–21). During his terms as governor he introduced such notable reform measures as the workmen's compensation law, the provision of a minimum wage and a nine-hour day for women, the initiative and referendum and the establishment of a state tuberculosis hospital. He favoured the abolition of the federal inheritance tax, believing that the state alone should have jurisdiction over inheritances. Cox energetically suppressed violence in connection with strikes, his general policy being to hold local instead of state authorities responsible.

In 1920 the Democratic party nominated him for the presidency, with Franklin D. Roosevelt as his running mate. Cox was a strong supporter of Pres. Woodrow Wilson's policies and of the League of Nations, an issue that contributed to his defeat by Warren G. Harding, the Republican nominee. The electoral vote was 404 for Harding, 127 for Cox, with the popular vote being 16,152,200 for Harding and 9,147,353 for Cox.

He retired from political life until 1933, when President Roosevelt appointed him as a delegate to the World Monetary and Economic conference in London. In later life he operated a model scientific farm near Jacksonburg, O. Besides the ownership of several newspapers, he also owned radio and television stations. Cox died on July 15, 1957, in Dayton, O.

See *Journey Through My Years* (1946), an autobiography.

COX, KENYON (1856–1919), U.S. painter and critic, who achieved prominence through his murals and decorative work, was born at Warren, O., on Oct. 27, 1856, the son of Gen. Jacob Dolson Cox. He was a pupil of Carolus Duran and of J. L. Gérôme in Paris from 1877 to 1882, when he returned to New York, subsequently teaching with much success in the Art Students' league. Among the better-known examples of his work are the frieze for the courtroom of the appellate court, New York city, and decorations for the Walker Art gallery, Bowdoin college, Brunswick, Me., and for the capitol at St. Paul, Minn. He was the author of several books, generally against new movements in art and for what he termed "the classic point of view." Cox became a National academician in 1903, and in 1910 was awarded the medal of honour for mural painting by the Architectural league. Cox died in New York city on March 17, 1919.

His wife, Louise H. King (1865–1945), whom he married in 1892, also became a figure and portrait painter of note.

COX, SIR PERCY (1864–1937), British diplomat, remembered especially for his work in the foundation of modern Iraq, was born at Herongate, Essex, on Nov. 20, 1864. Educated at Harrow and the Royal Military college, Sandhurst, he joined the Cameronian regiment, then stationed in India, in 1884. In India Cox was posted to an Indian regiment and then joined the Indian political service. He gained varied experience, serving in princely states, learning languages and spending two years in Somaliland. The years 1896–1914 were passed almost entirely in Oman, the Persian gulf area and southwest Iran where Cox, showing great patience, sagacity and humanitarian interest, carried out some remarkable hinterland journeys. He dealt with the many local and international problems of a wide, lawless and ungoverned area and established cordial relations far and wide. He became a political resident in the Persian gulf, under the government of India, in 1909 and was knighted in 1911. As chief political officer to the Mesopotamia expeditionary force during World War I, Cox was responsible for all local relations in occupied Iraq. He was British minister to Teheran (1918–20) and negotiated an important (but never ratified) Anglo-Iranian agreement. Appointed high commissioner to the new state of Iraq, under British mandate, in 1920, he was deeply concerned with the establishment of the Iraqi monarchy, constitution and political life. The successful overcoming of many intractable initial difficulties was largely his work and that of King Faisal. Cox retired in 1923 and died while hunting near Bedford on Feb. 20, 1937.

See P. Graves, *Life of Sir Percy Cox* (1941). (S. H. Lo.)

COX, RICHARD (*c.* 1500–1581), bishop of Ely and an active promoter of the Reformation in England, was born at Whaddon, Buckinghamshire, and educated at Eton and at King's college, Cambridge. He became a member of Cardinal Wolsey's new foundation at Oxford, being appointed first dean of Christ Church in 1547, and after holding various offices was installed as dean of Westminster in 1549. He had an important share in drawing up the 1549 and 1552 prayer books. As chancellor of the University of Oxford (1547–53) he encouraged foreign theologians such as Peter Martyr, and sought to remove all traces of Romanism from the books, manuscripts and ornaments of the university. On Mary's accession he was imprisoned for a short time, then released, and in May 1554 he escaped to the continent of Europe, eventually arriving at Frankfurt. Trouble there between the supporters of Cox and those of John Knox and William Whittingham, who had adopted an extremely puritanical form of service, ended with Knox's expulsion, and the 1552 prayer book was restored.

On Mary's death (1559) Cox returned to England, took part in the Westminster disputation with the Roman Catholics and was appointed bishop of Ely. He was intolerant and always anxious to constrain those who differed from him. While he refused to minister in the royal chapel, where crucifix and lights were retained, and was a bitter enemy to the Roman Catholics, he had little more patience with the Puritans. He was avaricious, and often came into conflict with courtiers who coveted episcopal lands. Elizabeth I intervened when he refused to grant his palace in Holborn to her favourite, Christopher Hatton, and Cox had to give way. In 1580 he resigned his see. He died on July 22, 1581.

See W. Whittingham, *A Brief Discourse of the Troubles at Frankfurt*, ed. by E. Arber (1908); C. H. Garrett, *The Marian Exiles* (1938). (G. Hu.)

COXEY'S ARMY, a small group of about 100 disgruntled, unemployed persons who set out on foot from Massillon, O., March 25, 1894, for Washington, D.C. Led by Jacob S. Coxey, a self-made businessman, this "army" was the most famous of many such pilgrimages to the national capital in 1894 to popularize the need for economic reform. Sometimes referred to as the "Commonweal of Christ," Coxey's army favoured the Populist party program and the free coinage of silver. It successfully trekked across Ohio, Pennsylvania and Maryland, arriving in Washington on May 1, 1894. Now about 500 strong, the army peaceably descended on the capitol for the purpose of influencing congress to consider favourably two Coxey-sponsored bills—a good roads bill and a noninterest-bearing bond bill. The latter called for the issuance by the treasury of $500,000,000 in legal tender notes. This "petition in boots" ended ignominiously when Coxey and several of his followers were arrested for trespassing on public property. Shortly thereafter the whole industrial army movement collapsed as armies disbanded and enthusiasm waned.

See D. L. McMurry, *Coxey's Army* (1929). (R. K. M.)

COYOTE, a North American member of the dog family (Canidae), also known as the prairie wolf, *Canis latrans*. Ranging from Alaska in the north to Costa Rica in the south and frequenting almost every kind of country, especially the plains, the coyote is smaller than the wolf and more jackal-like (usually under 30 lb. in weight). The over-all length of about 36 in. includes 12 to 15 in. of tail. The general colour is grizzled buff above and whitish below; the legs, reddish. The bushy tail, directed downward when the coyote runs, has a black tip and a dark gland patch near the root. There is, however, considerable local variation in size and colour as seen in the many subspecies.

JOHN H. GERARD

COYOTE (CANIS LATRANS)

Although coyotes are slinking and stealthy nocturnal hunters, they often attain a speed of 40 m.p.h. in their pursuit of fast game, which they frequently run down in relays. Their attacks on domestic animals have been greatly overrated. Hares, chipmunks and mice form a large portion of their food; but also eaten are the fawns of deer and prongbuck and sage hens and other game birds. A surprising amount of vegetable food is also taken, including the fruit of prickly pear cactus, rose hips and juniper berries. Coyotes dig burrows for themselves, usually on a slope, or take possession of those already made by badgers and prairie dogs. There, in the spring, the half-dozen or more coyote pups are born. The parents, lifelong mates (life span about 13 years), are attentive and solicitous, feeding and teaching the young until fall. The coyote, alone or in company, performs a regular nocturnal ritual—his distinctive serenade, consisting of short yaps, whines and barks to mournful howls. *See* CARNIVORE. (J. E. HL.; X.)

COYPEL, the name of a French family of painters who executed many of the large historical compositions that decorated the royal palaces of France. NOEL COYPEL (1628–1707), also called from the fact that he was much influenced by Poussin, COYPEL LE POUSSIN, was employed by Charles Errard to paint some pictures required for the Louvre. In 1672 he was appointed director of the French Academy at Rome. After four years he returned to France; and not long after he became director of the Academy of Painting. The "Martyrdom of St. James" in Notre Dame is perhaps his finest work.

His son and pupil, ANTOINE COYPEL (1661–1722), was more celebrated than his father, with whom he spent four years at Rome. At the age of 18 he was admitted into the Academy of Painting, of which he became professor and rector in 1707, and director in 1714. In 1716 he was appointed king's painter, and he was ennobled in 1717. He was a clever etcher and engraver several of his own works. His *Discours prononcés dans les conférences de l'Académie royale de Peinture*, etc., appeared in 1741

Antoine's half-brother, NOEL NICHOLAS COYPEL (1692–1734) was also an exceedingly popular artist; and Antoine's son, CHARLE ANTOINE COYPEL (1694–1752), was painter to the king and director of the Academy of Painting.

COYPU, a large South American aquatic rodent whose rec dish-brown fur is of some commercial value and is known as nutri *See* NUTRIA.

COYSEVOX, ANTOINE (1640–1720), French sculptor c Spanish descent, best known for his portrait busts and his decora tive work at the palace of Versailles, was born at Lyons on Sep 29, 1640. He came to Paris in 1657 and studied under L. Leran bert. He was made sculptor to the king in 1666. By 1679 h was at Versailles, where he contributed to the decoration of th

alerie des Glaces, Ambassadors' staircase and the Salon de la uerre, for which he carved the brilliant equestrian relief of ouis XIV (*c.* 1688).

Coysevox executed much decorative sculpture for the royal ardens, notably the equestrian "Renown" and "Mercury" at arly (1700–02). His work also includes a number of important mbs, notably those of Colbert (1685–87) and Mazarin (1689–3) and the great votive group of Louis XIV on the high altar of otre Dame. These, like his formal portrait busts of the king nd state dignitaries, are of a far more baroque character than he work of any of the great sculptors working at Versailles. But n the more intimate of his magnificent series of portrait sculptures, uch as the statue of the duchesse de Bourgogne as Diana (1710), e drops the Berninesque swagger and formality of his state portraits and anticipates the naturalism and grace of the rococo style. lis principal pupils were his nephews Nicolas and Guillaume oustou and the elder Lemoyne. Through these three sculptors is influence extended almost through the 18th century. He died n Paris on Oct. 10, 1720.

See G. Keller-Dorian, *Antoine Coysevox,* 2 vol (1920); Luc-Benoist, *ntoine Coysevox* (1930). (F. J. B. W.)

COZENS, ALEXANDER and **JOHN ROBERT,** English raftsmen and painters of landscape in water colours.

Alexander Cozens (*c.* 1717–1786) was born in Russia, the on of Richard Cozens, shipbuilder to the tsar. He settled in ngland after visiting Rome in 1746, and became a fashionable rawing master. William Beckford was his pupil and has preerved almost all that is known of his personal characteristics. lis fondness for systematization found expression in many pubcations for artists. *A New Method of Assisting the Invention . . . Landscape* advocated the free manipulation of ink for uggesting compositions, and his own "blots" done in this manner re among his most effective drawings. He exercised considerable nfluence on English water-colour drawing. His own work was arried out almost exclusively in monochrome washes, but he chieved breadth and atmospheric effect. He died in London on pril 23, 1786. The British museum's collection of his works inudes 53 drawings lost by him when returning from Italy, which is son recovered in Florence 30 years later.

John Robert Cozens (1752–1797), son of Alexander Cozens, as born in London and began to exhibit drawings with the Society f Artists at the age of 15. The two long visits he paid to the conent, during 1776–79 and 1782–83, were the formative and decive events in his career. On the first occasion he traveled through witzerland to Italy, it is said as draftsman to the antiquary ichard Payne Knight, and spent much time in Rome. His second isit was made with William Beckford, whom he accompanied s far as Naples. Cozens became insane in 1793, and spent the emainder of his life under the care of Thomas Monro, an alienist, so known as a collector and amateur draftsman. He died in ondon in Dec. 1797.

Cozens found the subject matter of his art in the Alps and the oman Campagna. Painting in low-toned combinations of blue, reen and gray water colour, he evoked from these wild scenes, harged with historical associations, a haunting and sometimes elancholy poetry. T. Girtin and J. M. W. Turner, by copying is works in their early years, first learned from him the full range f water colour as an expressive medium. The British museum as 37 and the Victoria and Albert museum, London, has 28 water olours by him.

See A. P. Oppé, *Alexander and John Robert Cozens* (1952). (G. Rs.)

COZZENS, JAMES GOULD (1903–), U.S. novelist, ho became a well-known literary figure in the late 1950s, was orn in Chicago, Ill., on Aug. 19, 1903. He grew up on Staten sland, N.Y., and was educated there and at the Kent school, ent, Conn., from which he graduated in 1922, and at Harvard, here he spent two years. While at Kent he had a piece accepted y the *Atlantic Monthly,* a feat of precocity that he more than atched during his sophomore year at Harvard by publishing his rst novel. During a year's teaching in Cuba he accumulated ackground material for *Cockpit* (1928) and *The Son of Perdition* (1929). Cozzens first realized some acclaim in 1931, when his novella *S.S. San Pedro* won the Scribner's prize. Thereafter he published increasingly complex and able novels, most of which deal with human reverberations of the professions that his major characters practise. Thus, *The Last Adam* (1933) deals with a doctor, *Men and Brethren* (1936) with an Episcopalian minister, *The Just and the Unjust* (1942) and *By Love Possessed* (1957) with lawyers and *Guard of Honor* (1948) with officers and men at an army air force base in Florida.

Although Cozzens won the Pulitzer prize for *Guard of Honor,* he did not become a popular author until the publication of his most pretentious work, *By Love Possessed,* which not only garnered prizes and immense sales but became the centre of a critical controversy about the influence of Cozzens' conservative ideas on his former obscurity and later success. Perhaps the chief benefit of the controversy was that it led to reprintings and wider reading of his most important novels, *Men and Brethren, Ask Me Tomorrow* (1940) and *Guard of Honor.* (R. G. St.)

CRAB, a name applied to the short-tailed decapod Crustacea, the Brachyura, and to other forms, especially of the section Anomura, which may resemble them in appearance and habits. Brachyurans, or true crabs, are distinguished from the long-tailed lobsters and shrimps by the small abdomen or "tail," folded up under the body.

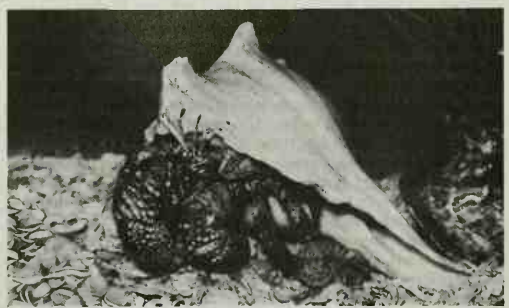
Distribution and Natural History.—Most crabs live in the sea; even the land crabs, which are abundant in tropical countries, visit the sea occasionally and pass through their early stages in it. The river crab of southern Europe, the Lenten crab (*Potamon edulis*), is an example of the fresh-water crabs that are abundant in most of the warmer regions of the world. As a rule, crabs breathe by gills, which are lodged in a pair of cavities beneath the sides of the hard shell, or carapace, but in the true land crabs the cavities become enlarged and modified so as to act as lungs for breathing air.

Walking or crawling is the usual mode of locomotion, and the peculiar sidelong gait familiar to most people in the common shore crab is characteristic of most members of the group. The crabs of the family Portunidae, and some others, swim with great dexterity by means of their flattened paddle-shaped feet.

Like many other Crustacea, crabs are often omnivorous and act as scavengers, but many are predatory in their habits and some are content with a vegetable diet.

Though no crab, perhaps, is truly parasitic, some live commensally with other animals. Examples are the little pea crabs (Pinnotheridae), which live within the shells of mussels and other bivalve mollusks and share the food of their hosts, and the coral-gall crabs (Hapalocarcinidae), which irritate the growing tips of certain corals so that they grow to enclose the female in a stony prison from which there is no escape. Many of the sluggish spider crabs (Majidae) cover their shells with growing seaweeds, zoophytes and sponges, which afford them a very effective disguise.

The giant crab of Japan (*Macrocheira kaempferi*) and the huge Tasmanian crab (*Pseudocarcinus gigas*) are two of the largest known Crustacea. Among the smaller brachyurans are the so-



BY COURTESY OF MARINE STUDIOS, MARINELAND, FLORIDA

FIG. 1.—LARGE HERMIT CRAB (PETROCHIRUS DIOGENES) IN A WHELK SHELL

called mud crabs of the family Xanthidae, which are seen on the seashores in most latitudes.

Better known anomuran crabs are the hermit crabs that live in empty shells of gasteropod mollusks, which they carry about with them as portable dwellings. As the crab grows it changes its abode from time to time, often having to fight with its fellows for the possession of an empty shell. In tropical countries the hermit crabs of the family Coenobitidae live on land, often at considerable distances from the sea, to which they must return to hatch out their spawn. The large robber or coconut crab of the Indo-Pacific islands (*Birgus latro*), which belongs to this family, has given up the habit of carrying a portable dwelling, and the upper surface of its abdomen has become covered by shelly plates.

CHARLES E. LANE

FIG. 2.—FIDDLER CRAB (UCA PUGILATOR): (TOP) FEMALE; (BOTTOM) MALE DISPLAYING ITS CLAW IN COURTING THE FEMALE

External Features and Development.—In most brachyurans the body is transversely oval or triangular in outline, more or less flattened and covered by the carapace. There are five pairs of legs. The first pair end in pincers or chelae and are usually much more massive than the others, which are used in walking or swimming. The eyes are set on movable stalks and can generally be withdrawn into sockets in the front part of the carapace. There are six pairs of jaws and foot-jaws (maxillipedes) enclosed within a "buccal cavern," the opening of which is covered by the broad and flattened third pair of foot-jaws. The abdomen is usually narrow and triangular in the males, but in the females is broad and rounded and bears appendages to which the eggs are attached after spawning.

As in most crustaceans, the young of nearly all crabs, when newly hatched, are very different from their parents. The first larval stage, known as the zoea, is a minute transparent organism, swimming at the surface of the sea. It has a rounded body, armed with long spines, and a long segmented tail. The legs are not yet developed and the foot-jaws form swimming paddles. After casting off its skin several times as it grows in size, the young crab passes into a stage known as the megalops, in which the body and limbs are more crablike, but the abdomen is large and not folded up. After a further molt the animal assumes a form very similar to that of the adult. There are a few crabs, especially those living in fresh water, that do not pass through a metamorphosis but leave the egg as miniature adults.

Economic Importance.—Many crabs are sought as food by man. The most important and valuable are the edible crab of British and European coasts (*Cancer pagurus*), the blue crab (*Callinectes sapidus*) of the Atlantic coast and the Dungeness crab (*Cancer magister*) of the Pacific coast of North America. The *Cancer* crab fishery of Europe ranks next in importance to its lobster industry. The crustacean fisheries of India outweigh in quantity and value the yield of all other fisheries of that country, the crabs being outranked only by the shrimps in importance. The swimming crabs, *Scylla* and *Portunus*, related to the American blue crab, are among the most important sources of sea food throughout the entire Indo-Pacific region. *Scylla serrata* reaches a large size, 8 to 12 in. in width, exceptionally 18 in. in the brackish waters of Chilka lake, India. Commercially valuable Anomura are the lithodid (literally "stone") crabs, of which the so-called king crab (*Paralithodes camtschatica*) of Japan, the Bering sea, and Alaskan waters is the most important.

Crabs are usually caught in baited traps or "pots," but the blue crab of the American Atlantic coast is frequently taken on baited lines, and the king crab fishery of the North Pacific employs trawling vessels, accompanied by factory ships to which the catches are transferred for immediate freezing or canning.

See CRUSTACEA; MALACOSTRACA. *See* also references under "Crab" in the Index volume.

(W. T. C.; W. L. St.; F. A. Ch.)

CRAB APPLE, the name applied to the fruits or plants of various species of *Malus*, the apple genus; also to certain crosses of such species with improved cultivated types, which give small-size tart fruits. The genus *Malus*, the apples (included by some botanists in *Pyrus*, the pear genus), includes approximately 25 species indigenous in temperate regions of North America, Europe and Asia. In general, they resemble the cultivated apple in flowers and foliage but have more slender trunks, stiffer and more or less spiny branches, and much smaller, usually very acid fruits. They are extensively used as ornamental shrubs or small trees, of which many horticultural varieties exist. The blossoms, white to pink and carmine, of many of the crab apples are extremely showy in the spring, and many species of crab apple are characterized by brightly coloured fruit that may hang on well into the winter. Crab apples most widely used as ornamentals include *Malus spectabilis*, the Chinese flowering crab; *M. baccata*, Siberian crab; *M. sieboldi*, Toringo crab; *M. floribunda*, the Japanese flowering crab; and *M. pumila* var. *niedwetzkyana*, the redvein crab.

The American crab apples include the following: *M. coronaria*, indigenous from western New York and southern Ontario to Wisconsin and southward to North Carolina and Missouri, a beautiful tree when in blossom in April or May and cultivated to some extent as an ornamental. The fruit is delicately scented but very acid, 1 to 1½ in. in diameter.

M. angustifolia, the southern crab apple, is native from southern Virginia to southern Illinois and southward to Florida and Louisiana. It produces fruit three-fourths to one inch in diameter. *M. ioensis*, the prairie crab apple, is indigenous from Wisconsin and Minnesota southward to Nebraska, Kansas and Missouri. The Oregon crab apple, *M. fusca*, is found along the Pacific coast from Alaska to California. The fruit is oblong, one-half inch or less in diameter.

ROCHE

FLOWERS AND FRUIT OF JAPANESE FLOWERING CRAB APPLE (MALUS FLORIBUNDA)

Fruits of all the crab apples may be used for jelly and other culinary purposes. The Siberian crab is rather widely grown for fruit, which is used mainly for jelly and for preserving and pickling. Most of the crab apple species can be crossed with standard apple varieties and many such crosses have been made, particularly in Canada, to secure very hardy, early ripening apples adapted to severe weather conditions. In general, the progeny are intermediate in size and quality between the parents.

In Europe many horticultural varieties producing small, highly acid fruit are grown primarily for cider making and are commonly referred to as crab apples or cider apples. Many of these may have originated as crosses between the *Malus* species and cultivated apples. They represent a large proportion of the apple production, particularly of France. (J. R. Mag.)

CRABBE, GEORGE (1754–1832), one of England's finest writers of verse-tales, a poet who handled with skill and imagination the realistic details of life. Born on Dec. 24, 1754, at Aldeburgh, Suffolk, where his father was a customs officer, Crabbe became a doctor's assistant, and set up his own practice in Aldeburgh in 1775. But he was not successful, and so in 1780 he

orrowed £5 and went to London. He had already published a oem *Inebriety* in 1775, but neither this nor *The Candidate* (1780) rought him any fame. In 1781 he wrote a desperate letter to the tatesman Edmund Burke. Burke acted at once; he read Crabbe's ompositions, selected a descriptive and didactic poem, *The Library*, and persuaded James Dodsley to publish it in 1781. In the ame year Burke used his influence to have Crabbe accepted for rdination, and after a few months as curate at Aldeburgh, in 782 Crabbe became chaplain to the duke of Rutland at Belvoir astle.

In the next year, Crabbe published the first poem in which he eally found his own voice, *The Village*. Dr. Johnson, who read he manuscript and suggested a few minor revisions, praised it as original, vigorous, and elegant."

The Village was in part a protest against Oliver Goldsmith's *The Deserted Village* (1770), which was thought by Crabbe to give oo sentimental and idyllic a picture of country life. Crabbe had esolved to tell the truth: "I paint the Cot, As Truth will paint it, nd as Bards will not." He was perhaps the first to express with igour and seriousness the dissatisfaction which many 18th-century oets had felt at the sentimental pastoral. In *The Village*, Crabbe ade good use of his detailed observation of humble life and of he grim countryside of his home. Already he had begun to earn yron's description of him as "Though Nature's sternest Painter, et the best."

Crabbe married Sarah Elmy in 1783. For more than 20 years fter *The Newspaper* (1785) he published nothing, though he wrote great deal. Then in 1807 he reprinted his poems, together with new work, *The Parish Register;* its success led him to publish n 1810 *The Borough*. Both were long poems which incorporated erse-tales; and Crabbe evidently thought that he had discovered he right form for his talent, since his next work was *Tales in Verse* 1812). By 1819 his success had been such that John Murray, he publisher, paid him £3,000 for the copyright of the previous olumes and of his new *Tales of the Hall*, 2 vol. (1819). Crabbe's ife had died in 1813; and, after receiving several preferments, rabbe was given in 1814 the living of Trowbridge, Wiltshire, his ome till his death. He was now a famous figure, and he became cquainted with such leading literary men as Sir Walter Scott, homas Moore and Thomas Campbell. After a retired life in his ter years, he died at Trowbridge, Feb. 3, 1832.

Crabbe is often, and rightly, called the last of the Augustans. e follows such Augustan poets as John Dryden, Alexander Pope nd Dr. Johnson, in using for almost all his poems the heroic ouplet. He handles this traditional instrument with great skill; nd although he lacks Pope's brilliant wit, he has his own weighty rewdness. His attitudes, too, are firmly Augustan. His moral dgments have much in common with the stern but humane outook of Dr. Johnson; and it is not surprising that Jane Austen, in any ways another late Augustan, lightheartedly imagined herself Mrs. Crabbe. But Crabbe is not merely what the parodist orace Smith called him, "Pope in worsted stockings." He had his vn subject-matter—the distresses, miseries and guilt of ordinary ily life (and not merely the life of the well-to-do). In 1825, illiam Hazlitt, though he disliked Crabbe's "literal fidelity," escribed it in a neat paradox: "he assumes importance by a numer of petty details; he rivets attention by being tedious." Hazlitt so saw that Crabbe's real strength lay in his psychological inght, his "intimate knowledge of the small and intricate folds of e human heart."

Earlier 18th-century poets such as Jonathan Swift and John ay had made use of the realistic and even sordid details of life; nd there had been a few realistic verse-tales, such as Soame nyns' *The Modern Fine Lady* (1751). But it was Crabbe who ppreciated what riches there were in this vein, and who became e first poet since Chaucer to combine, in his tales, traditional oral attitudes with the compassion that comes from understandg of human character. To these endowments he added a gift r storytelling, and an excellent understanding of how to use landapes to mirror the minds of his characters. He also had great ill at adapting the heroic couplet to the reproduction of conversan and repartee.

Crabbe is unlikely to be again a widely popular poet, because of the narrowness of his range and his deliberate avoidance of the "poetic" and the lyrical. But his power and sturdy poetic skill can still make their impact, and, for example, led Benjamin Britten to adapt the story "Peter Grimes" into an opera. It is not surprising that Crabbe's poems have always won the praise of his fellow poets, from Wordsworth and Byron to Ezra Pound and T. S. Eliot.

BIBLIOGRAPHY.—The edition of Crabbe's *Works*, 8 vol. (1834) contains a *Life of the Rev. George Crabbe* by his son; this was reprinted separately in the Worlds' Classics series in 1932. *Poems by George Crabbe* were ed. by Sir A. W. Ward, 3 vol. (1905–07); *New Poems* were ed. by A. Pollard (1960). *See* also R. Huchon, *George Crabbe and his Times*, Eng. trans. by F. Clarke (1907); L. Haddakin, *The Poetry of Crabbe* (1955). (C. B. Ri.)

CRAB GRASS, or finger grass, the common names for various species of *Digitaria*, especially *D. sanguinalis* and *D. ischaemum*, both natives of Europe widely naturalized as weeds in North America. Both of the above species and a few closely related ones become very troublesome weeds in lawns and on agricultural land because they have decumbent stems that root at the joints. Such a habit, in spite of their being annual grasses, makes eradication difficult, especially if they have seeded into existing lawns.

Rooting at the joints, even in the face of constant mowing, makes thickset patches of the weed, and mowing merely induces new flowering and fruiting spikes that shed their prolific seed and infest the ground for the succeeding season.

BY COURTESY OF THE IOWA EXPERIMENTAL STATION

CRAB GRASS, A WEED, INTRODUCED FROM EUROPE INTO AMERICA

Since crab grass is an annual, the only means of perpetuation is by seeds that overwinter in the ground, usually in great quantity. Generally, in ordinary temperate climates, the seed germinates in May or June, distinctly later than the spring growth of good lawn grasses, and causes bare patches in lawns that were infested with crab grass the previous season. This relatively tardy germination suggested the use of so-called preemergence sprays, which kill only the seeds. Applied in late April or early May, 2,4-D will often (but not always) kill these seeds without injuring desirable lawn grasses. The compound is poisonous. It is sold under a variety of trade names and should be used only in the concentration printed on the container. Preemergence sprays do not give such good control as do post-emergence sprays (*see* below), but in small areas they may kill off many seeds that would otherwise germinate. One reason for the partial ineffectiveness of 2,4-D is that in the temperate zone in late April or early May air temperatures are likely to be below 70° F., the temperature at which the compound is most effective.

Once crab grass has germinated it is essential to use post-emergence sprays designed to kill the crab grass but not other grasses. There are many such sprays on the market; all of them are dangerous poisons and must be used only in the concentration printed on the container. Three of them, in the relative order of effectiveness, are PMA (phenyl mercuric acetate); DSMA (disodium methyl arsonate), useful also for chickweed; and potassium cyanate. All should be used when the young seedlings are noticeable, and because none of them kill all seedlings, the treatment should be repeated two or three times in the summer.

After many years of experiment, authorities have concluded that the weed cannot be eradicated by chemicals alone. Seed will inevitably be carried in and become established, especially on poor soils that will not maintain a good lawn. The best remedy is to so improve the soil that a strong thick turf will smother the seedlings of crab grass long before their maturity.

See also LAWNS, CARE OF; WEED. (N. TR.)

CRACKING PROCESS, the thermal decomposition of petroleum to form more useful products. Cracking involves the use

of heat, pressure and catalysts and more than doubles the amount of gasoline obtainable from crude oil by the straight-run (boiling) method of distillation. *See* PETROLEUM; GASOLINE.

CRACOW (Pol. KRAKOW), a *wojewodztwo* (voivoidship) in southern Poland, bordering on Czechoslovakia. Pop. (1960) 1,989,200. Area 15,350 sq.km. (5,927 sq.mi.). Its southern region consists of the slopes of the Carpathian mountains. The high Tatra mountains, of granite and limestone, lie on the Czechoslovak frontier, their highest peak being Gerlach (8,711 ft.) on Slovak territory. The whole is a national park, as is the small Pieniny group with the picturesque Dunajec valley. North of the Carpathians lies the Sandomierz valley, watered by the Vistula river. Rich deposits of salt are found at the edge of the mountains and the valley (*see* WIELICZKA). The Little Polish plateau extends on the left bank of the Vistula. In its western part there are coal deposits (a continuation of the Upper Silesian coal basin), as well as zinc and graphite ores. The limestone belt of the Cracow-Czestochowa plateau is a tourist area, while the Miechow area, north of Cracow, with its fertile soils, is agricultural. Woods covering 25.8% of the land provide for the timber industry (Klucze, Zywiec). Coal deposits and water resources supply power, and the second largest Polish power station is at Jaworzno. After World War II the iron and steel industry was considerably extended (Nowa Huta, in Cracow town), and an aluminum foundry was built at Skawina. Besides the metal industry, the chemical (Oswiecim, Tarnow), building materials, textile (Andrychow) and food (Cracow) industries were developed. The tourist industry owes its growth to the fine landscapes, mineral springs, parks and reserves, places of architectural interest and the extensive folk traditions, especially in the Tatra mountains.

The largest towns (pop., 1960) are Tarnow (*q.v.;* 71,000), Jaworzno (53,000), Nowy Sacz (*q.v.;* 34,000), Oswiecim (*q.v.;* 31,000), Zakopane (*q.v.;* 25,000), Chrzanow (21,000), Zywiec and Nowy Targ. (T. K. W.)

CRACOW (Pol. KRAKOW), a city in southern Poland, the former capital of the country and the seat of a Roman Catholic archbishop (from 1925), is the chief town of Cracow *wojewodztwo* but (from June 1, 1950) is a separate administrative unit. It lies 696 ft. above sea level, on both banks of the upper Vistula, 249 km. (155 mi.) S.S.W. of Warsaw. Pop. (1960) 479,000.

At the centre of Cracow is the old city, which was once moated and walled. Of the medieval fortifications, pulled down at the beginning of the 19th century and replaced by shady promenades (*planty*), only two towers of the 13th century, with the St. Florian's gate (1307) and the Barbican (1498), are left. At the heart of the old city is Market square (Rynek) with the Drapers' hall (Sukiennice), a Gothic edifice of the 14th century, converted in the 16th century to the Renaissance style and restored in the 19th century. From each side of Market square run three parallel streets, but their chessboard arrangement is interrupted by older buildings and by Grodzka street, which leads from Market square to the royal castle standing on the rocky hill of Wawel, on the left bank of the Vistula.

Traces of the oldest building site are to be found on Wawel hill, where the pre-Romanesque rotunda of Felix and Adaukt was discovered. The remains were also found there of two successive cathedrals. The present cathedral (the third) was started in 1320. Added to and decorated by succeeding generations, it constitutes a harmonious blend of styles. The Sigismund (Zygmunt) chapel (1530), built by Bartolomeo Berecci, stands out in the whole complex as a masterpiece of Renaissance architecture. The interior of the cathedral contains the tombs of Polish kings, national heroes and poets. A silver coffin holds the alleged relics of St. Stanislaw, patron saint of the Poles who, as bishop of Cracow, was slain before the altar by King Boleslaw II in 1079.

From an early period Wawel hill was the site of the prince's court. The present castle, begun in the 12th century, was successively enlarged by Casimir the Great and Sigismund I Jagiello, and was until the end of the 16th century the residence of the Polish kings. It has a 16th-century Renaissance-style courtyard which, with its three-storied arcades, is one of the finest and largest of its kind in the world. The restoration of the castle, from 1846 an Austrian military barracks and hospital, was begun in 1905. Among its most precious ornaments are the 16th-century Flemish tapestries.

No other city in Poland has so many historic buildings. There are no fewer than 58 ancient churches, many of them containing famous works of art. The largest, and in many ways the finest, is that of Our Lady (13th–14th century) in a corner of Market square, a typical example of Polish Gothic. It contains stained-glass windows of the 14th century and a triptych by Veit Stoss. Sculptured in linden wood, it depicts scenes from the life of the Blessed Virgin. Seized and removed to Nürnberg by the Germans in 1939, it was returned to Poland in 1945 and replaced on the high altar of the church.

The university, the second oldest in central Europe, was founded by Casimir the Great in 1364. It is called Jagiellonian university after Wladyslaw Jagiello who transferred it in 1400 to the town parish of St. Ann's where it remained. The Collegium Maius, dating from the 15th century, is one of the few Gothic university buildings surviving in Europe. New university buildings were erected in 1883–87. The university library, completed in 1938, one of the largest in Poland, houses more than 1,000,000 volumes. Cracow also has ten other establishments of higher education, ten museums, nine theatres and an opera house.

Close to the city are four artificially built huge memorial mounds. Two of them date from the early middle ages: the first, that of Prince Krak (or Krakus) was erected probably in the 8th century to the memory of the legendary founder of Cracow; the second to that of his daughter Wanda who allegedly chose to drown herself in the Vistula rather than marry a German prince. The other two mounds are modern: one was erected in 1823 in honour of Tadeusz Kosciuszko (*q.v.*); the other in honour of Jozef Pilsudski (*q.v.*) in 1937.

Cracow is linked with Warsaw by two railway lines, one of which (through Czestochowa) is electrified. Other lines lead north to Danzig, west to Wroclaw and Berlin, to Prague and (through Presov) to Vienna, south to Zakopane in the Tatra mountains and east to Lvov. There is also an airport (5.6 km. or 3½ mi. distant).

Situated on the medieval trade routes between central Europe and the Black sea and between southern Europe and the Baltic, Cracow early became an important commercial centre. Many handicraft and some industrial enterprises existed there in the late middle ages, but industrial expansion began after the restoration of Poland's independence in 1918. The erection of the Nowa Huta iron- and steelworks, started in 1949 on the territory of Mogila village, 10 km. (6¼ mi.) to the east, with a modern settlement for 100,000 inhabitants, transformed Cracow into a considerable industrial centre. Within the boundaries of its new administrative area there are about 300 factories. The chemical, foodstuffs, printing, clothing, tanning, stoneworking and metallurgical industries are represented.

History.—Cracow, the political centre of the tribe of Wislanie (Vistulans), is thought to have been under Czech rule at one time, but about the year 1000 it was retrieved by Boleslaw I who made it the seat of a Polish bishopric. It became the capital of the most important of the principalities into which Poland was divided by King Boleslaw III in 1138. The city was practically ruined during the first Tatar invasion of Poland in 1241, but was soon rebuilt. In 1257 it received from Prince Boleslaw the Shy (Wstydliwy) "Magdeburg rights"; *i.e.,* a civic constitution modeled on that of Magdeburg. The city passed through many vicissitudes until King Wladyslaw I, who reunited Poland, made it his capital in 1320 and from that time it remained the coronation and burial place of the Polish kings.

The transfer of the country's capital to Warsaw in 1609 reduced Cracow's political importance. After the Swedish wars of the 17th century Cracow was also impoverished economically. The anti-Russian insurrection, headed by Kosciuszko, started in Cracow on March 24, 1794. One year later the third partition of Poland took place and Cracow became Austrian, but in 1809 Napoleon incorporated it with the duchy of Warsaw. In 1815, at the Vienna congress, Cracow and the adjoining territory were formed into an independent republic (pop. 140,000; area 3,160 sq.km. [1,22

q.mi.]), but in 1846 it was incorporated with Austria.

At the conclusion of World War I Cracow was again a part of estored Poland. In World War II it fell to the Germans on Sept. , 1939. Hans Frank, the German governor of the occupied and runcated Poland, established his headquarters at the Wawel castle.)n Nov. 6, 1939, he ordered the deportation of 186 professors and ecturers of the university to concentration camps in Germany vhere many of them died, including Stanislaw Estreicher, Kazi-nierz Kostanecki and Ignacy Chrzanowski. Frank was also re-ponsible for sending in March 1943 about 55,000 Cracow Jews to)swiecim (Auschwitz) extermination camp. On Jan. 19, 1945, Cracow was liberated by Soviet army groups under Marshal Ivan . Konev.

See also references under "Cracow" in the Index volume.

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CRADDOCK, CHARLES EGBERT (1850–1922), the pen name of MARY NOAILLES MURFREE, U.S. author, who was born near Murfreesboro, Tenn., Jan. 24, 1850. She was crippled in childhood by paralysis, but attended school in Nashville and Philadelphia. During her summers in the mountains of eastern Tennessee, she came to know the simple people there whom her writings portray. She contributed to *Appleton's Journal* and, first in 1878, to the *Atlantic Monthly*. No one, apparently, suspected that the author of these tales was a woman, and her identity was not disclosed until after the publication of her first volume of short stories, *In the Tennessee Mountains* (1884). She deals mainly with the narrow, stern life of the mountaineers, who, left behind in the advance of civilization, live amid traditions and customs and speak a dialect peculiarly their own. Her work abounds in effective descriptions of scenery. Among her other works are: *Where the Battle Was Fought* (1884), a novel dealing with the old aristocratic southern life, *The Prophet of the Great Smoky Mountains* (1885), *In the Clouds* (1886), *The Despot of Broomsedge Cove* (1888) and *His Vanished Star* (1894), novels; *The Mystery of Witch Face Mountain* (1895), *The Phantoms of the Footbridge* (1895), *The Young Mountaineers* (1897) and *The Bush Whackers* (1899), short stories. Her later books are inferior to those written when the local-colour movement was at its height. She died at Murfreesboro, Tenn., July 31, 1922.

See E. W. Parks, *Charles Egbert Craddock* (1941); F. L. Pattee, *A History of American Literature Since 1870* (1915).

CRADLE, a child's bed of wood, wicker or iron, with enclosed sides, slung upon pivots or mounted on rockers. It is a very ancient piece of furniture, and the date when it first assumed its characteristic swinging or rocking form is by no means clear. A miniature in an illuminated *Histoire de la belle Hélaine* in the Bibliothèque Nationale in Paris (end of the 14th or beginning of the 15th century) shows an infant sleeping in a tiny four-post bed slung upon rockers. In its oldest forms the cradle is an oblong oak box without a lid—originally the rockers appear to have been detachable but, like all other pieces of furniture, it has been subject to changes of fashion alike in shape and adornment. It has been panelled and carved, supported by Renaissance pillars, inlaid with marqueterie or mounted in gilded bronze. The original simple shape persisted for two or three centuries—even the hood made its appearance very early. In the 18th century, however, cradles were often very elaborate—indeed in France they had begun to be so much earlier, but the richly carved and upholstered examples were used chiefly for purposes of state, being in fact miniature *lits de parade*. In later times they became lighter and simpler and eventually were replaced by the barred crib.

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, N.Y., (TOP) ROGERS FUND (1906), (BOTTOM) GIFT OF MRS. RUSSELL SAGE (1909)

TOP: FLORENTINE CARVED WOOD CRADLE, 16TH–17TH CENTURY

BOTTOM: AMERICAN OR ENGLISH OAK CRADLE, 1625–1675

CRAGGS, JAMES (1657–1721), English politician, who helped promote the South Sea Bubble (*q.v.*), was born at Wyserly, Durham, on June 10, 1657. His business talents won him the patronage of the duchess of Marlborough, who obtained his election to parliament as member for Grampound (1702–13). Craggs's connection with Marlborough established his reputation in the City of London and gave him intimate access to the speculative opportunities created by rapid developments in public finance. He held various posts in military administration until 1714. He was reappointed clerk of the deliveries after the Hanoverian accession, and he became joint postmaster general in 1715. Characteristically Craggs received heavy bribes from the South Sea company directors; after the "Bubble" he tried to secure a settlement with the government and the Bank of England. Under examination by a parliamentary committee he broke down badly, and his sudden death on March 16, 1721, appeared to many to be a confession of guilt by suicide. Much of his vast estate was sequestrated for the relief of sufferers by the collapse.

His son, JAMES CRAGGS the younger (1686–1721) was born at Westminster on April 9, 1686. He was member of parliament for Tregony from 1713 until his death, and was rapidly advanced after the split in the Whig party, succeeding William Pulteney as secretary of war in 1717 and Joseph Addison as secretary of state in 1718. He was suspected of being involved with his father in the South Sea scandals, but on Feb. 16, 1721, during the inquiry, died of smallpox. (W. R. WD.)

CRAIG, EDWARD GORDON (1872–), English stage designer and writer on the art of the theatre, was born Jan. 16, 1872, the son of the actress Ellen Terry and the architect-stage designer E. W. Godwin. For eight years (1889–97) Craig was a younger member of Sir Henry Irving's Lyceum Theatre company, London, of which his mother was a distinguished star. His early career as a successful actor always coloured his views on the theatre. His early drawings, etchings and woodcuts (he was a self-trained artist) for the new stagecraft assaulted the false realism of the traditional painted settings of the Lyceum stage. His first six productions (1900–03) included Henrik Ibsen's *The Vikings of Helgeland* and *Much Ado About Nothing* for his mother. All revealed his emphasis on simplified plastic designs and his use of curtains, screens and abstract lighting.

Craig's striking innovations were rewarded with artistic success in London, but in Berlin (1904–06) they aroused enthusiastic support from Count Harry Kessler, Otto Brahm, Max Reinhardt and Isadora Duncan. His designs were widely exhibited in German cities and in Vienna. In 1905 *The Art of the Theatre* set forth his iconoclastic theories of production and was soon published in many languages. He took up residence in Italy in 1906. In Florence, from the Arena Goldoni, he edited and published *The Mask*, containing many of his own essays and illustrations. This international magazine was dedicated for many years to advancing the new movement in the theatre. In Florence also he founded his school of the theatre (1912–14), but World War I defeated his high hopes for its success.

After leaving England, Craig's most important stage productions were *Rosmersholm* for Eleanora Duse (Florence, 1906), *Hamlet* for Stanislavski at the Moscow Art theatre (1912), Ibsen's *Pretenders* for the Theatre Royal, Copenhagen (1927), and *Macbeth* for George Tyler (New York, 1928). He rarely returned to England. During World War II he carried on his theatre research in Paris under the German occupation, later settling in Vence, in southern France, where he designed and wrote of the theatre of the past, the present and the future. His writing and drawings influenced the course of the 20th-century theatre of Europe and America far more than did his few stage productions.

Among Craig's most provocative volumes are *On the Art of the Theatre* (1911), *Toward a New Theatre* (1913) and *The Theatre Advancing* (1924). *Woodcuts and Some Words* attests his craftsman's skill in the graphic arts. *Hamlet* (1929), published for Count Kessler by the Cranach press, with Craig's woodcuts, is a monumental achievement in book design. *Henry Irving* (1930) and *Ellen Terry and Her Secret Self* (1931) reveal his early inspiration and his passionate dedication to the art of the theatre. *See* also STAGE DESIGN.

See J. Leeper, *Edward Gordon Craig* (1948). (D. M. O.)

CRAIG, JOHN (1512?–1600), Scottish reformer, was educated at St. Andrews and became a Dominican. He came under suspicion of heresy, and made his way in 1536 to England and then to Italy. His heretical tendencies having been revived by the reading of John Calvin's *Institutes*, he was condemned to be burned, but escaped and returned to Scotland. There in 1561 he was ordained minister of Holyrood, and in 1562 became John Knox's colleague in the high church. Craig helped to draw up the National covenant in 1580 and prepared (1581) the "King's Confession" which became the basis of the covenant of 1638. He died on Dec. 12, 1600.

CRAIG, SIR THOMAS (*c.* 1538–1608), Scottish jurist and poet whose treatise *Ius feudale*, intended to assimilate the laws of England and Scotland, was instead an important factor in building up the law of Scotland into a separate system. He was born about 1538, a member of the Craigfintray family. He was educated at St. Andrews, where he took the B.A. degree in 1555. From St. Andrews he went to Paris to study the canon and the civil laws. He returned to Scotland about 1561 and was admitted advocate in Feb. 1563. In 1564 he was appointed justice depute by the justice general, Archibald, 5th earl of Argyll; in 1573 he was appointed sheriff depute of Edinburgh, and in 1606 procurator for the church. In 1604 he came to London on the commission regarding the union of the two kingdoms. It is said that he wished to refuse the knighthood offered to him, but he has always been styled and reputed a knight. He died on Feb. 26, 1608. Works by Craig in addition to the *Ius feudale* (1603) include *De unione regnorum Britanniae tractatus*, *De iure successionis regni Angliae* and *De hominio disputatio*. Translations of the last two have been published, and in 1909 an edition of the *De unione* appeared, with translation and notes by C. S. Terry. Craig's first poem, an *Epithalamium* in honour of the marriage of Mary, queen of Scots, and Lord Darnley, appeared in 1565.

See P. F. Tytler, *Life and Writings of Sir Thomas Craig* (1823); life prefixed by J. Baillie's edition of the *Ius feudale* (1732).

CRAIGAVON, JAMES CRAIG, 1ST VISCOUNT (1871–1940), Irish soldier and statesman who struggled to maintain the union of Ireland and Great Britain and became the first prime minister of Northern Ireland, was born at Sydenham, Belfast, on Jan. 8, 1871, son of James Craig of Craigavon, near Holywood, County Down. Educated at Merchiston college, Edinburgh, he went into business as a stockbroker, served with the Royal Irish rifles in the South African War and entered parliament in 1906, winning back for the Unionist party one of the County Down seats. In the Irish Home Rule controversy which became acute after 1910 he emerged as a leader of the Ulster Unionists and worked with Sir Edward Carson to oppose Home Rule and later to secure the exclusion of Ulster from it. He had a major responsibility for the policy of threatening to establish a separate provisional government of Ulster, for the signing of the Ulster covenant, for the organization of an Ulster volunteer force and for the Larne gunrunning.

During World War I he recruited and organized the 36th (Ulster) division. In 1916 he was treasurer of the household, in 1919 parliamentary secretary to the ministry of pensions and in 1920 financial secretary to the admiralty. When the Government of Ireland act, 1920, came into operation he became prime minister and held this office for 19 years, until his death at Glencraig, County Down, on Nov. 24, 1940, securing strong Unionist majorities at every general election. His government introduced many changes and reforms, including a new education system, improved agricultural marketing schemes, a nationalized road transport system and reform of the lower courts. In 1918 he was created a baronet and in 1927 a viscount. *See* IRELAND, NORTHERN: *History*.

See Hugh Shearman, *Not an Inch* (1942); St. John Ervine, *Craigavon, Ulsterman* (1948). (HU. S.)

CRAIK, DINAH MARIA (née MULOCK) (1826–1887), English novelist, whose *John Halifax, Gentleman* (1857), a Victorian best seller, is still read for its vivid picture of a life regulated by the ideals of philanthropy, hard work and self-discipline. Born at Stoke-on-Trent, Staffordshire, April 20, 1826, she began a literary career in London in 1846, writing fanciful stories and poems for children, novels (*The Ogilvies*, 1849; *The Head of the Family*, 1851; *A Life for a Life*, 1859; *Christian's Mistake*, 1865) and, later, didactic essays. Her life as a literary and social success in Hampstead and, after her marriage in 1864, at Shortlands, Kent, was marked by the domestic virtue praised in her work. She died at Shortlands, Oct. 12, 1887.

CRAIL, a royal and small burgh and seaside town of Fifeshire, Scot., 10 mi. S.E. of St. Andrews by road and 2 mi. from Fife Ness, the most easterly point of the shire. Pop. (1961) 1,066. Formerly called Karel, it is said to have been a town of some note as early as the 9th century; its castle, of which there are hardly any remains, was the residence of David I and other Scottish kings. It was constituted a royal burgh by a charter of Robert Bruce in 1306 and had its privileges confirmed by Robert II in 1371, by Mary in 1553 and by Charles I in 1635. Of its priory, dedicated to St. Rufus, a few ruins exist. The church, which dates from the 13th century and is dedicated to Maelrubha, the patron saint of Crail, was made a collegiate church in 1517. Many of the red-roofed houses are picturesque and the public buildings include an unusual early 16th-century town hall with a Dutch tower. The chief industry is fishing, especially for crabs.

Balcomie castle, about 2 mi. to the northeast, dates from the 14th century. There Mary of Guise landed in 1538, a few days before her marriage to James V in St. Andrews cathedral. Balcomie has fine sands and a famous golf links. Six miles out from Crail is the Isle of May (*q.v.*).

CRAIOVA, a town of Rumania, the administrative centre of the Oltenia region, is situated 193 km. (120 mi.) W.S.W. of Bucharest in the Jiu river valley. Pop. (1960 est.) 108,773. An industrial, commercial and cultural centre of western Rumania, the town stands on the ruins of a Thracic fortress (Palendava) and there are Roman ruins in the neighbourhood. From the 15th century to the 18th century it was the residence of the Craiova military governors or bani. St. Dumitru church was erected in 1651 by Matei Basarab, prince of Walachia. In 1802 the town was burned by the Turks.

Craiova has machine-building, electrical equipment, agricultural machinery and food-processing enterprises. Its national theatre, one of the oldest in the country, was rebuilt and modernized. There are also agronomic and technical institutes and a state philharmonic orchestra. The Craiova museum contains an art gallery and historical and natural history exhibits.

OLTENIA ADMINISTRATIVE AND ECONOMIC REGION is situated in southwest Rumania, on the Yugoslav and Bulgarian borders. Area 20,300 sq.km. (7,838 sq.mi.). Pop. (1960 est.) 1,549,976. It is divided into 15 administrative districts. In the north of the region are the Mehedinţi, Vîlcea and Parîng mountains while the south is largely plains. The climate is continental. Drainage is through the Olt and Jiu rivers and their tributaries. Lakes Potelu, Nedeia and Rastu are in the region.

The principal agricultural products are grain, industrial crops and vegetables. Fruit and vine growing and cattle breeding are well developed. The area is rich in oil deposits and natural gas (north of Craiova). There are opencast coal mines at Rovinari and Schela and graphite is mined at Baia de Aramă. The region has steadily become more industrialized. There are important dockyards at Turnu Severin building tugboats, lighters and similar craft.

CRAM, RALPH ADAMS (1863–1942), U.S. architect, one of the advocates of the Gothic revival, was born on Dec. 16, 1863, at Hampton Falls, N.H. Inspired by Ruskin and Viollet

-Duc, he became an ardent advocate of English and French ·othic styles, on which he became an authority. In 1889 he ·pened an office in Boston, where he became associated with B. G. oodhue and later with C. F. Ferguson. Together they designed t. Thomas church (New York city), Emmanuel church (Cleve-nd), the First Baptist church (Pittsburgh) and buildings of the nited States Military academy at West Point. Cram and Fer-ıson were consulting architects for the Washington cathedral, ıd transformed the cathedral of St. John the Divine (New York ty) from Romanesque to late Gothic.

Cram attempted to create an environment that would convey ›iritual values as a corrective to technological civilization. He sisted that educational buildings be Gothic, and designed the aduate college (1913) and chapel (1929) at Princeton univer-ty in this style. His traditionalism occasionally asserted itself other styles, as in the classic Second Unitarian church (Bos-n) and the colonial buildings of Sweet Briar college (Va.). ram was professor of architecture at Massachusetts Institute of echnology from 1914 to 1921, and served as first chairman of e Boston city planning board from 1915 to 1922. He died on ept. 22, 1942, in Boston.

Cram's writings include *Church Building* (1901); *The Ruined bbeys of Great Britain* (1905); *The Gothic Quest* (1907); *The inistry of Art* (1914); *The Substance of Gothic,* Lowell Lec-res (1916); *The Nemesis of Mediocrity* (1918); *My Life in rchitecture* (1936); *The End of Democracy* (1937).

See also Albert Bush-Brown, "Cram and Gropius: Traditionalism d Progressivism," *New England Quarterly,* vol. xxv (March, 1952). (A. B.-B.)

CRAMBO, an old rhyming game which, according to Joseph rutt in *The Sports and Pastimes of the People of England* 801), was played as early as the 14th century under the name the ABC of Aristotle. Crambo, or capping the rhyme, fre-ıently mentioned in the literature of the 17th and 18th centuries, ıs played by one player thinking of a word and telling the others ıat it rhymed with, the others not naming the actual word they essed but its meaning. Thus one said "I know a word that ymes with bird." A second asked "Is it ridiculous?" "No, it is ›t absurd." "Is it a part of speech?" "No, it is not a word." ıis proceeded until the right word was guessed.

In Dumb Crambo the guessers, instead of naming the word, ex-essed its meaning in pantomime, a rhyme being given them as clue. *See* also Bouts-Rimes.

CRAMER, JOHANN BAPTIST (1771–1858), pianist, ımposer and founder (1824) of the London music publishing firm ramer & Co., was born at Mannheim, Ger., Feb. 24, 1771, and ıs taken to England the following year by his father, a celebrated ›linist. His piano teachers included Muzio Clementi, under ıom he developed the exceptional abilities that gained him a ›ropean reputation as a performer. A prolific composer, he is ıembered exclusively for his pianoforte studies, which, like his ›ying, were highly regarded by Beethoven. Cramer died in ›ndon, April 16, 1858. (H. Ru.)

CRAMP, a painful, involuntary spasmodic contraction of ıuscle, commonest in the limbs, but also affecting certain inter-ıl organs. Cramping is the common denominator in a variety ‹ medical entities. Examples include menstrual cramps and ıasms of the circular muscles of the bowel (irritable colon), ›od vessels (vasospasm) and pylorus of the stomach (pyloro-ıasm).

Cramps of the muscles of the extremities may occur under a ›riety of circumstances. Overexertion is responsible for swim-ıer's cramp, and the ensuing disability may lead to drowning un-ls the individual is rescued immediately. The violent activity ‹ a football, basketball or hockey player may produce a cramp ıat stops the athlete in his tracks.

Severe cramp in the calf of a leg often awakens many persons ›m a sound sleep. The origin may be overstretching or strain of ›e affected muscle on the previous day or poor circulation, espe-ılly in the older individual. Drugs that lessen muscle irrita-lity usually bring relief. Persons with hardening of the leg ıeries also develop cramp in the calf of one leg after walking a short distance (intermittent claudication). Pain subsides after a few moments of rest but returns after walking an equal distance. In such instances, the muscle receives enough blood when resting but cramps when it does not receive its quota during exercise.

Heat cramps involving the muscles of the extremities or abdomen stem from loss of salt following periods of profuse perspiration. Overexertion in a hot environment usually is responsible. Alkalosis also increases the excitability of nerves and muscles, leading to tetany—a severe form of cramping that is noticed first in the muscles of the extremities.

There are many neurological, reflex and psychic causes for muscle cramps. The condition is particularly bothersome in victims of multiple sclerosis and Parkinsonism.

Professional or occupational cramp is a functional spasm affecting certain muscles that are used constantly in the daily occupation. Cramping does not occur when the same muscles are employed in activities of a different kind. At first there is a gradually increasing difficulty, or clumsiness, in making the movements required for the work at hand. Writers, for example, cannot move the pen or pencil with freedom and the typist loses her dexterity in finding the right key. The telegraph operator, painter, pianist and seamstress also are candidates for occupational cramp. The first requisite of treatment is cessation of the employment that produced it. Thereafter, all causes of anxiety, overconcern and ill health are investigated thoroughly. (T. R. V. D.)

CRANACH, LUCAS (1472–1553), one of the leading German painters of the Renaissance, derives his name from Kronach, in upper Franconia, where he was born on Oct. 4, 1472, and where, after training in the studio of his father, Hans, he apparently remained until about 1498. In 1503, and probably for several years before, he was in Vienna, but by the spring of 1505 he had

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"SAINT CHRISTOPHER," A WOODCUT BY LUCAS CRANACH, 1506 (THE "S" IS REVERSED ON THE WOODCUT). IN THE ART INSTITUTE, CHICAGO

settled in Wittenberg as court painter to the electors of Saxony, a position he held until his death at Weimar on Oct. 16, 1553. Apart from a visit to the Netherlands in 1508, Cranach resided almost continuously at Wittenberg. He was a prominent citizen, a member of the town council in 1519 and burgomaster in 1537 and 1540. He was intimate with Martin Luther and with the electoral family and, apart from his other duties as court artist, he was the chief pictorial propagandist of the Protestant cause in Germany, multiplying the images of the reformers and the Protestant princes in innumerable painted, engraved and woodcut portraits. The scope of this activity is indicated by a single payment in the electoral accounts (1533) for "sixty pairs of small paintings of the late Electors." It was not without reason that Cranach's tombstone celebrated him as *pictor celerrimus*—swiftest of painters!

Hundreds of pictures now in museums and private collections, many of them dated and signed with the device of the winged serpent, which he adopted in 1508, testify to his exceptional productivity. His style was fully formed and underwent little development after about 1515, and it was faithfully imitated by a well-drilled group of studio assistants. The highly finished, mass-produced paintings of this later period suffer by comparison with the more individual work of his early manhood. His earliest known pictures, all probably executed in Vienna, show him as an avant-garde artist of considerable emotional force, one of the initiators of the Danube school. Notable among them are a "Crucifixion" (*c.* 1500) and "St. Jerome" (1502) in Vienna; a "Crucifixion" (1503) in Munich; portraits of "Dr. Cuspinian and His Wife" (1502–03; Reinhart collection, Winterthur) and of "Dr. Reuss and His Wife" (1503; Nuremberg, Berlin); and a "Flight Into Egypt" (1504; Berlin). In these paintings the incidents of sacred story and the accidents of human appearance merge with a wildly luxuriant landscape into a painterly vision at once pathetic and lyrical. Here, and still more in his earliest designs for woodcuts, he challenges comparison with Albrecht Dürer.

The first decade of Cranach's stay at Wittenberg was marked by a series of experiments in which he adapted his style to suit the demands of the Saxon court. The "Martyrdom of St. Catherine" (1506; Dresden) already shows a radical break with his earlier manner; there is exquisite detail in the realistic portrait heads, but courtly decorum has purged the scene of all emotion and given it a decorative bias, with strong emphasis on the patterns of dress. Following his visit to the Netherlands in 1508, Cranach experimented with Italo-Netherlandish ideas of spatial construction (Frankfurt altar, 1509) and monumental nudes ("Venus" woodcut, 1509; painted version, 1509; Leningrad). But his true bent lay elsewhere, as is shown by the splendid full-length portraits of "Duke Heinrich and Duchess Katharina of Saxony" (1514; Dresden) which mark the establishment of his official portrait style. Here space and volume are annihilated; magnificent clothes, set off by a featureless backdrop, are topped by faces reduced to their essential, typical features. Cranach was a pioneer of the frigid state portraiture of the 16th century, but he fell short of the icy reserve of his successors—Holbein, Bronzino or Mor—because his abiding Gothic taste invariably led him to exaggerate a feature or elaborate a beard or dress for the sake of linear rhythms or calligraphic effects. With male sitters his method sometimes yields an image of startling power; *e.g.*, "Dr. Schoner" (1529; Brussels). His female portraits are uniformly vapid.

The resurgence of Gothic linear rhythms is fundamental for the whole of Cranach's later work. His "River Nymph" (1518; Leipzig) demonstrates the assurance with which he now translated a Renaissance model—Giorgione's "Venus" (*c.* 1510; Dresden)—into his personal language of linear arabesque. It inaugurated a long series of paintings, of Venus, Lucretia, the Graces, the Judgment of Paris and numerous other subjects serving as pretexts for the female nude, in which Cranach appears as a kind of 16th-century Boucher. The naïve elegance of these ladies and their sinuous lines, defying every principle of anatomy, were clearly to the taste of the German courts and have an enduring charm. But in conception and style they look back to the international Gothic painting of a century before.

Thus from the historical viewpoint Cranach's work was a backwater in European art of the 16th century. Though during his lifetime he was the dominant figure in the painting of northeastern Germany, his influence was confined to his immediate circle. Both his sons were members of the studio. The elder, HANS CRANACH, who died in Bologna in 1537, has left two signed works, indistinguishable in style from those of his father. LUCAS CRANACH THE YOUNGER (1515–86), whose part in the joint production of the studio became important from about 1545, continued to work in the family style and to use the family trade-mark of the winged serpent long after his father's death.

See M. J. Friedländer and J. Rosenberg, *Die Gemälde von Lucas Cranach* (1932); J. Jahn, *Lucas Cranach als Graphiker* (1955).
(D. Kg.)

CRANBERRY, the fruit of several small creeping or trailing woody plants allied to the blueberries. The small-fruited or northern cranberry (*Vaccinium oxycoccos*) is found in marshy land in northern North America, northern Asia and northern and central Europe. Its stems are wiry and creeping; the leaves are evergreen, oval or elliptical in shape and less than half an inch long; the flowers, which appear in June, are small and have a four-lobed, rose-tinted corolla; the berries ripen in September, are mostly round, about the size of currants, crimson in colour and often spotted, with an acid taste.

The American cranberry (*V. macrocarpon*) is found wild from Newfoundland to the Carolinas and westward to Minnesota and Arkansas. It is much like *V. oxycoccos,* but is more robust with larger, round, oblong or pear-shaped berries that vary from pink to very dark red or may be mottled red and white. It is cultivated on acid soils of peat or vegetable mold, free from loam and clay, cleared of turf and with a surface layer of sand. Additional sand is applied to the surface every few years. It is grown extensively in Massachusetts, New Jersey and Wisconsin and near the coast in Washington and Oregon. Early Black and Howes are the main varieties in the east, McFarlin and Searls in Wisconsin and Mc Farlin in the far west. Three new varieties are Beckwith, Stevens and Wilcox.

False blossom is a very harmful, though easily controlled, virus disease in Massachusetts and New Jersey. Fruit-rot control is especially important in New Jersey. There are many injurious insects. Weed control by chemicals, mowing and hand weeding are important. The vines are protected from winter injury and from frosts by flooding. The picking of the berries begins early in September and continues until late October.

J. HORACE MCFARLAND CO.

AMERICAN CRANBERRY (VACCINIUM MACROCARPON)

More than 3,000,000 bu. are ordinarily produced annually. They are used mostly as a sauce and as a relish for meats but are also much used in pies and in making a fresh fruit beverage; most of the consumption is in the United States and Canada. More than half the U.S. crop is made into a canned sauce.

The cowberry or foxberry (*V. vitis-idaea*), called mountain cranberry in the eastern United States, and by some lingenberry, is not cultivated but is used extensively in northern Europe and by Scandinavians in U.S. cities. The so-called southern cranberry or red huckleberry (*V. erythrocarpum*) is indigenous in the mountains from West Virginia to Georgia and is remarkable for the fine flavour of its dark-red berry. The fruit of the cranberry tree or highbush cranberry (*Viburnum trilobum*) is sometimes used as a substitute for true cranberries in Canada and the northern United States.

See also VACCINIUM.

See *Cranberries* (national cranberry magazine); *Bulletins 445* (1948) *447* (1948), *450* (1948) and *463* (1952) of the Massachusetts Agricultural Experiment Station.
(G. M. D.)

CRANBROOK, GATHORNE GATHORNE-HARDY, ST EARL OF (1814–1906), British statesman, a member of successive Conservative ministries, was born at Bradford on Oct. 1, 1814. He graduated from Oriel college, Oxford (1836), and was called to the bar (1840), practising on the northern circuit with slight success. He became M.P. for Leominster in 1856 and soon made his mark as a ready debater and a stern upholder of the Conservative party. He was undersecretary at the home office from 1858 to 1859 and in 1865, after a sharp contest, he won a seat for Oxford university from Gladstone. He entered Lord Derby's cabinet as president of the poor law board (1866) and succeeded Spencer Walpole as home secretary (1867). In the early 1870s he often acted as Disraeli's deputy in the commons and was war secretary in the cabinet of 1874, gaining the full confidence of the queen. He loyally supported Sir Stafford Northcote when the latter succeeded Disraeli as leader of the commons in 1876, and two years later he retired to the lords as Viscount Cranbrook of Hemsted, in Kent (May 1878), a year after having exchanged the war office for the India office.

Throughout the near eastern crisis of the late 1870s (*see* ENGLISH HISTORY: *The Victorian Age, 1837–1901*) Lord Cranbrook strongly supported Disraeli, who once described him to the queen as the leader in the cabinet of "the war party pure and simple." In Lord Salisbury's governments of 1885 and 1886–92 Lord Cranbrook was president of the council, and on retiring from public life when the ministry resigned in 1892 he was raised to an earldom. He lived on, amid a large family, to the age of 92, and died at Hemsted Park on Oct. 30, 1906.

See A. E. Gathorne-Hardy (ed.), *Gathorne Hardy, 1st Earl of Cranbrook* (1910). (M. R. D. F.)

CRANDALL, PRUDENCE (1803–1890), U.S. schoolteacher whose efforts to educate Negro girls aroused controversy in the 1830s, was born of Quaker parentage at Hopkinton, R.I., Sept. 3, 1803. She was educated in the Friends' school at Providence, taught at Plainfield, Conn., and in 1831 established a private academy for girls at Canterbury, Conn. Although the school was recognized as one of the best in the state, by admitting a Negro girl she lost her white patrons, and in March 1833, on the advice of William Lloyd Garrison and Samuel J. May, she opened a school for "young ladies and little misses of colour." For this she was persecuted, boycotted and socially ostracized; measures were taken in the Canterbury town meeting to break up the school, and finally in May 1833 the state legislature passed the notorious Connecticut "Black law," prohibiting the establishment of schools for nonresident Negroes in any city or township of Connecticut without the consent of the local authorities. Miss Crandall, refusing to submit, was arrested, tried and convicted in the lower courts, whose verdict, however, was reversed on a technicality by the court of appeals in July 1834. Thereupon the local opposition to her redoubled, and she was finally in Sept. 1834 forced to close her school. She married the Rev. Calvin Philleo a Baptist clergyman in 1834, and the couple moved to Illinois. After her husband's death she lived with her brother in Kansas, dying at Elk Falls on Jan. 28, 1890. The Connecticut "Black laws" were repealed in 1838. The episode of Miss Crandall's school is significant as showing the attitude of a New England community toward the Negro at that time, and throws light on the social background of the abolition movement (*q.v.*) in the U.S.

CRANE, (HAROLD) HART (1899–1932), U.S. poet who achieved renown by rhapsodically fusing American life, themes and spiritual aspirations in poetry distinguished for its experimentation and technical mastery. Born at Garrettsville, O., July 21, 1899, he had a turbulent and unhappy youth disturbed also by the industrialization of the agrarian middle west. *White Buildings* (1926), his first book, stressed his probings into the nuances of emotion. Then, unlike many contemporaries, Crane turned away from despair toward mystical affirmation. Although still reluctant to accept all phases of American life, he derived fresh impetus from Walt Whitman's faith in America's democratic future. Finally, with religious passion whose fervour was awesome, he undertook to reveal the spiritual essence of America's destiny in a series of poems unified by that great symbol of American engineering and art, the Brooklyn bridge. *The Bridge* (1930), shadowed by Crane's recurrent doubts, was not entirely successful. Nonetheless, it confirmed his poetic powers and won him critical honours. His life, however, had been disintegrating under the pressures of personal and economic insecurity. Returning from Mexico, where he had gone to write an epic dealing with Cortés and Montezuma, Crane jumped or fell overboard into the Caribbean sea and was drowned April 27, 1932. Important in the literary renaissance of the 1920s, Crane profoundly influenced modern literature. (B. W.; X.)

Crane's *Collected Poems*, ed. by Waldo Frank, appeared in 1933, and his *Letters, 1916–1932*, ed. by Brom Weber, in 1952. *See* also Philip Horton, *Hart Crane* (1937); Brom Weber, *Hart Crane* (1948); and H. D. Rowe, *Hart Crane, a Bibliography* (1955).

CRANE, STEPHEN (1871–1900), U.S. author, won outstanding fame as novelist, poet and short-story writer. Born Nov. 1, 1871, in Newark, N.J., Crane was still a brilliant prodigy when he died of tuberculosis in Germany at the age of 29. As William Dean Howells said, Crane's genius seemed to "spring to life fully armed." The sources of his vivid style and individual vision of life are still somewhat mysterious. His father, Jonathan Crane, an intellectually inclined Methodist minister of good family, died in 1880, leaving Stephen, the last of 14 children, to be reared by his devout, strong-minded mother. After preparatory school at the Claverack college or Hudson River Military institute, Crane spent one baseball-minded semester at Lafayette college and another at Syracuse university in 1890–91 and then went to New York to live in a medical students' boardinghouse while freelancing his way to a literary career. Alternating Bohemian student life and exploration of the Bowery slums with genteel visits to relatives in the country near Port Jervis, N.Y., Crane gathered his forces for his first book, *Maggie: A Girl of the Streets* (1893), a sympathetic study of the bitter warfare of life in the slums.

At that time so shocking that Crane published it under a pseudonym and at his own expense, *Maggie* left him to struggle as a free-lance journalist, poor and unknown until he was befriended by Hamlin Garland and Howells. Suddenly in 1895 *The Red Badge of Courage* and his first book of poems, *The Black Riders*, brought him dazzling international fame. Strikingly different in tone and technique from *Maggie*, *The Red Badge of Courage* reaffirms Crane's view of life as warfare, and studies a young person trying to find reality amid conflict. His hero, Henry Fleming, survives fear, cowardice, illusion and vainglory and so discovers courage, humility, and perhaps wisdom in the confusion of an unnamed Civil War battle. Crane, who had as yet seen no war, was widely praised by veterans for his uncanny power to imagine and reproduce the sense of actual combat.

Crane's few remaining years were chaotic and personally disastrous. His unconventionality and sympathy for the downtrodden were distorted by malicious gossip into false charges of drug addiction and Satanism which disgusted the fastidious Crane. His reputation as a war writer, his desire to see if he had guessed right about the psychology of combat, and his fascination with death and danger sent him to Greece and then to Cuba as a war correspondent. After his marriage in 1897 he made his headquarters in England until just before his death. There he won the friendships of two other American expatriates, Henry James and Harold Frederic, as well as Joseph Conrad. Privation and exposure in his Bowery years and as a correspondent, together with an almost deliberate disregard for his health, probably hastened if they did not bring on the disease which killed him so young.

After *The Red Badge of Courage*, Crane's few attempts at the novel were of small importance, but he achieved extraordinary mastery of the short story. He exploited youthful small-town experiences, *The Monster and Other Stories* (1899) and *Whilomville Stories* (1900); the Bowery again, *George's Mother* (1896); an early trip to the southwest and Mexico, "The Blue Hotel," "The Bride Comes to Yellow Sky"; the Civil War again, *The Little Regiment* (1896), and war correspondent experiences, *The Open Boat and Other Tales of Adventure* (1898) and *Wounds in the Rain* (1900). In the best of these tales Crane showed rare ability to shape colourful settings, dramatic action and perceptive char-

acterization into ironic explorations of human nature and destiny. In even briefer scope, rhymeless, cadenced and "free" in form, his unique, flashing poetry was extended into *War Is Kind* (1899). Dramatic, symbolic, ironic in method, astringent in atmosphere and sound, Crane's poetry has often been accounted one of the earliest effective revolts against 19th-century Tennysonian verse and the next important step after Emily Dickinson toward modern poetry.

Crane's literary generation was a tragic one, also losing Frank Norris and Harold Frederic prematurely from its ranks. Yet had the generation produced nothing more than the unique work of Stephen Crane, it would be secure in the major position he has won in the history of American literature.

There is an edition of Crane's work in 12 volumes, edited by Wilson Follett (1925–26), which, however, omits some work of interest. Follett also edited *Collected Poems of Stephen Crane* (1930). R. W. Stallman's *Stephen Crane: An Omnibus* (1952) includes novels, short stories, poems, newspaper articles and letters, with critical notes and introductions. *Stephen Crane's Love Letters to Nellie Crouse, with Six Other Letters* was edited by Edwin H. Cady and Lester G. Well (1954).

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CRANE, WALTER (1845–1915), English illustrator and painter, known for his imaginative illustrations of children's books, was the second son of the portrait painter and miniaturist Thomas Crane (1808–59) and was born in Liverpool on Aug. 15, 1845. Having moved to London, Crane became an apprentice to the wood engraver W. J. Linton, 1859–62, and thus was able to study both the Italian old masters and contemporary work by D. G. Rossetti, Sir John Millais, Sir John Tenniel and Frederick Sandys. Probably the most important technical development in his art derived from the study of Japanese colour prints, whose methods he used in a series of toy books (1869–75), thereby starting a new fashion. The ideas and teachings of the Pre-Raphaelites and of John Ruskin manifested themselves in his early paintings such as "The Lady of Shalott" (Royal Academy, 1862). The Academy steadily refused his later work, but the opening of the Grosvenor gallery in 1877 enabled him regularly to show there until 1888. He became an associate of the Royal Water-colour society in 1889 and a member in 1902. In 1864 he began to illustrate for Edmund Evans, the colour printer, an admirable series of sixpenny toy books of nursery rhymes. A new series, beginning with *The Frog Prince* (1873), was more elaborate, and to the Japanese influence was added that of Florentine 15th-century painting, following upon a long visit to Italy.

A strong didactic, moral element underlies much of his work, and for several years Crane contributed weekly cartoons for the socialist periodicals *Justice* and *The Commonweal*, many of which were collected as *Cartoons for the Cause* (1896). He was founder-president of the Art Workers' guild, and in 1888 founded the Arts and Crafts Exhibition society. As a teacher he exerted wide influence, becoming art director first of the Manchester School of Art (1893–96), then of Reading college (1896–98) and finally principal of the Royal College of Art, South Kensington (1898–99). His chief importance lies in book illustration, the standard of which he helped greatly to raise. He worked with William Morris in 1894 on the page decorations of *The Story of the Glittering Plain*, printed by the Kelmscott press in the style of 16th-century German and Italian woodcuts. Among the best of his book illustrations are those for Edmund Spenser's *The Faerie Queene* (1894–96) and *The Shepheard's Calendar*. He died at Horsham, Sussex, on March 14, 1915.

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CRANE, any of 14 species of tall wading birds of the family Gruidae, placed with rails (*q.v.*) in the order Gruiformes. They are commonly confused with herons (*q.v.*), which they resemble superficially, but are usually larger and have a part-naked head,

ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

WHOOPING CRANE (GRUS AMERICANA)

heavier bill, more compact plumage and elevated hind toe. In flight the long neck is stretched out in front, the stiltlike legs trailing out behind.

Cranes form an ancient group, the earliest fossils having been recovered from the Eocene of North America; the fossils *Geranoides* and *Eogrus* are placed in separate families in the superfamily Gruoidea. Living forms inhabit all the great zoogeographical regions except the neotropical (South America).

These graceful terrestrial birds stalk about in marshes and on plains, eating small animals of all sorts as well as grain and grass shoots. Two olive-gray eggs spotted with brown and measuring 4 by 2½ in., are laid in a nest of grasses and weed stalks on dried ground in marsh or field; the same nest may be used year after year. The brownish, downy young can run about shortly after hatching. The trachea or windpipe is simple in the chick ready to leave the egg; with advancing age the trachea lengthens, coiling upon itself, like a French horn. The trachea lies buried in the hollow keel of the breastbone and reaches a length of five feet in the whooping crane (*Grus americana*), noted for its peculiar loud whooplike call.

The whooping crane, on the verge of extinction, is the tallest of American birds. It is white with black primaries, measures about 52 in. long (wingspread 92 in.) and breeds in southern Mackenzie district and northern Saskatchewan, wintering in south eastern Texas. The little brown crane (*G. canadensis canadensis*) 35 in. long, breeds from Alaska to Hudson bay, wintering from California and Texas south into Mexico. The sand-hill crane (*G. c. tabida*), 44 in. long and chiefly brownish-gray in colour formerly bred in southern Canada and the northern half of the U.S., is now rare east of the Mississippi. Its call is long, harsh penetrating. The Florida crane (*G. c. pratensis*) breeds in Florida (Okefinokee swamp), southern Georgia and probably Louisiana. The common crane (*G. grus*) breeds in Europe and northern Asia, formerly in England, migrating southward in large flocks in autumn to winter in northern Africa, India and China. The native companion (*G. rubicunda*) lives in Australia and southern New Guinea. The demoiselle crane (*Anthropoides virgo*) breeds in Algeria, southeastern Europe and central Asia; the crowned crane (*Balearica pavonina*), over nearly all of Africa; and the wattled crane (*Bugeranus carunculatus*), in eastern and southern Africa.

(G. F. Ss.)

CRANE, a machine by means of which heavy bodies may be lifted and also be displaced horizontally, within certain definite limits, and which is so called from its resemblance to the long neck of the bird of this name. Strictly speaking, the name alludes to the arm or jib from which the load to be moved is suspended, but it is now used in a wider sense to include the whole mechanism by which a load is raised vertically and moved horizontally. Machines used for lifting only are not called cranes, but winches, lifts or hoists, while the term elevator or conveyor is commonly given to appliances which continuously, not in separate loads, move materials like grain or coal in a vertical, horizontal or inclined direction (*see* MATERIAL HANDLING). The use of cranes is of great antiquity, but it is only since the great industrial development of the 19th century and the introduction of motive powers other than hand labour that the crane has acquired the indispensable position it now occupies. In all places where finished goods are handled, or manufactured goods are made, cranes of various forms are in universal use.

CLASSIFICATION OF MOTIVE POWER

Crane Movements and Stability.—Cranes may be divided

ito two main classes—revolving and nonrevolving. In the first he load can be lifted vertically and then moved round a central ivot so as to be deposited at any convenient point within the rane's range. Typical of this class is the ordinary jib crane. In he second class there are, in addition to the lifting motion, two orizontal movements at right angles to each other. Representa- ive of this class is the overhead traveler. The two classes repre- ent, respectively, systems of polar and rectangular co-ordinates. ib cranes can be subdivided into fixed cranes and portable cranes; n the former the central post or pivot is firmly fixed in a perma- ent position, while in the latter the whole crane is mounted on heels so that it may be transported from place to place.

Problems concerning stability always arise with jib cranes, and n the case of larger cranes which lift heavy loads at long out- each, special care has to be taken to avoid tipping of the crane. or this purpose it is customary to use ballast weights to counter- ct the overturning moment produced by the load. The ballast is sually in the form of cast-iron slabs fitted to the tail of the crane.

Manual Power.—The different kinds of motive power used to ctuate cranes—manual, electric, diesel, hydraulic, steam, pneu- natic—provide a further means of classification. Hand cranes re extremely useful when the load is not excessive and the quanti- es to be dealt with are not great, also when speed is not important nd first cost is an essential consideration. The net effective work f lifting that can be performed by a man turning a handle may e taken, for intermittent work, as being on an average about 000 ft.-lb. per minute; this is equivalent to 1 ton lifted about ¼ ft. per minute or 9 tons at 1 ft. per minute. It is at once evi- ent that hand operation is suitable only for cranes of moderate ower or in cases where heavy loads have to be lifted only occa- onally.

Electric Power.—Most cranes, and particularly overhead anes and traveling quay cranes, use electricity as the motive ower. Electrical energy can be transmitted with an efficiency not ached by any other method.

Electric motors for cranes can take for their supply electric rrent of either the alternating- or the direct-current type. anes are increasingly fitted with alternating-current (A.C.) mo- rs rather than with direct-current (D.C.) machines, although in ses where special control features are required, D.C. motors e often preferred.

For cranes designed to work from A.C. supply, the electric mo- rs are usually of the slip-ring induction type, and the horsepower f the motors depends on the load and on the speed of operation quired. For crane motors of up to about 60 h.p., it is usual for ntrollers to be of the simple drum type, whereas motors larger an 60 h.p. usually have master-controller-operated contactor uipment. This equipment is also used with smaller horsepower otors where the duty is arduous, and where a drum-type con- oller would cause considerable fatigue to the crane operator.

One of the disadvantages of the A.C. as compared with the D.C. otor is that its electric braking is inferior. Many schemes have en adopted in order to obtain braking similar to that of D.C. ma- ines, those most successful being the countercurrent system, or stems incorporating D.C. injection. Special types of A.C. mo- rs have been designed to obtain wide speed variation, and the incipal type is known as the commutator motor.

Many crane users prefer D.C. motors. These are in every way mirable for crane work, being capable of a wide speed range and ving inherent braking features.

When a very wide range of speed control is required, whether e incoming current supply is A.C. or D.C., it is usual for cranes be fitted with Ward-Leonard or constant-current control sys- ms. When fitted to the hoisting motor of a crane, this equipment n be arranged to give speeds of about $\frac{1}{10}$ of the full-load speed nen hoisting or lowering; it can also, by means of a load-discrimi- ting device, give faster than full-load hoisting speeds when light ds are being lifted.

Diesel Power.—It is becoming increasingly usual to drive by esel-powered cranes that are required to be self-contained, espe- lly rail-mounted and mobile cranes. These can be driven di- ctly from the diesel engine with the use of a suitable clutch, or, for larger and more complicated cranes, transmission can be effected through a fluid coupling or a torque converter.

Diesel-electric drive is also used in cranes and is preferred where wide variations of speed control are required. In this case a diesel engine drives a D.C. generator, which in turn provides the energy for D.C. electric motors. The use of a variable-voltage generator coupled to a diesel engine is preferred in some cases.

Hydraulic Steam and Pneumatic Power.—For hydraulic cranes, the use of water has decreased in favour of special oils or hydraulic fluid. The use of special hydraulic fluid, together with that of hydraulic pumps and motors, has overcome the difficulties associated with hydraulic cranes which used water; *i.e.*, corrosion, freezing and the expense of maintaining hydraulic mains.

The steam engine has been largely superseded by the diesel engine when a self-contained unit is required, although steam is sometimes favoured, especially for railroad wrecking cranes, which are subjected to particularly arduous duty.

The use of pneumatic power for cranes is very limited and is mainly confined to the operation of small blocks and winches.

CLASSIFICATION OF TYPES OF CRANES

Hand Jib Cranes.—While many hand jib cranes are used throughout the world, their obvious limitations of speed and performance restrict their usefulness. They are installed in locations where power supplies are not available, and where occasional lifts only are required. This type of crane, therefore, is often found in small railroad depots. An example of a hand crane is shown in fig. 1. It is normal, with this type of crane, for the weight of the revolving part of the superstructure to be carried on top of a forged steel centre post, the overturning moment of the load being taken on rollers, carried at the bottom of the superstructure, which roll around the part of the post immediately above the bed of the crane.

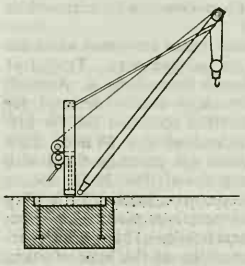

FIG. 1.—SIMPLE HAND CRANE

Overhead and Goliath Cranes.—There is no doubt that the crane in widest use throughout the world is the overhead crane, which runs on elevated gantry rails and consists, in the main, of two beams resting on traveling end girders and supporting a cab or trolley (*see* fig. 2[A]). This type of crane has three motions, those of hoisting, long traveling and cross traversing. The overhead type of crane is mainly used inside buildings for general lifts and has the advantage of causing no obstruction at floor level. These cranes are sometimes used on gantries in the open; *e.g.*, in stockyards. In this case, full weather protection is given to the machinery. Most overhead cranes are operated by electric motors, although smaller cranes may be manually operated. Overhead cranes are manufactured in sizes up to 300–400 tons lifting capacity. It is usual for the smaller sizes of crane, up to 50 tons capacity, to be designed to standard dimensions and clearances. The span of the girders naturally varies with the size of the building, but it is not normal for overhead cranes to have a span greater than about 120 ft. A typical overhead crane for lifting loads of about 50 tons, and having a span of 50 ft., would have a hoisting speed of 10 ft. per minute, a trolley traverse speed of 70 ft. per minute and a downshop traveling speed of 230 ft. per minute.

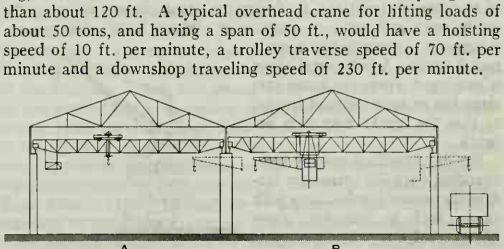

FIG. 2.—(A) OVERHEAD ELECTRIC TRAVELING CRANE; (B) OVERHEAD TRAVELING CRANE WITH UNDERSLUNG CAB AND BOOM

A variation of the overhead crane is shown in fig. 2(B). This, instead of being fitted with a plain trolley and hook, incorporates an underslung jib. The advantage of this type of crane is apparent from the illustration, which shows that it can handle loads outside the span of its supporting gantries.

It is not always practicable to erect a gantry for an overhead crane. In this case a goliath crane is used. With this type of crane the runway track is at ground level and is designed to cause the least possible interference at this level in the area where the crane operates. Goliath cranes with lifting capacities as great as 300 tons have been built, and they are sometimes used for building power stations, as this necessitates the handling of heavy loads in the open. In such a case the cranes are occasionally dismantled and removed after construction is completed.

The duties of cranes of the overhead and goliath types vary considerably. Sometimes a heavy crane, though necessary, may be used only occasionally for maintenance purposes; on the other hand it may be worked on a continuous day and night duty cycle. The steelworks ladle crane is an example of the latter use. This type of crane can be designed for loads of 300 tons or more. Also used in steelworks are special steelworks charging cranes, a typical example of which is shown in fig. 3. This type of crane is specially designed not only to stand up to the continuous and arduous duty in a steelworks but also to withstand the heat and dust prevalent in a foundry and, in addition, to be speedily maintained.

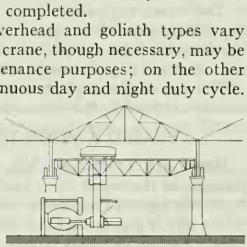

FIG. 3.—STEELWORKS CHARGER

Scotch Derricks.—There is always a need for cranes which are portable and which can be used on building sites. Typical of cranes for this work is the scotch derrick shown in fig. 4. A scotch derrick is usually designed for electrical operation and for lifting loads of up to 30 tons. Such cranes are generally fitted with long jibs of 100–120 ft., and, to obtain extra height of lift, they are sometimes mounted on structural trestles. The principal characteristics of this type of crane are exceptional height of lift and ease of erection and dismantling for transfer from site to site.

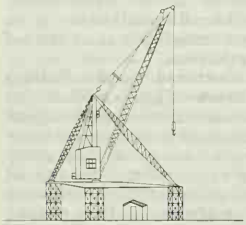

FIG. 4.—SCOTCH DERRICK CRANE

Dockside Cranes.—For the rapid loading and discharging of ships' cargo, the most popular type of crane is the level-luffing traveling dockside crane. These cranes are nearly always electrically driven, although occasionally the luffing, or change of altitude, of the jib is obtained by hydraulic means. Dockside cranes are manufactured principally with lifting capacities ranging from 3 to 10 tons, although cranes of this type have been designed for lifting 15 and 20 tons. A typical dockside crane of 3 tons capacity would have a hoisting speed of 240 ft. per minute, a traveling speed of 100 ft. per minute, a slewing speed of 1½ r.p.m., and a luffing speed of 150 ft. per minute. It is often necessary, for the purpose of avoiding obstructions, to design the crane for mounting partly on the quay and partly on a gantry at a higher level. Such an arrangement is described as a semi-portal crane. A full portal crane is employed where the crane carriage has to span railroad tracks, so that the trucks may pass beneath.

Besides handling general merchandise, dockside cranes are frequently required to discharge bulk cargo, such as iron ore, phosphates, coal, etc., when they must use grabs. These are hook on, self-dumping, ring discharge or multirope. For a dockside crane used mainly for grabbing duty, the multirope type grab is preferred.

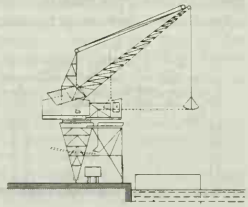

FIG. 5.—ELECTRIC LEVEL-LUFFING WHARF CRANE, KANGAROO TYPE

A variety of crane specially developed for the bulk discharge of materials is the kangaroo crane (*see* fig. 5). In this case the material is deposited in a hopper in front of the gantry, from where it passes through a weighing machine onto a belt conveyor, which discharges it through the rear of the gantry onto another conveyor.

Most dockside cranes are designed for level luffing, which means that the load is neither lifted nor lowered when the jib is luffed in or out. This feature has been found to be indispensable for rapid cargo-handling operations, and many designs have been developed to achieve it. In one, the jib is of the balanced type and is fitted with a lever arm at its head, the relative movement of which at varying radii of the crane and with a normal rope reeving, achieves the level luffing of the load. In another type, the jib is likewise balanced but is luffed by a rack and pinion. A special rope reeving is arranged in three parts between the jib head and the apex frame to provide level luffing. This arrangement is employed in the kangaroo type of crane shown in fig. 5, but the jib is crank operated for luffing.

A further system of level luffing incorporates a parallelogram jib arrangement which, together with a normal rope reeving, gives level luffing of the load.

Shipyard Cranes.—For the construction and fitting-out of ships in shipyards, various types of special cranes have been developed. The heavy lifts in shipbuilding usually occur when the main machinery is being installed, and for this purpose fitting-out berths are generally equipped with one heavy crane, usually of the fixed cantilever type. Such cranes have been manufactured with a lifting capacity of about 250 tons. One example lifts this load at a radius of 115 ft., the height to the rotating portion being 133 ft. The speed of hoisting 250 tons is 6 ft. per minute, and the trolley has a traversing speed of 30 ft. per minute with the full load. The crane is capable of slewing through one revolution in about seven minutes when loaded. This type of crane is found in naval dockyards.

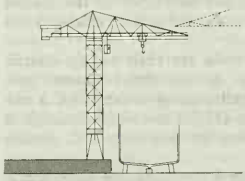

FIG. 6.—FIXED ELECTRIC REVOLVING SHIPYARD CRANE

For shipbuilding berths, cranes of the tower or monotower type are usually employed (*see* fig. 6). As many as six of these cranes are often installed adjacent to shipbuilding berth. Their lifting capacity is usually between 15 and 50 tons.

Dry docks are equipped with heavy cranes for moving propeller machinery, etc., from ships during refitting. The usual type of crane employed is shown in fig. 7. In this design the luffing of the jib is effected by the use of wire ropes, and in the crane shown in fig. 8 the jib is operated by special screws. This type of dry-dock crane has a lifting capacity of 30–50 tons.

Both shipyard and fitting-out cranes are often required to place loads accurately, and this necessitates extremely fine electrical control for the hoisting and lowering motions. This can be achieved by using A.C. commutator motors or Ward-Leonard electric drive. There is an increasing preference for the level-luffing feature to be incorporated in this type of crane.

Transporter Cranes.—The handling of bulk cargo by means of grabbing cranes has been mentioned and particular reference made to the kangaroo, which lifts the load and luffs it over its own hopper, no slewing being involved. When the handling of bulk cargo is undertaken on a large scale, however, preference is given to the transporter cranes. These are made in three designs: the first unloads (*see* fig. 9), the second reclaims and the third does

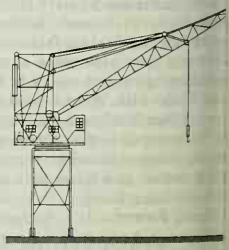

FIG. 7.—HEAVY ELECTRIC TRAVELING CRANE, ROPE-LUFFING TYPE

)th. The unloading transporter ually incorporates a hinged oom which can be raised to me within the quay line and so oid obstructing vessels when ey are berthing. It is arranged deliver material through a hop- r direct to trucks or conveyors. ne reclaiming transporter is nerally an inland appliance, the rpose of which is to reclaim aterial from a stockyard or a le and feed it into a conveyor stem or into railroad trucks. ne unloading and reclaiming ansporter can unload from ships rectly into trucks or onto the stockpile, and when not unloading, can be used for loading material from the stockpile into trucks. ne transporter crane is expensive, but its initial cost is often stified when substantial tonnages of bulk materials have to be ndled. A typical transporter would have a lifting capacity for ab and contents of 15–20 tons, and its hoisting speed would be 0–300 ft. per minute. The trolley, which is usually of the man- ling type, can have a traveling speed of 800–1,000 ft. per minute, d the traveling speed of the transporter is 50–80 ft. per minute. ne time taken to raise the boom is not of great importance, and is can be done in 5–7 min. Ore-handling plants using trans- rters have been designed to deal with bulk material at a rate of to 1,000 tons per hour.

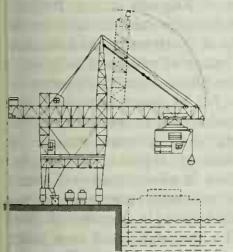

FIG. 9.—ELECTRIC TRANSPORTER CRANE FOR UNLOADING

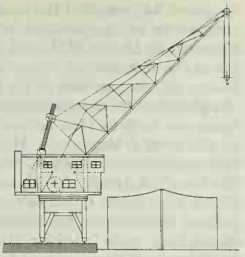

FIG. 8.—HEAVY TRAVELING CRANE WITH SCREW DERRICK

Floating Cranes.—In ports and dockyards it is often preferred for heavy lifts to be undertaken by a floating crane rather than by a land crane. The floating crane has the great advantage of mobility, and can often be taken to a moored ship to assist in unloading when a berth is not available. In this case the floating crane is able to transport the cargo on its deck. Floating cranes are either self-propelling or mounted on dumb pontoons. Self-propelled cranes are capable of speeds of up to nine knots. Cranes ted with dumb pontoons are moved by means of tugs. The majority of floating cranes have a lifting capacity of from 30 to 100 ns, although special floating cranes have been manufactured hich can lift as much as 350 tons. Those which are self-propelled e either twin screws or the Voith-Schneider system. Both self- ppelled and dumb floating cranes are fitted with diesel-driven nerators which supply power for the crane's motions and also r the main propelling machinery. It is sometimes necessary r a floating crane to undertake journeys in the open sea, and nes specially manufactured for this purpose can lower the jib to a special structure fitted to the crane pontoon.

Railroad Traveling and Wrecking Cranes.—These are de with lifting capacities of from 5 to 250 tons. The smaller pacity cranes are used mostly for general engineering duties, for ing assistance in loading and loading freight cars and for civil gineering work, such as track pair, etc. (*See* fig. 10.) With se cranes it is customary for te prime mover to be a diesel gine used in conjunction with draulic or electric transmission. Cranes used for wrecking duties a driven by either steam en- es or diesel engines using tique converter drive. They ve been built to lift up to 250 tons, and their construction must be particularly robust, since they often have to handle loads and clear wreckage, the weight of which cannot be determined. The larger type of railroad wrecking crane is, of necessity, a heavy piece of rolling stock, and where narrow-gauge and lightweight track is used, such cranes have to be provided with relieving bogies or auxiliary trucks so that the axle loads in running condition can be kept within the permissible limits.

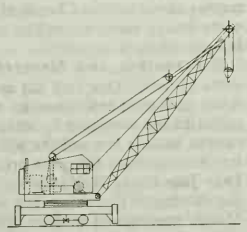

FIG. 10.—DIESEL TRAVELING CRANE

Mobile Cranes.—There is an increasing use of cranes mounted on pneumatic rubber tires. They are employed principally for loading and unloading motor trucks, for civil engineering and construction work and for duty in material storage yards. These mobile cranes are of two kinds. One is a revolving crane superstructure mounted on a truck chassis and the other is a specially constructed self-propelled crane. The cranes have lifting capacities of up to 80 tons with the use of outriggers. Boom lengths can be varied by inserting extra sections, and there are examples of boom lengths exceeding 100 ft. Mobile cranes are always fitted with internal-combustion engines as prime movers, and the transmission can be either mechanical, hydraulic or electrical. They can travel under their own power on roads at speeds of up to 40 m.p.h.

Crane Operation.—There is a considerable element of responsibility in the operation of cranes of all types, especially when heavy and valuable loads are to be transferred. Formerly, operating a crane was very arduous, but modern design and layout of crane controls have considerably reduced operator fatigue; most modern cranes, too, are fitted with safety devices of various kinds, which assure crane safety should the human element fail for any reason.

See also references under "Crane" in the Index volume.

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CRANE FLY, a common name for narrow-bodied, two-winged flies with long, fragile legs. Many of them resemble large mosquitoes. They are harmless to man. *See* FLY.

CRANE'S-BILL is a common name applied to many species of the genus *Geranium*. *See* GERANIUM.

CRANK. In mechanisms, a crank is an element comprising an arm secured at right angles to a shaft with which it can rotate or oscillate. Simple forms include the familiar hand crank and crank wheel. *See* LINKAGES.

CRANMER, THOMAS (1489–1556), the first archbishop of Canterbury of the reformed Church of England and a martyr in the reign of Queen Mary I, was born at Aslacton, Nottinghamshire, on July 2, 1489, the second son of Thomas Cranmer and Agnes, née Hatfield. His father seems to have belonged to the lowest rank of the gentry; at any rate, he had only enough property to endow his eldest son, John, while Thomas and his younger brother, Edmund, were destined for the church. After experiencing the teaching of a "marvellous severe and cruel schoolmaster," whose ministrations Cranmer later maintained instilled in him a permanent uncertainty and pliability, the boy went on to Cambridge (1503). It is not known to which college he belonged as an undergraduate, but by 1510 or 1511 he had been elected into a fellowship at Jesus college. This he was soon compelled to vacate because he married a certain Joan, a relative to the landlady of the Dolphin inn. During this time he kept himself by teaching for Buckingham (later Magdalene) college and left his wife to lodge at the Dolphin; out of this arrangement grew the later story that he had started life as an ostler. Joan, however, died in childbirth a year after their marriage, and Jesus college restored Cranmer to his fellowship. He now entered the church and threw himself into his studies, becoming one of the outstanding theologians of his time, a man of immense though not very original learning. From about 1520 he formed one of a group of scholars who met regularly at the White Horse inn to discuss the theological and ecclesiological problems raised by Luther's revolt; known to be inclined to the new way of thinking, they were dubbed "Little Germany." Here gathered some who were to lead the first gen-

eration of the English Reformation—William Tyndale, Robert Barnes, John Frith, Thomas Bilney and, above all, Cranmer, who by 1525 included among his prayers one for the abolition of papal power in England.

Entry Into Royal Service.—However, these ambitions would have remained as academic as their author but for the political events into which Cranmer was soon drawn, much contrary to his upbringing and tastes. From 1527 onward, Henry VIII pursued his desire to be freed from his first wife, and in 1529 the wheels of the "divorce" seized also upon Cranmer. An accidental meeting with two of the king's councilors (Stephen Gardiner and Edward Foxe, both old Cambridge men), at which Cranmer is alleged to have suggested that the king might strengthen his case by seeking the opinions of the European universities, brought the middle-aged scholar to an interview with Henry. Cranmer accepted a commission to write a propaganda treatise in the king's interest, was (probably) appointed archdeacon of Taunton and suddenly found himself, like so many others, in the royal service. It was a fateful moment, from which stemmed the whole remaining history of his life. Soon he was employed in a variety of duties, defending the king's position before the English universities, serving as a minor member of one of the many embassies sent to Rome (1530) and as the leading member of one sent to Germany (1532), officially to the emperor but with instructions to establish contact with the Lutheran princes. At Nürnberg he made the acquaintance of Andreas Osiander whose theological position midway between Luther and the old orthodoxy appealed to Cranmer's cautious temperament, while his niece Margaret appealed even more strongly to the instincts of one who had for too long remained in uncongenial celibacy. Despite his priest's orders he married her in 1532; at the same time, his theological views underwent a further decided change in the direction of reformed opinion.

Archbishop of Canterbury.—In fact, the year 1532 proved to be a critical one altogether, for in August William Warham, the aged archbishop of Canterbury, died. At first the usual practice was followed of extending the vacancy for the benefit of the king's finances, but by the end of the year it was apparent that the see would have to be filled because the divorce question was coming to a head. Thomas Cromwell's arrival in power had heralded a more energetic policy; by Jan. 1533 the act against appeals to Rome, intended as the gage of battle, was being drafted and Anne Boleyn was pregnant. Since Gardiner, the obvious candidate for the archbishopric, was out of favour, the king chose Cranmer; by March 1533 he was consecrated and instituted at Canterbury, with the assistance of confirmatory papal bulls and after a declaration that he took the obligatory oath to the pope without feeling bound by it. He proceeded to do what was expected of him. In May he convened his court at Dunstable (Bedfordshire), declared the king's marriage to Catherine of Aragon void from the beginning and pronounced the second marriage to Anne Boleyn valid. In 1536, convinced by the dubious evidence of Anne's alleged adulteries, he in turn invalidated that marriage; in 1540 he assisted at the freeing of Henry VIII from Anne of Cleves; and in 1542 he was forced to be prominent in the proceedings which resulted in Catherine Howard's execution for treasonable unchastity. There is no question that in these matrimonial politics he did as he was told, though it is entirely improbable that his private opinions on the issues in question in any way contradicted his public doings.

More significant, in any case, are his activities as archbishop in the reconstructed church. Cranmer had not sought high promotion. His marriage just before his elevation to Canterbury is fair proof that he expected no such career in the priesthood, in which a necessarily unacknowledged wife would be nothing but an embarrassment. Not until 1548 was he able publicly to recognize her, though the story of his carrying her about with him in a chest with air holes is part of the scurrilous legend which grew up around him. Once put in power, however, he could not avoid the consequences; a convinced reformer with leanings toward a succession of continental theological changes, he found himself assisting at the shaping of the Church of England under a master who on the whole had no taste for change. In co-operation with Cromwell he promoted the publication of an English Bible, made compulsory in the parishes by Cromwell's Injunctions of 1538. Even before Henry VIII died (1547), his archbishop had drifted far in the direction of Protestantism, had composed (1545) the Litany still in use, one of his masterpieces, and (by 1538) had abandoned belief in transubstantiation though not in the real presence. As early as 1536 he was recognized by the northern rebels as the leading innovator. His position was in consequence far from comfortable after the reaction to the old ways signaled by the Act of Six Articles (1539) and Cromwell's fall (1540). During Henry's last years, Cranmer's enemies laid at least three elaborate plots to destroy him by convicting him of heresy, but on each occasion they were foiled by Henry's curious attachment to him. In Cranmer this king, who as a rule kept himself entirely free from personal feelings for his servants and advisers, found a man whom he both trusted and liked. Unlike the rest of them, the archbishop was neither greedy nor devious; he sought nothing for himself alone was willing to plead for those who fell into disfavour (a service he performed with equal courage and futility for Thomas More, Anne Boleyn, Thomas Cromwell and others) and miraculously retained Henry's good will throughout. The king regarded him with that mixture of awe and amusement which the worldly and selfish bestow on those who appear simple in affairs; he liked him, listened to him, protected him but allowed him no political influence whatsoever. Not surprisingly it was to Cranmer that he turned when death came.

Achievements Under Edward VI.—Cranmer's time really arrived with the accession of Edward VI in 1547. Edward Seymour, the protector Somerset, from the first demonstrated his intention to transform the Church of England into a Protestant church, and when he fell in 1549 the expected Catholic reaction did not take place because the duke of Northumberland decided to introduce an even more extreme brand of reformed religion. In the doctrinal labours demanded by these changes Cranmer took the chief and directing part. In 1547 he was responsible for the publication of a *Book of Homilies* designed to meet the notorious grievance that the unreformed clergy did not preach enough. The first prayer book, moderately Protestant, appeared in 1549, to be followed in 1552 by the second which in effect came very near the extremes of Zürich. Cranmer was personally responsible for much of the work, but he had the assistance of a number of foreign theologians for whom Edward VI's England acted as a magnet. The most influential of these was probably Martin Bucer from Strasbourg whose position on the Eucharist is reflected especially in the communion service of the second prayer book. However it was not so much Bucer who persuaded Cranmer away from the vague Lutheranism, which seems to have been his position in 1547, as either the Pole John à Lasco or the Englishman Nicholas Ridley, both men possessed of a more determined and unquestioning temper than was the archbishop. The ferment of those years also produced Cranmer's 42 Articles (1553), the basis of the later 39 and a monument to his comprehensive spirit, as well as his striking attempt to revise the canon law of the English church never enacted but published in 1571 as the *Reformatio legum ecclesiasticarum.* Though still deprived of any serious influence in affairs of state, Cranmer dominated and guided the religious revolution of the reign by his learning, authority and unwavering diligence. He settled in turn the doctrine, ritual and law of his church in a manner which was to remain fundamental to later developments; above all, the Church of England owed to him the beauty of its liturgy which shows him to have been not only a theologian but something of a poet.

Degradation and Martyrdom.—Edward VI's approaching death (July 1553) at long last involved Cranmer fatally in politics. After prolonged resistance he was forced by the dying king to subscribe the document by which Northumberland hoped to uphold custom, statute law and the will of Henry VIII in order to transfer the succession from the princess Mary to his daughter-in-law Lady Jane Grey. The failure of the plot brought Cranmer within the clutches of the treason law under which he was condemned by Mary's government in Nov. 1553. It had in any case become obvious before this that his future held no more bright promise

lary's accession temporarily destroyed the English Reformation; ranmer's embittered enemy Stephen Gardiner was at once re- ased from imprisonment and promoted to the chancellorship, and Nov. 1554 Cardinal Reginald Pole arrived to occupy Canterbury nd direct the extirpation of heresy. Cranmer's trial for treason as but a pretaste; the queen and her advisers did not intend him o die for the technical offense of having supported Northumber- nd's insane conspiracy but meant to destroy him for his long- anding offense in promoting Protestantism. They had to wait ntil they could get parliament to repeal the acts of Henry VIII nd Edward VI and to reintroduce the laws which enabled the ecular arm to burn heretics. With Ridley and Hugh Latimer, ranmer in March 1554 was removed to Oxford where the Counter- eformation felt safer than in Cranmer's own university. Late in hat year the heresy laws were revived, and in Sept. 1555, after nfeebling imprisonment, Cranmer was subjected to a long trial in hich he stoutly defended himself against the charge of having njustifiably departed from his own earlier position on the sacra- ents and the papacy. The foregone conclusion was arrived at ter a variety of technical processes; on Feb. 14, 1556, in a cere- ony full of carefully designed humiliation, he was degraded from s episcopal and sacerdotal offices and handed over to the state. However, Mary's government had not done with him yet. The rning of the archheretic would be an even more useful deed if e could be made to renounce his errors in public, and so a number ways were tried to break him down. In the previous October e had been made to witness the martyrdom of Ridley and Lati- er; now he was temporarily removed from prison into pleasanter rroundings while government agents tried to stir up his doubts. n fact, Cranmer signed five so-called recantations of which the st four did no more than record his consistent belief that what onarch and parliament had decreed must be obeyed by all Eng- shmen. His convictions on this point logically forced him to cept the Marian Counter-Reformation as valid, and this in turn, his weak and uncertain state, not unaffected by the delay of ath and the faint hope of mercy, finally induced him to make an ject recantation (the sixth) of his whole religious development. he government had every reason to hope that the publication of ranmer's defection would wreck Protestantism in England. No ercy was to be extended to the old man; though the vengeful ardiner had died, Mary and Pole were quite determined that the ntence must be carried out. Thus on March 21, 1556, Cranmer as taken out to be burned, being first required to make his recan- tion public. The proximity of death, however, restored both his ith and his dignity. With nothing to lose and only peace of ul to gain, he shocked his enemies by disavowing his recantation d emphatically reasserting that the pope's power was usurped d transubstantiation untrue. At one blow he undid all that vernment propaganda had achieved and restored heart to the rviving reformers. Then he went to his death. As he had omised, he steadfastly held his right hand—which "had offended" signing the false recantations—into the flame until it was con- med, and soon afterward the fire killed him. His brave and dig- fied end made an enormous impression.

Character and Opinions.—Cranmer was a very human man o in consequence has attracted a good deal of obloquy from ose who have not had to share his tribulations and temptations. ssentially he was and remained a scholar who lacked the strength ich single-mindedness and fanaticism instill into the less reflec- e. He has sometimes been thought of as infirm in moral pur- se, but this is to misjudge him. His doubts at the last were verly induced by mental torture, and his gradual development ay from traditional orthodoxy into more and more definitely otestant views represents fairly the spiritual career of a man o obeyed reason rather than instinct. Cranmer was always rning and never ashamed to admit it; his was essentially a hum- e temper. He had not sought high office and did not enjoy it ch, though he valued his place for the chance it gave him to omote the changes which he came to regard as essential to the tablishment of God's truth. He refused to bear malice or pun- h those who traduced him. When Cromwell once told him, in me exasperation, that the "popish knaves" would have his eyes and cut his throat before he would do something about it, Cranmer turned the prophecy with a shrug. In a persecuting age he stood out for his clemency, though in 1550 he did take part in the trial and burning of Joan Bocher; it should be remembered that she was condemned for open blasphemy in denying the Trinity, the one offense which all the church had regarded as unforgivable ever since the struggle with Arianism. For his order and the authority of the church Cranmer had a high respect which, for instance, appears in his revision of the canon law.

However, his most consistent principle was one which was unlikely to gain him much sympathy in later ages. It was part of his religious beliefs that he owed obedience to the king; though he did not worship the state, he served it without hesitation and as a matter of principle. This did not, as is sometimes alleged, make him servile; alone of Henry VIII's councilors, he time and again spoke up for the unpopular victim of the moment, and his tart criticism of the king's theology and grammar in the debates over the King's Book of 1543 speaks well for his courage. He stood up to Northumberland when everyone else quailed before that half-demented demon. These occasional disputes only underline the fact that with him submission to royal authority was ordinarily a fundamental, indeed a doctrinal, tenet. However, though he may have been more consistent in this than most, he only stressed more heavily what nearly everybody held at the time. His other guiding star was his study of theology in which he early discarded the arid aftermath of late medieval scholasticism and turned instead to Scripture and the early Fathers. Between them, his belief in the divine right of kings to rule the *ecclesia* as well as the *res publica* and his biblical theology made him the characteristic Anglican of his day, the intellectual and in part the spiritual founder-father of that particular reformed church.

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CRANNOG, an Irish word applied in Scotland and Ireland to artificially constructed house or settlement sites built of timber, sometimes with stone structures, and situated off the edge of a lake. They range in time from the Late Bronze Age into the Middle Ages. Usually constructed on islets or shallows in the lakes, they were fortified by single or double stockaded defenses around the margin. Their distinctive substructures of brushwood and logs built up from the bottom set them apart from the pile constructions of earlier periods in Switzerland (*see* Lake Dwellings). Implements and weapons from Irish and Scottish crannogs are usually iron; even the objects of bronze and stone are typical of those dating from the Iron Age. Crannogs are among the latest prehistoric strongholds, and seem to have reached their greatest development in early historic times. A few remains of lake-village structures that have been excavated in England and Wales suggest typical crannog structure (*see* Glastonbury). *See* also Ireland: *Archaeology.*

See "Lake Dwellings, Crannogs and Terremare," in G. E. Daniel, *A Hundred Years of Archaeology* (1950). (S. Pt.; X.)

CRANSTON, a city of Rhode Island, U.S., is in Providence county on the west shore of Narragansett bay. Dependent for many services on Providence, which it adjoins, Cranston is primarily a residential suburb. However, industrial plants produce textiles, machinery, wire, rubber and beer. Agriculture is limited to a few dairy farms, market gardens and nurseries.

The first settlement was at Pawtuxet in 1636 by William Arnold, a compatriot of Roger Williams. Cranston separated from Providence in 1754 and was named for Samuel Cranston, governor of Rhode Island from 1698 to 1727. Its early growth was dependent on the textile industry and dates from the founding in 1824 of the Cranston Print works.

Cranston became a city in 1910. Growth has been rapid since 1940 with several large housing developments. Population in 1960

was 66,766 according to the federal census.

State institutions located on 667 ac. of land include the adult correctional institutions, the juvenile training schools, the hospital for mental diseases, the state infirmary and the county jail. Points of interest are the Friends Meeting-House (1729), the Budlong Rose Company gardens (commercial) and the pre-Revolutionary Caleb Arnold tavern. There are two yacht clubs and five recreational areas including Meshanticut park, a 42-ac. state reservation. (V. H. Wil.)

CRANTOR (4th–3rd century B.C.), Greek philosopher, a native of Soli in Cilicia, a pupil of Xenocrates and Polemo and the teacher of Arcesilaus, wrote the first commentary on Plato's *Timaeus*, denying that Plato actually ascribed a beginning in time to the universe and its soul. In one of his works he presented a contest in which manliness (*andreia*—equated with "virtue") wins over wealth, health and pleasure. His writing *On Grief* created a new literary genre; viz., the consolation (offered on the occasion of a misfortune such as death). One of Crantor's consolatory arguments, reminiscent of Plato's *Phaedo* or Aristotle's *Eudemus*, was that life is actually punishment, death the release of the soul. He advocated moderation of emotions rather than their suppression as demanded by Stoics. His writings are lost. *See* also Academy, Greek. (Pp. M.)

CRANWORTH, ROBERT MONSEY ROLFE, Baron (1790–1868), lord chancellor of England, was born at Cranworth, Norfolk, on Dec. 18, 1790. Educated at Bury St. Edmund's, Winchester, and Trinity College, Cambridge, he was called to the bar at Lincoln's Inn in 1816 and attached himself to the Chancery Courts. He represented Penryn and Falmouth in Parliament from 1832 till his promotion to the bench as baron of the exchequer in 1839. In 1850 he was appointed a vice-chancellor and created Baron Cranworth, and in 1852 he became lord chancellor in Aberdeen's ministry. He continued to hold the chancellorship in the administration of Palmerston until the latter's resignation in 1857. He was not reappointed when Palmerston returned to office in 1859, but on the retirement of Lord Westbury in 1865 he accepted the great seal for a second time and held it until the fall of the Russell administration in 1866. Cranworth died in London on July 26, 1868. His name is associated in the statute book with only one small measure on conveyancing. He left no issue and the barony became extinct on his death.

CRASH, a group of coarse, rugged fabrics made from yarns that are irregular, firm, strong and smooth but sometimes raw and unprocessed. This fabric group includes gray, bleached, boiled, plain, twill and fancy-weave crash. The coarsest type is called Russian crash. Crash is used frequently for toweling, especially the type that is 14 to 20 in. wide and is dispensed from a roller.

Linen is generally used for the warp yarn, while linen, jute or a mixture of linen and jute may be used for the filler. In the U.S., fibre content must be declared, according to a ruling of the Federal Trade commission. Crash may or may not be made with novel or fancy borders, and it is sold in white or natural shades or in dyed colours. Other uses of crash, in addition to the production of toweling, include the manufacture of draperies and other decorative cloths, doilies, dresses, caps, summer suits and sport coats.

The term is derived from the Latin *crassus*, meaning coarse. (G. E. L.)

CRASHAW, RICHARD (1613?–1649), English poet famous for his ardent faith, glowing imagination and brilliant wit, was born in London *c.* 1613. His father, William Crashaw, a learned and zealous Puritan, was preacher to the Inner Temple and (1618–26) incumbent of St. Mary Matfellon, Whitechapel. Richard Crashaw went to the Charterhouse and, in 1631, to Pembroke college, Cambridge, whence he graduated B.A. in 1634. In that year also he published *Epigrammatum Sacrorum Liber*, a collection of Latin verses on scriptural subjects, some of which may have been written much earlier, as school exercises. In 1635 he was admitted to a fellowship at Peterhouse, a centre of Laudianism, and was soon ordained. His High Church leanings appear again in his friendship with Nicholas Ferrar's religious community at Little Gidding, Huntingdonshire. During the Great Rebellion his position at Cambridge became difficult and he seems to have relinquished it in 1643, about a year before he was formally ejected from it by the Parliamentarians. Crashaw made his way first to Holland and then to France, and he became a Roman Catholic. When Queen Henrietta Maria and her entourage moved to Paris, Crashaw was found there by his Cambridge friend Abraham Cowley, living in great poverty; and he was then sent to Rome with a recommendation from the queen to the pope. After some delay he was appointed, in 1649, to a canonry at the cathedral of the Santa Casa at Loreto; but his tenure was short for he was taken ill and died there on Aug. 21, 1649.

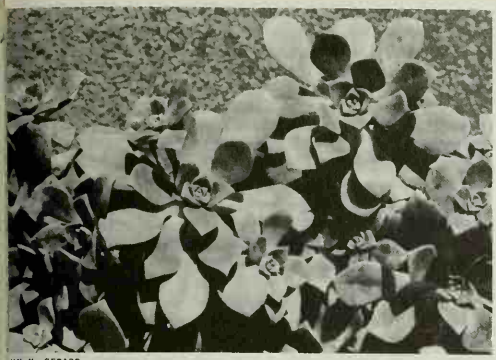
Crashaw's *Steps to the Temple with The Delights of the Muses* was published in 1646 with an anonymous preface, and again in 1648, with a few additions. The preface speaks admiringly not only of his poetry but of his linguistic knowledge, his proficiency in music and painting and his saintly character. His English religious verse was republished in Paris in 1652 with more additions, including some of his finest lines, those appended to "The Flaming Heart," a poem on St. Teresa, and beginning "O thou undaunted daughter of desires."

Crashaw left only a small amount of verse, but enough to give him a peculiar eminence among the writers of his day. Most of it is religious and highly individual. It reflects a mind untroubled by doubts and not much given to philosophical speculation, but vitally and ardently responsive to the Christian faith, fascinated by its implications and glorying in its paradoxes. And because Crashaw was by nature both otherworldly and sensuous, he was well qualified to capture in his poetry the spirit of Catholic worship. His thoughts are sometimes surprising and even disconcerting to modern taste, as in the conceit of Mary Magdalene weeping upward (to heaven) or the comparison of her sorrowful eyes to "portable and compendious oceans." Much of his poetry is translated from Latin or Italian, but even here his exuberance and originality can be seen, for often when he translates he transforms sometimes adding many lines of his own invention. Some of his religious poems, those for instance on St. Teresa or on the Assumption, are justly famous, but their outstanding qualities—the eagerness and rapture, the brilliant imagery and the light, flexible rhythms—are also found in favourite secular pieces such as "Wishes, to his supposed Mistress," or "Music's Duel," which describes a contest between a lute player and a nightingale.

Crashaw was little read for 150 years after his death, though his memory was kept alive by Cowley's fine elegy. In the 19th century, however, he gained his deserved recognition and his poems were reprinted several times. They were edited again by A. R. Waller (1904) and by L. C. Martin (1927; 2nd ed., 1957).

See A. Warren, *Crashaw: a Study in Baroque Sensibility* (1939). (L. C. Mn.)

CRASSULACEAE, the orpine or stonecrop family of succulent plants, containing 15 or more genera and 500 or more species, distributed in many parts of the world. The plants, many of which are interesting garden ornamentals, are herbs or rarely shrubs, generally with thick fleshy stems and leaves adapted for life in rocky, often dry, places. The fleshy leaves sometimes are reduced to a more or less cylindrical structure, as in a few stonecrops (*Sedum*), or they form closely crowded rosettes as in the houseleek (*Sempervivum*). Correlated with their life in dry situations, much of the tissue is succulent, forming a water storage that is protected from loss through evaporation by a thickly cuticularized epidermis, that is, one covered by a waxy secretion or bloom, which gives a glaucous appearance to the plant. The flowers, often red or yellow, rarely white, are usually arranged in terminal or axillary clusters, are radially symmetrical and have the same number of parts in each series. However, this number though usually 5, varies in some genera. The sepals and petals are free or sometimes more or less coalescent. The stamens are as many or twice as many as the petals. The carpels, usually free, are equal to the petals in number. In fruit they become follicles. Some species spread by means of a creeping much branched rootstock or, as in the houseleek, by runners that perish after producing a terminal leaf rosette. In other cases sma



HN H. GERARD

HOUSELEEK (SEMPERVIVUM)

ortions of the stem or leaves give rise to new plants by budding, in bryophyllums (*Kalanchoe*), where buds at the edges of the af may form new plants.

The family is almost absent from Australia and Polynesia, and has but few representatives in South America; otherwise it is enerally distributed. Numbers of described species have been ultiplied by enthusiasts, and an accurate estimate for any genus difficult. The largest genus, *Sedum*, occurs in the temperate and older parts of the northern hemisphere; many species occur in orth America and nine in Britain. The species are easily culti- ated, and they thrive in almost any soil. *Crassula* grows chiefly ar the Cape of Good Hope. *Cotyledon*, a widely distributed d world genus, is represented in the British Isles by *C. umbilicus*, nnywort or navelwort. The genus *Echeveria* of Mexico and its ssible segregate *Dudleya* of western North America are cul- vated widely. *Sempervivum* occurs in the mountains of central d southern Europe, in the Himalayas, Abyssinia, the Canaries d Madeira; *S. tectorum*, common houseleek, or hen and chickens, seen often in gardens. The hardy species grow well in sandy il, and they are suitable for rockeries, old walls or edgings.

In North America the representatives of the family are most merous from the Rocky mountains westward, especially in lifornia where several genera are represented.

The family is allied closely to the family Saxifragaceae, from hich it is distinguished by the fleshy habit and the larger number carpels.

BIBLIOGRAPHY.—Alwin Berger, *Crassulaceae;* Adolph Engler and K. antl, *Die Naturlichen Pflanzenfamilien*, 18a:352–483, fig. 183–212 930). Several journals are devoted to succulent plants, especially the *ctus and Succulent Journal; The Cactus and Succulent Journal of eat Britain; The National Cactus and Succulent Journal* (England). (L. BN.; X.)

CRASSUS ("thick, dense"), a *cognomen* or third name be- ging from the 3rd century B.C. onward to the Licinii, who, iginally Etruscan, were the most distinguished plebeian family Rome.

PUBLIUS LICINIUS CRASSUS DIVES MUCIANUS (*c.* 180–130), *ntifex maximus* (high priest) at Rome and consul in 131 B.C. Mucius Scaevola by birth and a Licinius Crassus by adoption, was a political opponent of Scipio Aemilianus Africanus (*q.v.*), nember of the Gracchan land commission and father-in-law of ius Gracchus. The first *pontifex maximus* in Roman history undertake military command outside Italy, he was defeated and lled fighting Aristonicus of Pergamum in Asia early in 130.

LUCIUS LICINIUS CRASSUS (140–91 B.C.) and M. Antonius, two greatest orators at Rome before Cicero, are vividly de- ted in Cicero's *De Oratore*. Crassus made his reputation at bar in 119 by his prosecution of Carbo, consul of 130, a con- cuous deserter from the cause of Tiberius Gracchus. The *Licinia Mucia*, passed in his consulship in 95, allowing prose- ion of anyone who was alleged to be laying false claim to man citizenship, offended the Italians. In 91 he supported the younger Drusus, having changed sides in politics since 106 when he had supported the consul Q. Servilius Caepio.

MARCUS LICINIUS CRASSUS DIVES (*c.* 115–53 B.C.), prominent and wealthy politician in the late republic. On the fall of Rome to Gaius Marius in 87 (when his only surviving brother was killed and his father, P. Licinius Crassus, consul in 97 and censor in 89, committed suicide) he escaped to Spain. Returning with Sulla to Italy, he fought successfully at the battle of the Colline gate in 82. His abiding jealousy of Pompey perhaps originated in Sulla's clear preference for Pompey. After his praetorship (probably in 73) he suppressed the slave revolt of Spartacus, and was consul with Pompey in 70. His wealth, derived largely from the Sullan proscriptions, gave him disproportionate influence as the creditor of indebted senators and the representative in politics of the business world (the *equites*). Apart from his early recognition of the quality of Caesar and his tenure of the censorship in 65, he achieved little in the 60s, the period of Pompey's great military achievements, and, though he may have encouraged Catiline in 65 and 64, he dropped him in 63 as soon as his schemes threatened existing capitalist tenure of property. He formed a political alliance with Pompey and Caesar (the "first triumvirate") in 60, in order to secure the passage in 59 of a law in favour of the company which collected the tithes in Asia. He supported P. Clodius in neutralizing Pompey in politics from 58 to 56, was consul with Pompey for the second time in 55 and, after that, governor of Syria. At the age of 60 he embarked on an unwarranted invasion of Parthia, and was disastrously defeated at Carrhae in 53. He was killed, as was his younger son, Publius, whom Cicero had encouraged as a promising orator but Caesar had taught to prefer soldiering. His elder son, Marcus, serving with Caesar in Gaul, survived, and through his son (and by adoption from the Calpurnii Pisones) the family name continued, down to M. Licinius Crassus Frugi, consul in A.D. 64.

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CRATAEGUS: *see* HAWTHORN.

CRATER LAKE NATIONAL PARK, in southwestern Oregon, U.S., was established in 1902 to preserve in its natural condition an area of 160,290 ac. The park's principal feature is an intensely blue lake, 1,932 ft. deep, set in a caldera (volcanic crater). The shores are almost sheer cliffs that rise from 500 to 2,000 ft., forming a nearly circular rim 6 mi. in diameter and 26 mi. in circumference.

This is the stump of a mountain, Mt. Mazama, that is believed to have once reached a height of 12,000 ft. above sea level. Centuries ago an eruption destroyed the peak, and the caldera is all that remains of it. Later intermittent outbreaks occurred, as shown by several cinder cones on the caldera floor. One of these, Wizard Island, rises 750 ft. above the water. The lake, with neither visible inlet nor outlet, is replenished by rain and snow, its level kept nearly constant by evaporation. Volcanologists consider that the volcano may be temporarily dormant.

North of the caldera there is a pumice "desert," except for which, the park's lower elevations are heavily forested; lodgepole, ponderosa and sugar pine and white and Douglas fir are the dominant tree species. At higher elevations, stands of Shasta red and alpine fir, whitebark pine and mountain hemlock are interspersed with meadows that are carpeted with wild flowers in summer.

Annual precipitation is heavy, and winter snow blows into drifts 20 to 30 ft. deep. Mammals include all three species of American deer—mule, blacktail and whitetail—black bear, pine marten, porcupine, marmot, badger, beaver and mountain beaver. Eagles, hawks, owls and grouse occur and, particularly in summer, there is an abundance of song and insectivorous birds. (Dx. B.)

CRATERS OF THE MOON NATIONAL MONUMENT, a tract of about 48,000 ac. in south central Idaho, U.S., set apart in 1924 as a government reservation. It is a region of cones and craters formed by volcanoes which have probably

been extinct for only a few centuries, and the name of the reservation was suggested by its resemblance to the surface of the moon. While the black lava and cinders allow only the scantiest vegetation and quickly absorb the very light rainfall, water is to be found in tunnels which were formed by eruptions through a partly formed crust. Lava stalactites and stalagmites in red and blue are striking features of these tunnels.

CRATES, Athenian actor and author of comedies, flourished about 450–470 B.C. He was regarded as the founder of Greek comedy proper, since he abandoned political lampoons on individuals and introduced more general subjects and a well-developed plot (Aristotle, *Poetics,* 5). He is stated to have been the first to represent the drunkard on the stage.

CRATES, the name of four Greek philosophers.

1. CRATES OF THEBES (fl. late 4th century B.C.), Cynic philosopher, was a pupil of Diogenes. He gave up his fortune and made it his mission to castigate vice and pretense. Hipparchia, daughter of a wealthy Thracian family and sister of Metrocles, forced her parents to allow her to join him in his ascetic and missionary life. He had a gift for amusing parody of serious poetry, by which he mocked other philosophers and praised the Cynic way of living. He was reputed to be the author of philosophic dramas and philosophic letters: the letters extant under his name (ed. by R. Hercher, *Epistolographi Graeci,* Paris, 1873) are spurious. His historical importance lies in the influence that he exerted on Zeno the Stoic, who greatly admired him. Plutarch's biography of him is no longer extant.

2. CRATES OF ATHENS (fl. early 3rd century B.C.), Academic philosopher, became scholarch or head of the Old Academy *c.* 270, in succession to Polemo (*see* ACADEMY, GREEK).

3. CRATES OF MALLUS (fl. early 2nd century B.C.), Stoic philosopher, from Mallus in Cilicia, was primarily important as a grammarian: his chief work was a commentary on Homer. Leader of the literary school and head of the library of Pergamum, he was the chief representative of the allegorical theory of exegesis, maintaining that Homer intended to express scientific or philosophical truths in the form of poetry. About 170 B.C., he went to Rome as ambassador of Eumenes II, king of Pergamum; the lectures that he delivered there gave the first impulse to the study of grammar and criticism among the Romans (Suetonius, *De grammaticis,* 2).

See C. Wachsmuth, *De Cratete Mallota* (1860), containing an account of the life, pupils and writings of Crates; J. E. Sandys, *History of Classical Scholarship,* 3rd ed. (1921).

4. CRATES OF TARSUS (late 2nd century B.C.), Academic philosopher, was scholarch from 131/130 to 127/126.

CRATINUS (*c.* 495–*c.* 420 B.C.) was generally classed in antiquity together with Eupolis and Aristophanes as the greatest of Athenian writers of comedy. Though Cratinus was probably born *c.* 495 B.C. some authorities put the date considerably earlier. The 21 comedies attributed to him (of which only some 400 odd fragments remain) may be divided roughly into two classes: personal and political satires, and mythological burlesques. Of the second type may be mentioned the *Odysses,* which seems to have been a kind of skit on the Odyssey, the chorus of which was probably composed half of Odysseus' companions and half of Cyclopes; the *Thrassai,* which was an attack on the orgiastic rites of the Thracian goddess, Bendis; the *Nemesis,* which contained the story of the egg which produced Helen; and the *Dionysalexandros,* a comedy with a chorus of satyrs, which burlesqued the story of the judgment of Paris. Political satire evidently entered into the three last-mentioned plays, for in the *Nemesis* Pericles is travestied in the person of Zeus, and his mistress, Aspasia, in that of Hera; and the same statesman is referred to, in unflattering terms, in the other two. Among the plays dealing solely with personal and political satire may be included the *Panoptai* (*The All-seers*), which must have borne some resemblance to Aristophanes' *Clouds,* in that it made fun of the Sophists, and the *Putine* (*The Bottle*). In this play Cratinus defends himself against the charge of drunkenness leveled at him by Aristophanes in the *Knights.* The chorus is composed of Cratinus' friends, who attempt—successfully—to break the poet's liaison with his mistress, Methe (drunkenness), and bring him back to the arms of his true wife, Komodia (comedy), by smashing his wine jars. The *Putine* took first prize in 423 B.C., defeating Aristophanes' *Clouds.* Cratinus' vigorous style has earned him the title of the Aeschylus of comedy.

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(M. PR.)

CRATIPPUS (1st century B.C.), Greek Peripatetic philosopher, taught first at Mitylene, where Cicero made his acquaintance in 51 B.C. and where Pompey also had a conversation with him in Aug. 48 (after the defeat at Pharsalus). Moving to Athens (not later than 45), he had among his auditors there Cicero's son Marcus, whose father had chosen Cratippus as the young man's instructor. After the death of Andronicus of Rhodes, Cratippus became the most influential member of the Peripatos, though he probably was not its scholarch. Cicero, who procured Roman citizenship for him, speaks of him with high praise. The outline of his views on divination can be reconstructed from a passage quoted by Cicero (*De Divinatione,* i, 32, and ii, 52). Cratippus argues that the failure of some predictions is no disproof of prophecy, if it is matched by even a few successes not attributable to chance; but, following Dicaearchus, he rejects artificial modes of divination such as astrology and augury and accepts only prophecy in dreams or through divine afflatus. The psychological explanation is that the rational power in the soul (as distinct from the sense-faculty, which is inseparable from the body) is of divine origin and becomes strengthened when the body is inactive.
(D. J. A.)

CRAVAT, the name given by the French in the reign of Louis XIV to the neck scarf worn by the Croatian soldiers enlisted in the royal Croatian regiment (Fr. *Cravate,* a Croatian). The term came to be applied in England and France to any kind of a neckerchief worn by a man.

After the battle of Steenkerke (Steenkirk) in 1692, a loosely tied cravat made of linen or muslin with wide lace on the edges and worn negligently knotted with one end passed through the buttonhole was called a steinkirk. In the late 18th and early 19th centuries the cravat was an elaborately folded and lightly starched linen or cambric neckcloth worn under the collar of the shirt.

The simplification and standardization of men's dress in the late 19th and early 20th centuries made the cravat the necktie worn by men today. It is applied more specifically to the formal scarf worn with a dress suit; this cravat is folded or tied in front and the ends are tucked into the inside coat. (M. B. K.)

CRAVEN, FRANK (1880–1945), U.S. actor and playwright was born in Boston, Mass. He achieved his first Broadway success in *Bought and Paid For* (1911), after which he was very popular especially in slender comedies. Among his own plays are *Too Many Crooks* (1914), *The First Year* (1920) and *New Brooms* (1924). He played the stage manager in Thornton Wilder's *Our Town.* After 1929 most of his work was in films. (M. Rs.)

CRAVEN, WILLIAM CRAVEN, EARL OF (1606–1697) English royalist, remembered especially for his services to Elizabeth, consort of Frederick V, the elector palatine, was the eldest son of Sir William Craven, lord mayor of London (1610). He was educated at Trinity college, Oxford, and the Middle Temple but much of his youth was spent in military service abroad. In 1632 he went to assist Frederick V, the dispossessed king of Bohemia, in the defense of the Palatinate, and there began his life-long devotion to Elizabeth, the tragic "winter queen" of Bohemia. William, created Baron Craven in 1627, was taken prisoner by the emperor's forces in 1637 but ransomed himself and went to join Elizabeth in her exiled court at The Hague. His great wealth was their principal mainstay; during the English Civil War it was placed at the disposal of both Charles I and Charles II.

After the Restoration Craven commanded the Coldstream guards and was created Viscount Craven of Uffington and earl of Craven in 1665. The queen of Bohemia, whom it was rumoured he had married, lived at his house in Drury lane, London, un-

r death in Feb. 1662. Craven held many offices under the own, mainly honorific, and although a member of the council, entered little into politics. But he and his guardsmen figured ominently in civic emergencies such as fires, and he prized his ilitary command above all, retaining it until the arrival of Wil-m III's Dutch troops in London in Dec. 1688, when Craven was und stubbornly guarding Whitehall with his men, and with fficulty was persuaded to relinquish his post. He died, unmar-d, in London on April 9, 1697. He was a member of the Royal ciety but his reputation as a patron of the arts will hardly ar scrutiny.

His brother John (d. 1648), created Baron Craven of Ryton, ropshire, in 1643, was the founder of the Craven scholarships Oxford and Cambridge universities, of which the first was arded in 1649. (H. G. Ro.)

CRAWFORD, EARLS OF. The house of Lindsay, of ich the earl of Crawford is the head, traces its descent to the rons of Crawford who flourished in the 12th century. Sir exander Lindsay of Luffness (d. 1309) obtained Crawford, in narkshire, in 1297. His descendant, Sir James Lindsay (d. 97), lord of Crawford, was high chamberlain of Scotland and ught at the battle of Otterburn (1388). The chronicler Frois-rt tells of his wanderings after the battle. James's cousin and ccessor, Sir David Lindsay (*c.* 1360–1407), who married a ughter of King Robert II, was made earl of Crawford in 1398. ls grandson David (d. 1446), 3rd earl, formed with the earl of uglas a powerful alliance which was continued by his son exander (d. 1453), 4th earl, known as "the Tiger" or "Earl lardie." After the murder of Douglas, Alexander opposed King mes II, but he made full submission and was pardoned in 1453 rtly before his death.

Alexander's son David (*c.* 1440–95), 5th earl, was lord high miral and lord chamberlain, and several times ambassador to gland. He was created duke of Montrose in 1488 and fought f James III at Sauchieburn (1488). The dukedom did not cend to his son John (d. 1513), 6th earl, who was killed at dden. John's cousin David Lindsay (d. 1542), 8th earl, whose n Alexander, master of Crawford, known as "the wicked master," s sentenced to death in 1541 for attempting to kill his father, nveyed the title to his kinsman David Lindsay of Edzell (d. 58), 9th earl. The 9th earl adopted Alexander's son David (1574), 10th earl, and made him his successor with the consent the crown in 1558. The 10th earl was a firm supporter of ry Stuart. His son and successor, David (*c.* 1557–1607), h earl, took part in the risings under James VI, was converted t Roman Catholicism and communicated with Spain about an asion of England. Ludovic (1600–52), 16th earl, "the loyal el," took part in the plot of 1641 to overthrow the marquess Argyll and supported Charles I in the Civil War. His earldom s forfeited by the Scottish parliament in 1644 and he was im-soned. He was released by the marquess of Montrose in 45 and served under him until the king's surrender to the enanters. The earl died on the continent in 1652.

By the crown charter of 1642, Ludovic settled his earldom, ing his own male issue, on a distant kinsman, John (1596–18), 1st earl of Lindsay, who became 17th earl of Crawford d chief of the Lindsays. His branch of the Lindsays descended m Sir David Lindsay, grandfather of the 1st earl. A leader the covenanters, Lindsay had marched with the Scottish army to England in 1644. He became high treasurer of Scotland in 44 and president of the parliament, but he changed sides in 47 and signed the Engagement. He lost all his offices when h enemy Argyll won the upper hand. In 1661 he was restored his offices but his refusal to abjure the Covenant compelled h to resign them in 1663. His son William (1644–98), 18th el, also an ardent covenanter, was president of the Convention pliament of 1689. William's grandson John (1702–49), 20th e, "the gallant earl," served on the continent under Prince Eugene of Savoy and fought at the battles of Dettingen and Fontenoy. In 1740 he was made colonel of a new regiment, known then as Lord Crawford-Lindsay's highlanders and later as the Black Watch.

At the death of George (1758–1808), 22nd earl, without issue, the earldoms of Crawford and Lindsay separated. Alexander, 6th earl of Balcarres (heir male of the 16th earl), became *de jure* 23rd earl of Crawford and chief of the Lindsays, but the earldom remained dormant from 1808 until 1848 when the house of lords adjudged it to James Lindsay (1783–1869), 7th earl of Balcarres and 24th earl of Lindsay. His son Alexander William (1812–80), 25th earl of Crawford, wrote, among other works, a history of the family, *Lives of the Lindsays*, 3 vol. (1849). Alexander's only son, James Ludovic (1847–1913), 26th earl, was president of the Royal Astronomical society in 1882. He was a collector and bibliophile, bequeathing his great stamp collection to the British museum and many valuable manuscripts to the John Rylands library, Manchester. His son David (1871–1940), 27th earl, was also an authority on art and literature, published books on painting and sculpture and became chairman of the Royal Fine Art commission, founded in 1924. He took an active part in politics as well, becoming a member of Lloyd George's coalition cabinet in 1916. His son and successor, David Robert Alexander (1900–), 28th earl, followed in the literary and artistic traditions of his three predecessors.

See A. Jervise, *History and Traditions of the Land of the Lindsays* (1882); H. T. Folkard, *A Lindsay Record* (1899). (T. I.)

CRAWFORD, FRANCIS MARION (1854–1909), U.S. author who treated with vividness and accuracy widely varying periods and countries, was born at Bagni di Lucca, Italy, Aug. 2, 1854, son of the sculptor Thomas Crawford (*q.v.*), and nephew of Julia Ward Howe, the poet. The cosmopolitanism of his work is foreshadowed by his early training at St. Paul's school, Concord, N.H.; Trinity college, Cambridge; Heidelberg and Rome. In 1879 he went to India, where he studied Sanskrit and edited the *Allahabad Indian Herald*. Returning to the United States, he continued to study Sanskrit at Harvard university for a year, contributed to various periodicals, and in 1882 produced his first novel, *Mr. Isaacs*, a brilliant sketch of modern Anglo-Indian life mingled with a touch of oriental mystery. This book had an immediate success, and its author's promise was confirmed by the publication of *Dr. Claudius* (1883). After a brief residence in New York city and Boston and travel in Turkey and elsewhere, Crawford in 1883 returned to Italy, where he made his permanent home and about which he wrote numerous novels, including the excellent series *Saracinesca* (1887), *Sant' Ilario* (1889) and *Don Orsino* (1892). His interest in his adopted country is also revealed in his historical works, *Ave Roma immortalis* (1898), *Rulers of the South* (1900) —renamed *Sicily, Calabria* and *Malta* in 1904—and *Gleanings from Venetian History* (1905), in which his intimate knowledge of local Italian history combines with the romanticist's imaginative faculty to excellent effect. Among the most celebrated of his novels are: *A Roman Singer* (1884), *A Tale of a Lonely Parish* (1886), *Paul Patoff* (1887), *The Witch of Prague* (1891), *Via crucis* (1898), *In the Palace of the King* (1900), and *The White Sister* (1909). In his American novels such as *An American Politician* (1885) he was probably least successful. Nevertheless, he was always a gifted narrator, and his romances with their picturesque backgrounds and dramatic characterizations were very popular. In *The Novel—What Is It?* (1893) he set forth his belief that the novel should be "a pocket theatre" for entertainment only. It was but natural, therefore, that *A Cigarette Maker's Romance* (1890) should be effective on the stage, and that in 1902 an original play from his pen, *Francesca da Rimini*, should be produced in Paris by Sarah Bernhardt. He died at Sorrento April 9, 1909.

For criticism and bibliography *see* F. T. Cooper, *Some American Story Tellers* (1911). For biography, *see* Maud Howe Elliot, *My Cousin F. Marion Crawford* (1934).

CRAWFORD, ISABELLA VALANCY (1850–1887), the first Canadian woman poet of note, was born in Dublin, Ire., Dec. 25, 1850. The daughter of a physician who emigrated to Canada in 1858, she spent most of her girlhood in the picturesque Kawartha lakes district of Ontario. She received an excellent education in the classics and was widely read in French and Italian. The last years of her life she and her widowed mother lived over a

grocery store in Toronto, meagrely sustained by the sale of her stories and poems. Most of these appeared in Toronto newspapers, a few in U.S. magazines. A novel was serialized in the *Toronto Evening Globe*. Her only book was a paper-covered collection of her poems, published at her own expense in 1884, *Old Spookses' Pass, Malcolm's Katie, and Other Poems. Old Spookses' Pass* describes a cattle stampede in the Rockies, vigorously and vividly related in an irksome but consistent American cowboy idiom. *Malcolm's Katie* is a sentimental and melodramatic romance competently handled in the manner of Tennyson. Her best narrative and descriptive passages—mainly those with Canadian themes and settings—are marked by energy of rhythm and boldness of imagery. She died in Toronto, Feb. 12, 1887. A collection of her poems was published in 1905.

See Katherine Hale, *Isabella Valancy Crawford* (1923); C. F. Klinck and R. E. Watters, *Canadian Anthology* (1956). (A. M. Be.)

CRAWFORD, THOMAS (1814–1857), U.S. sculptor whose best-known work is the colossal "Statue of Freedom" on the dome of the capitol building in Washington, was born in New York city, March 22, 1814. Crawford was trained as a stonecutter in the marble yards of Frazee & Launitz in New York. In 1835, he went to Rome where he had some instruction from Bertel Thorwaldsen. He made his home there for most of the remainder of his life. Crawford designed sculpture for the senate pediment of the capitol symbolizing the progress of civilization in America, and a pair of bronze doors, but he died before these were completed. He also designed the Washington monument in Richmond, Va., and the statue of Beethoven in Boston. He died in London, Oct. 10, 1857. At the time of his death his reputation rivaled that of Hiram Powers and Horatio Greenough as a leading American sculptor. His work, however, like theirs, did not remain long in popular favour after his death. The novelist Francis Marion Crawford (*q.v.*) was his son.

Bibliography.—Lorado Taft, *History of American Sculpture* (1930); Albert G. Gardner, *Yankee Stonecutters* (1945); Thomas Hicks, *Eulogy on Thomas Crawford* (1865); Charles E. Fairman, *Art and Artists of the Capitol* (1927). (A. T. G.)

CRAWFORD, WILLIAM HARRIS (1772–1834), U.S. senator, cabinet member and presidential candidate, was born in Amherst county, Va., on Feb. 24, 1772. His family moved to South Carolina and then to Georgia. After study and teaching in an old-field school, Crawford attended Carmel academy, directed by the famous Presbyterian minister Moses Waddel. He taught in and was rector of the Richmond academy in Augusta and began to practise law in 1799. Coauthorship of a digest of the Georgia laws and service in the Georgia house of representatives (1803–1807) preceded his election to the U.S. senate in 1807. He was re-elected without opposition in 1811. Crawford was a strong advocate of the Bank of the United States and approached the views of the "War Hawks" in the dispute with Great Britain. He served as president pro tempore of the U.S. senate (1812–1813) and as minister to France (1813–1815). President Madison appointed him secretary of war in Aug. 1815, and in Oct. 1816 he became secretary of the treasury, a post he held until March 1825. In 1816, in spite of his disavowal of candidacy, Crawford received only 11 fewer votes in the presidential caucus than did James Monroe. Before the end of Monroe's second term, however, the political picture had changed and there were four strong candidates —John Quincy Adams, Henry Clay, Andrew Jackson and Crawford. As none won a majority of the electoral votes the choice went to the house of representatives, which chose Adams. Crawford's ruling as secretary of war on some of the provisions of the treaty with the Creek Indians had incited the ire of Andrew Jackson, who seems to have sparked the bitter intraparty strife that led to the choice of Adams. Crawford's ill health, resentment in the north against the continued control of the presidency by the south, popular discontent with caucus nominations, and the uncertainty of Crawford's position on internal improvements—all these factors seem to have had a bearing on the outcome. After the election Crawford declined President Adams's offer to remain as secretary of the treasury.

From 1827 until his death on Sept. 15, 1834, he was judge of the northern superior court circuit in Georgia.

Crawford was of imposing stature and possessed great char and conversational powers. He was deemed a skilful political o ganizer but he never achieved great popularity. His independen of mind and his refusal to adhere to party principles merely f the sake of party did not endear him to some of his contemporarie A slaveowner, he supported slavery where it existed but indicat that if he lived in a region where it did not exist he would oppo its establishment. In later years he became a strong advocate state rights but denounced nullification and secession, preferri instead the calling of a constitutional convention to deal primari with the tariff question. On his 1,200-ac. plantation, "Woodlawr not far from Lexington, Ga., for more than 25 years he carri out many experiments with plants and seeds imported from oth countries and various parts of the United States. (C. C. Mo.)

CRAWFORDSVILLE, a town and seat of Montgome county, Ind., U.S., is located on Sugar creek, 44 mi. W.N.W. Indianapolis. It was founded in 1823 and chartered in 1865. T leading industry is publishing, printing and bookbinding. Mar factures include wire fencing, nails, plastics, pellet mill dies, l trucks, gray iron castings, brick, caskets, sintered metal produc bottle caps, pre-cut houses and screw machine products.

Wabash college for men was founded there in 1832 by Presb terian missionaries. Crawfordsville was the home of Lew (Lew Wallace, author of *Ben Hur,* Henry S. Lane, statesman, al Maurice Thompson, poet and novelist. Historic memorials clude several college buildings, the Lew Wallace study and t Henry S. Lane mansion. The city maintains two recreational c tres, a municipal golf course, a park system and airport. Ir comparative population figures *see* table in Indiana: *Populati*. (T. G. G.)

CRAWLEY, an urban district formed in 1956 as a rest of the development of the New Town designated in 1946, in e Horsham parliamentary division of West Sussex, Eng., 9 mi. of Reigate and 7 mi. N.E. of Horsham on the main London o Brighton road. Pop. (1951) of civil parish 7,000; of Crawley Nv Town (1961) 54,065. The proposed population of the New Tow is 55,000. Area of district 7.0 sq.mi.; of Crawley New Town 3 sq.mi. Crawley New Town lies in West Sussex and East Sus and a small part of the industrial area is in Surrey. To the sou are the forests of St. Leonards, Tilgate and Worth, and nursy gardens and woods covering about 465 ac. are being retained wie most of the farms were built over. Crawley received a char from King John in 1202 and its medieval buildings have been pe served. The old industries include light engineering and wol working; new ones are chiefly engineering (making machiny, elevators), electrical (hearing aids, electronic apparatus), co printing and inks, plastics and food processing. *See* also Nw Towns.

CRAYER, CASPAR (Gaspard) **DE** (1584–1669), Flemish painter, who was strongly influenced by his friend Rubens, as born at Antwerp on Nov. 18, 1584. He was a pupil of Rapel Coxcie in Brussels, where he became a master in the painters' gld in 1607 and resided as a much-honoured citizen until 1664. In 1635 he was appointed court painter to the cardinal infant Fdi nand, for whose triumphal entry into Ghent he had designed co rations; after Ferdinand's death in 1641 he received the title a painter to the king. In 1664 he moved to Ghent where he die on Jan. 27, 1669. De Crayer was the painter of a large numbe of altarpieces which were produced with the help of many assists and still abound in the churches and museums all over Flanders nd elsewhere in Europe. His pictures of secular subjects are rare. Is artistic development runs parallel in various respects to th of Rubens, but he surpassed all other close followers of Rube in thoughtfulness and compositional skill. His portraits are inv ta- bly excellent. (W. Sv

CRAYFISH (Crawfish or Crawdad) are crustaceans lied to and resembling lobsters, and like them, belonging to the der Decapoda. They are found in fresh waters of all the contin tal land masses except Africa. Crayfishes range in size from the out 1-in.-long *Cambarellus diminutus* of Alabama to the giant 1 in. 8-lb. *Astacopsis gouldi* of Tasmania. In some parts of the wld.

he marine spiny or rock lobsters are called crawfish. Fresh-water
hrimp of the genus *Macrobrachium* are occasionally confused with
rayfish; however, in these animals the heavy pincers are on the
econd, rather than the first, pair of legs.

Although most species of crayfishes frequent streams, ponds or
akes, where they find shelter under stones, in debris or among
egetation, a number of them are found in temporary bodies of
ater. In fluctuating ponds or ditches they construct burrows as
he water level descends. These burrows (often mistakenly called
rake holes) reach the water table and may extend eight feet or
ore below the ground surface. Although there are no truly ter-
estrial crayfish, there are a number of species that spend their
ative lives in and about the mouths of their burrows. The soil
hat is removed from their excavations is frequently piled haphaz-
rdly round the opening but characteristic cylindrical chimneys,
ften exceeding one foot in height, are constructed at the mouths
f the burrows of some species. In the southeastern part of the
nited States many moist soil areas support such large popula-
ions of crayfishes that they are called "Crawfish lands." A num-
er of blind albinistic crayfishes occur in the subterranean waters
f the United States and Mexico. Among them is the unique
roglocambarus maclanei that clings, upside down, to ceilings of
nderground water systems in Florida. Most crayfishes are more
ctive at night than during the day.

The life histories of relatively few species are known; however,
t is evident that the European crayfishes mature much more slowly
nd have a considerably longer life span (seven or eight years in
orthern Europe) than do those species living east of the Rockies
North America (one to four years). When the eggs—less than
dozen to more than 1000—are laid, each, enclosed in a separate
apsule, is affixed by a slender stalk to the abdominal appendages
f the female. Development proceeds as the eggs are aerated by
ing swung back and forth in the water. Within a few weeks to
veral months, depending in part upon the temperature of the
ater, transparent miniatures of the adult hatch. Each offspring
still attached to the mother by a slender thread. Like other
hizopods crayfish grow only when their exoskeleton is shed.
nd at the first molt the young, although no longer attached
the mother, cling to her. With subsequent molts and further
owth they become independent, feeding upon both living and
ad plant and animal matter. Sexual maturity is attained within
few months in some species but requires several years in others.
he crayfish—like its ally the crab—has the ability to replace lost
rts, especially appendages and eyes, which have been either
roken off accidentally or sacrificed to a clutching enemy (*see* also
EGENERATION).

Although in certain parts of the world crayfish are food for
an and constitute important items in the diets of fish, amphib-
ns, reptiles, birds and mammals, they are frequently highly de-
uctive. Burrowing forms in the southeastern part of the United
ates destroy agricultural crops, disfigure lawns and burrow into
arthen dams; in Hawaii the recently introduced Louisiana red
rawfish has caused considerable damage in the taro fields. Cer-
in species serve as intermediate hosts in the life cycle of the
arasitic lung fluke of mammals.

The crayfish are classified into three families, the Astacidae,
habiting the northern hemisphere; and the Parastacidae and
stacostacidae, in the southern hemisphere, the latter family be-
g confined to Victoria, Austr. More than half of the described
rayfishes occur in North America; they include about 200 spe-
s and subspecies of the genera
acambarus, *Orconectes*, *Com-*
rus, *Cambarellus* and *Pacifas-*
us.

The crayfishes of Britain and
ost of Europe belong to the
nus *Austropotamobius*. Several
ecies of the genus *Astacus* are
o found on the European
ntinent. The genus *Com-*
robus occurs in eastern Asia
d Japan.

JOHN H. BERRY
CRAYFISH (ORCONECTES VIRILIS)

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CRAYFORD, an urban district of Kent, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with Bexley, Erith, and the northern part of Chislehurst and Sidcup to form the new London borough of Bexley (*see* LONDON). Crayford urban district is on the River Cray where it joins the Darent, which forms the district's eastern boundary and flows north to the Thames, part of the northern boundary. Crayford is also on the Roman Watling Street—the main London-to-Dover road through Rochester and Canterbury (A2). Pop. (1961) 51,287. The parliamentary constituency is Erith and Crayford. The district is residential and industrial; the biggest works are those of Vickers-Armstrong (Engineers) Ltd., making various kinds of machines. These works superseded Sir Hiram Maxim's machine gun factory (founded 1888) where one of the first "heavier-than-air" flying machines was made. Several deneholes, ancient excavations with shafts to underground chambers, have been found. In the late 17th century Sir Cloudesley Shovell bought the manor which included Newbery manor house and Mayplace mansion; the first is now an adult education centre and Mayplace (damaged in World War II and now consisting of the ground floor only) is the golf clubhouse. Howbery moated manor house is in ruins but the Jacobean tithe barn is preserved. The parish church is Perpendicular with parts from the 11th century.

CRAYON DRAWING is the general name given to broad-line drawing in black or coloured materials; formerly natural mineral substances cut into sticks were used, but after the early 19th century fabricated materials commonly were substituted. There is some looseness in the use of the term, partly because the French meaning of *crayon* includes the common graphite ("lead") pencil, partly because pastel (*q.v.*) was often called crayon before the pastel technique separated from line drawing. In the 20th century the growing use of the wax crayon of childhood as a serious artist's medium, and a common-sense desire for clarity, led to use of (1) the name crayon for solid (normally uncased) mediums having a waxy or fatty binder; (2) the name pastel is reserved for mediums having little or no binder and made in a range of values within a given colour; (3) fabricated chalk is the term used for mediums having a nongreasy binder (normally at full chroma without variation of values); and (4) cased mediums are called coloured pencils. Crayons and fabricated chalks are much less likely than pastels to be loaded with clays, kaolin or plaster of paris, but every pigment calls for its own extender or binder, or both, to produce optimum ductility.

There is also a tendency to define according to use as well as by material, so that the name pastel might be used for any dry coloured drawing medium when it is functioning as pastel (*i.e.*, covering the whole surface of the paper support); and the same medium might be called crayon or fabricated chalk when it is functioning in a linear way and not covering the whole surface.

Charcoal, originally a simple by-product put to draftsmen's use, has long been made for artists from split willow sticks. It is so devoid of adhesive power that it is of small use for permanent work unless sprayed with fixative; its brittleness and occasional failure to mark (because of uneven hard layers in the wood) present difficulties. Yet charcoal has served well as a preliminary sketching medium, easily erased after its lines were confirmed with ink. In modern times, powdered charcoal has been compressed into crayons so dense that they scarcely need a binder.

Oiled charcoal, made by soaking the sticks in linseed oil, gives a rich black adhesive mark. However it must be used at the right time: after the surplus oil has dripped away but before the oil in the charcoal has oxidized, leaving it again dry and brittle. The Tintoretto family, Giacomo Cavedone (1577–1660) and other 17th-century artists, as well as some in the 19th century, favoured oiled charcoal. Students who care to distinguish, after the fact, between lines in charcoal and those in black crayon will find under magnification that the particles of charcoal tend to lie in the hollows of paper, while those of crayon stick to the high spots

of paper. Oiled charcoal leaves a greasy ring or parallel lines around or along its course.

History.—Before the day of fabricated chalks, the adhesive power of natural black chalk, an impure carboniferous slate, made it preferable to charcoal as a drawing medium except where ease of erasure was desirable. In occidental art it is of record since Cennino Cennini (*c.* 1370–*c.* 1440); it was the standard material in Renaissance and post-Renaissance practice for studying details, especially figures. Black chalk heightened with white (gypsum or soapstone) was being used by 1500 on blue Venetian paper; red chalk (from hematites and other iron oxides) was in use before 1500 by Leonardo da Vinci. Red began to be combined with black and then with white chalk early in the 16th century, and in the time of Federigo Barocci (1528–1612) the combination of these three with blue paper was complete in its suggestion of greater range and variety of colour, its rich texture and its power to give the sense of third dimension. It remained for Rubens, Batista Tiepolo and Antoine Watteau to carry this three- or four-toned crayon drawing to greater heights.

Most of the old masters used crayon (natural or fabricated chalk) for drawing at one time or another. Fra Bartolommeo, Michelangelo, Andrea del Sarto, Tintoretto, Jacopo da Pontormo, Lucas van Leyden, Correggio, the young Rembrandt, the Ruisdaels, Jan van Goyen, Batista Piazzetta and Hubert Robert were among the most brilliant and also consistent users of red or black crayon or combinations. In the early 16th century there occurred with the Clouets in France and Hans Holbein on his English visits a great activity in portrait drawing in coloured chalks. The Clouets used red and black, often blending the two colours by rubbing or by association of small strokes; their followers would even wet the chalk drawing, thus forming a sort of unifying pale wash. Holbein used red, black, brown and yellow crayons, often on tinted grounds, and variously added metal point and pen lines for reinforcement.

Watteau, building in part upon Rubens, became the great master of the method called *à trois crayons*. He knew "how to commingle the red, black and white strokes with the tone of the paper so as to suggest the illusion of a natural garment of colour, how to rub the vermilion chalk on the black with the finger or a stump or a rag, so that a lovely tone [should] evolve, how to draw those expressive lines that positively sparkle with the living accent, how to judge the exact tones of white that [should] lighten the contours and the shadows" (M. C. Salaman). Watteau sometimes wet his *sanguine* (red crayon) for an especially strong touch in a nostril or the corner of an eye—a usage not unlike emphasizing a black chalk drawing with touches of oiled charcoal as some 17th-century men had done. Nicolas Lancret, J. B. J. Pater, François Boucher, Honoré Fragonard, J. B. Greuze and Clodion (Claude Michel) in their various ways followed Watteau's method but never surpassed his result.

Neo-classicism tended to dislike the sensuous and quasi-naturalistic colour of the three-chalk technique, but found black and white on blue paper useful for its bas-relieflike figure drawings (as in the work of Pierre Prud'hon). Nicolas Conté's slightly greasy fabricated crayon, developed about 1790 (not the first fabricated medium but probably the first with a trade name), was ready to hand. Yet such a man as Goya (who had drawn mostly with the brush) in his late years took up red chalk.

Richard Wilson and Thomas Gainsborough had used black and white on blue paper for serene or poetic landscapes; but Gainsborough often mixed techniques or applied his white heightening wet with a brush. William Hogarth occasionally used chalk; and John Singleton Copley, after his move from America to Britain, prepared many of his paintings with large studies in the three-tone method. John Linnell (1792–1882) was an early exponent of the 19th-century way of independent drawing in crayon; his landscapes in coloured chalks, often on tan paper, foretold Impressionism (though the Impressionists seldom drew).

Eugène Delacroix was a master of black crayon both for rapid notations (he said a young artist must learn to draw a man falling from a window before the body hit the ground) and for careful preparations for his paintings and for the *Hamlet* and *Faust* lithographs. Honoré Daumier freely mixed red or black chalk line with ink or colour brushwork. Jean Millet and Puvis de Chavannes rather soberly used black chalk for landscape and figure drawings; Millet's were often made for their own sake for sale, and occasionally had a little colour. Renoir used red chalk with much of the 18th-century feeling for its delights but on a large scale and with a bolder hand. Probably the most fascinating 19th-century draftsman in crayon was Edgar Degas, who, though he also used charcoal at the black end and pastel at the coloured end of the gamut, made quantities of studies which, in their not covering the paper support, qualify fully as drawings but have some coloured lines or areas. Toulouse-Lautrec apparently used coloured pencils and wax crayons as well as fabricated chalks and pastels.

Georges Seurat not only used coloured crayon but was an inventive crayon draftsman in black and white. His drawings in tone, almost without line and using the bold grain of his paper as a refracting surface, made white spaces as important as black; by the same token he was the modern user of creative erasure, probably invented in the 16th century by Battista Naldini and seldom used until Seurat resurrected it. Odilon Redon and Charles Sheeler are in his line of succession. The early black-chalk figure drawings of Vincent van Gogh are like a heavy-handed version of some Seurat figures in their study of mass and value rather than action or line.

Around the fringes of Impressionism, both before and after, there were draftsmen using specks of coloured crayon or pastel on toned grounds or coloured paper: Whistler, Hans von Marées, Jean F. Raffaelli, Pascin, even the young Picasso. The great illustrators of the late 19th and early 20th centuries, especially after photomechanical reproduction was perfected, made as fine use of broad crayon as the mid-19th century illustrators had done of pen and ink. In the time of George Bellows it became common for illustrators to draw with lithographic crayon, the fattest and blackest of all, for half-tone reproduction; Käthe Kollwitz, an all-round graphic artist, was a master of such broad crayon handling, and so was Henri Matisse.

The long-familiar convenience of chalk (or latterly of compressed charcoal and other fabricated media) for figure-study drawing has appealed much to sculptors. There is almost a direct line of descent of red-chalk drawings from Michelangelo to Bouchardon and Alfred Stevens and Aristide Maillol (whose sometimes independent drawings were made on a heavy paper of his own fomentation). Another sculptor, Henry Moore, has been the prime user in his drawings of wax crayons and of modern "negative" or resist techniques based on them and largely developed in commercial-art practice: lines or areas in coloured wax or (where a negative effect is wanted) white crayon are first drawn; ink or water colour superimposed then refuses to cover the waxy area which shows through and may be further differentiated by scratching it. *See* also DRAWING (TECHNIQUES OF); PASTEL.

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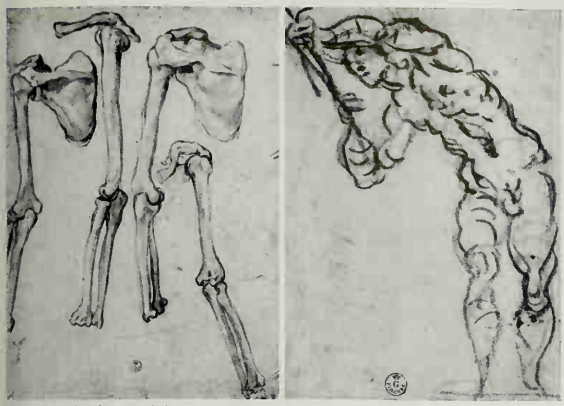
CRAZY HORSE (Indian name, TASHUNCA-UITCO) (1849?–1877), American Indian chief of the Oglala tribe of the Sioux considered by many to be the ablest Sioux tactician. He participated in the Fetterman massacre (Dec. 21, 1866) and the disastrous Wagon-Box fight (Aug. 2, 1867). He was a leader of the Indians in the Sioux war of 1875–77, when various Sioux bands refused to settle on reservations. Gen. George Crook surprised the Indian camp in mid-winter and drove off its ponies. Crazy Horse recovered the herd and moved north to the Rosebud river. There he defeated Crook in June 1876, forcing him out of the campaign. He joined Sitting Bull and other Sioux on the Little Bighorn river and was prominent in the annihilation of the force led by Col. George A. Custer (*q.v.*). After that victory the Sioux bands separated. While Sitting Bull retreated to Canada, Crazy Horse remained in Sioux country. He was pursued by Col. Nelson A. Miles until forced to surrender in the spring of 1877. Suspected of conspiring to lead the Oglalas on the warpath again, he was arrested



Left: Studies from a skeleton by Jacopo da Pontormo (1494–1556), Florentine. The slight rubbing of the crayon strokes gives an almost ivory texture to the bones. In the Uffizi gallery, Florence. *Right:* Figure study for the "Battle of Zara" by Tintoretto (1518–1594), Venetian. The use of rough paper and broad strokes produces an effect of rugged strength. Uffizi

Portrait of M. Pienne by François Clouet (d. 1572), French. Sharpened red and black crayons were used to produce a network of fine lines and dots. Houghton Library, Harvard university

CRAYON DRAWING, 16TH–19TH CENTURIES

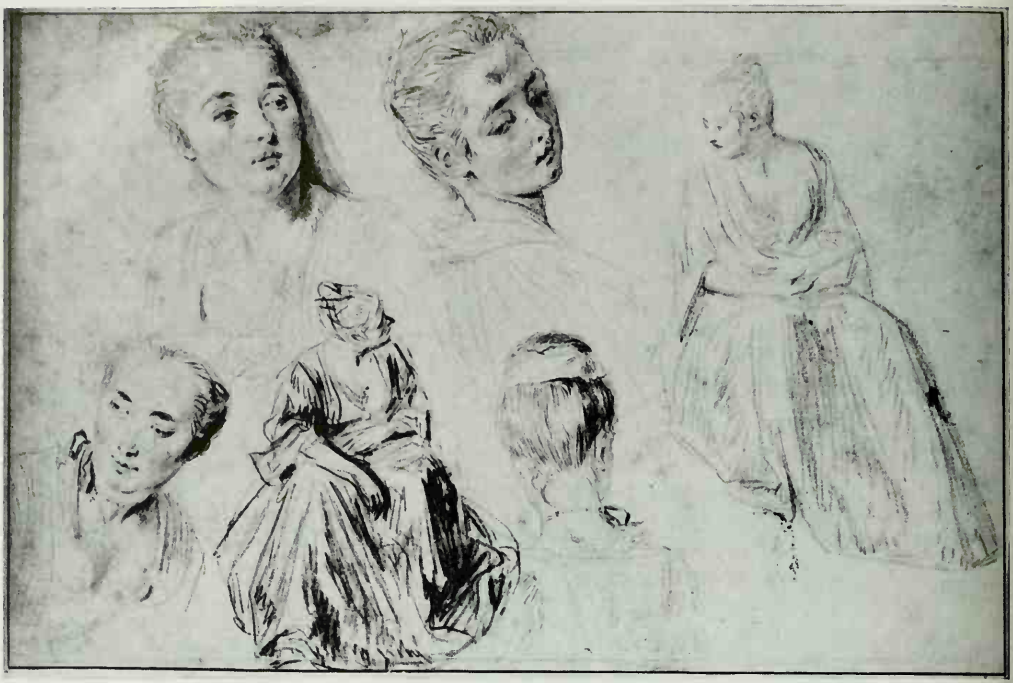
Left: Female head by Federico Baroccio (1535?–1612), Italian. Baroccio used black and white, sometimes also red and yellow, crayons on blue paper, a technique which became popular in the 18th century. In the Musée de Besançon, France

Two heads by Giovanni B. Piazzetta (1682–1754), Venetian. Black and white on blue paper in a typical drawing made independently of painting. In the collection of János Scholz, New York

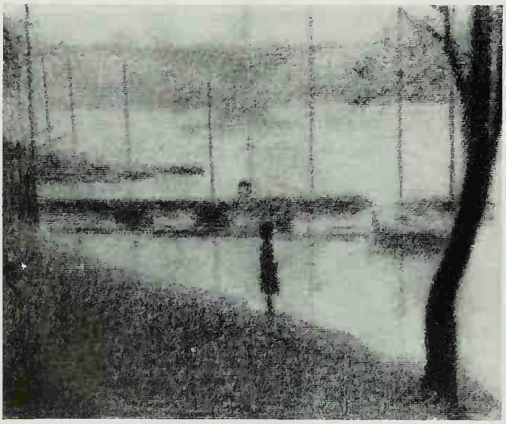
Study for a portrait of Jules Finot (or James Tissot?) by Edgar Degas (1834–1917), French. In such descriptive drawings Degas worked out his compositions by repeated trial. Fogg Museum of Art, Harvard university

BY COURTESY OF (TOP RIGHT) HARVARD COLLEGE LIBRARY, DEPT. OF GRAPHIC ARTS, (BOTTOM LEFT) THE FOGG MUSEUM OF ART, HARVARD UNIVERSITY, (BOTTOM RIGHT) WINSLOW AMES; PHOTOGRAPHS, (TOP LEFT, TOP CENTRE, CENTRE) CORPUS PHOTOGRAPHICUM GERNSHEIM

CRAYON DRAWING



Sheet of studies by Antoine Watteau (1684–1721), French. Typical of the accumulated notes from which Watteau chose motives for painting, this drawing has one figure all in black chalk, another all in red, others in red, black and white. There is also the use of pencil and wash. In the Rijksprentenkabinett, Amsterdam



"Le Pont de Courbevoie" by Georges Seurat (1859–91), French. Texture is produced by dragging the crayon broadside to the grain of the paper, with occasional finer work by the point of the crayon. Collection of Francis Kettaneh

WATTEAU, SEURAT AND MATISSE

"Reclining Nude" (sketch for the "Pink Nude") by Henri Matisse (1869–1954), French. Charcoal. Deliberate smudging of the broad lines, and highlighting by erasure in two places, produces a sumptuous inner modeling. In the Cone collection, Baltimore Museum of Art (Maryland)

BY COURTESY OF (TOP) RIJKSPRENTENKABINETT, AMSTERDAM, (LEFT) GERMAIN SELIGMAN, (RIGHT) BALTIMORE MUSEUM OF ART

Sept. 1877. Faced with imprisonment after being promised limited freedom, he presumably tried to break away from his guards and was killed, Sept. 5, 1877.

See Mari Sandoz, *Crazy Horse: the Strange Man of the Oglalas* (1942, 1955). (D. E. W.)

CREASY, SIR EDWARD SHEPHERD (1812–1878), English historian and lawyer, was the author of the popular *Fifteen Decisive Battles of the World* (Marathon, Syracuse, Arbela or Gaugamela, the Metaurus, the defeat of Varus, Châlons, Tours, Hastings, Joan of Arc's victory at Orléans, the Spanish Armada, Blenheim, Poltava, Saratoga, Valmy and Waterloo), first published in 1851. He was born Sept. 12, 1812, at Bexley, Kent, educated at Eton and King's college, Cambridge, elected fellow of King's (1834) and called to the bar at Lincoln's Inn (1837). He became professor of history in the University of London in 1840, and in 1860 was appointed chief justice of Ceylon and knighted. He retired in 1875 and died in London, Jan. 27, 1878. His other books include an *Account of the Several Invasions of England* (1852) and *Rise and Progress of the English Constitution* (1853).

CREATION, MYTHS OF. Myth, in primitive society, does not represent abstract philosophizing concerning the ultimate origin of the universe, or the beginning and essential nature of man; nor, indeed, is it a fanciful explanation of how the universe came into existence (as was formerly supposed), though fictitious incidents may be recorded frequently in the narrative. The primitive mind considers that things are as they are because they have been so created and ordained, and primitive interest in the past course of events is centred upon their bearing on present affairs and realities. This is demonstrated in myth by the belief that the spoken word is an oracle, and that the repetition of the word sets free the creative and re-creative power with which it is replete.

Thus, the numerous myths of origin which recur in primitive states of culture throughout the world are not the expression of an innate inquisitiveness about the problem of creation, an intellectual search for a "first cause" such as occupied the minds of the Ionian thinkers. Neither are they imaginative episodes such as Plato employed to give a clearer vision of the truth they were intended to convey, and to fill a gap in philosophical reasoning and empirical knowledge. Primitive myths originate from the conviction that the creation of the world had a permanent effect on subsequent behaviour and on the structure of society. Thus, among the Australian aborigines, the mythic past is concerned largely with the "dream time of long ago," the Alcheringa, when the ancestors brought the existing configuration of the country into being, created the various human groups and ordered their laws, customs, beliefs and the social and religious organization before they retired to the sky-world. What was then initiated has to be enacted by their descendants in the prescribed cultus because the well-being of the tribe depends upon the repetition of the events in the creative period. So the myth lives on in its ritual, and the creative process is an ever-present reality giving stability to the social structure and institutions.

The problem of ultimate origins and the idea of creation *ex nihilo* lie outside the range of the primitive mind; in cosmological myths all things are assumed usually to have been created from an existing order, such as a primeval ocean. According to one of the myths of the Crow Indians of Montana, for instance, long ago there was only water in which were ducks. Then the Sun as the creator, who has become merged with the "transformer" known as the Coyote, told them to dive into the waters and from the mud in the webbed feet of one of them he created the earth and peopled it with living creatures. This episode is a typical example of the cycle of creation stories associated with the Sun-Coyote as a "transformer" in the myths of the Crow and of the Thompson River Indians of British Columbia. They have parallels throughout the new world, in the cosmological myths in southern and eastern Australia, in Africa and the Pacific. In these myths the problem of a beginning *in* time or *of* time never occurs in the sense in which it has vexed the minds of later sophisticated thinkers. Creation centres in the production of the earth in its present form and the way it was made habitable and serviceable for human beings.

Creation Myths in Egypt and Mesopotamia.—In the great collection of myths and liturgies that recur in the texts belonging to the 3rd and 2nd millennia B.C. in Egypt, Mesopotamia, Syria and Palestine, the drama of creation is set forth as a series of births and struggles in the realms of the gods. In Egypt, the cosmic order was said to have been established from dry land which appeared out of the primordial abysmal ocean, deified as Nun. This is hardly surprising as in the Nile valley the annual inundation was the most significant event upon which vegetation and the economy of the country depended.

Atum, god of the Sun and father of all the other gods, also arose out of the abyss; according to one legend he appeared as a child sitting in a lotus bud. In Heliopolitan theology he was later known as Ra, and was said to have given birth to the gods and goddesses and performed his acts as creator on the primeval hill at Heliopolis where his temple was built afterward. In Memphite theology, however, the gods were regarded as manifestations of the uncreated Ptah, who produced them in conjunction with Nun, and who created all other objects in the world from his own thought.

In all these involved myths of origin, Egypt was represented as the centre of the universe, the creative process being renewed daily, as it was supposed, by the rebirth of the Sun, and annually by the rise and fall of the Nile. In Mesopotamia, on the other hand, conditions were far less predictable; there was constant danger from torrential rain, scorching winds and the uncertain behaviour of the Tigris and Euphrates. Therefore, although there was a similar conception of creation from a primeval watery abyss (*Apsu*), the world and mankind came into being from a violent conflict between the older and younger generations of the gods. This is related in the *Enuma elish*, the Babylonian creation epic which is recorded in its later form in the cuneiform texts of the 7th century B.C. but which goes back to the middle of the 2nd millennium, and beyond this to the ancient Sumerian story of about 3000 B.C. In the later version Marduk, the god of Babylon and head of the pantheon, made the sky and the earth from the two halves of the body of Tiamat, the Chaos-dragon personifying the powers of evil, whom Marduk had overcome in a long and fierce battle. In none of the Sumero-Babylonian creation stories were the gods actually creators in a transcendental sense, being themselves an integral part of the universe and a product of its creative process. Moreover, they created mankind primarily to supply themselves with sacrificial nourishment and were dependent upon their own creatures for their sustenance. No Mesopotamian deity was regarded as the source of all existence as were Ra or Ptah in Egypt. Creation was essentially a political enterprise, and the status of the gods concerned was determined by that of the cities over which they presided, rising and falling with the fortunes of their chief cult cities.

Anatolia and Syria.—A group of myths found in the Hurrian and Hittite texts of Anatolia have parallels in the Mesopotamian cycles; *e.g.*, the Hittite cultic myths of Telipinu and of the *illuyankas* dragon who was vanquished by the weather-god of the Hatti are of the same type as the Babylonian epic of creation and like it were associated with the New Year festival; their theme is also similar to the Tammuz-Ishtar myths, and to the Osiris-Isis-Horus myths in Egypt. However in none of the texts from Anatolia have creation stories been found. The same is true of Syria: the Ugaritic texts excavated at Ras Shamra depict a shadowy creative supreme being, El, who dwells in a cosmic paradise and is head of the Canaanite pantheon, but they make no mention of the creation of this paradise or of the manner in which the pantheon emerged.

Hebrew Creation Stories.—Genesis gives two accounts of the creation. The story in Gen. i and ii, 1–4 was compiled by the Priestly school (*see* PENTATEUCH) in the 5th century B.C. Although it was based on the Babylonian *Enuma elish* to a considerable extent, the ancient mythology lay deep in the background. Thus the heaven and earth were formed out of a primordial ocean, as in the Babylonian myth, but the Hebrew *tehom*, or "deep," was not personified like Apsu. Moreover it was the Spirit of God which hovered over the waters, dividing the light from the darkness and the upper from the lower firma-

ment; alone he created the heavens and the earth. No mention is made of the struggle between Yahweh and Rahab and Leviathan. The succession of creative acts occupying six days followed virtually in the same order as that in the Babylonian bilingual texts and the *Enuma elish*, culminating in the creation of the human species. This ended with a sabbatical rest of the Creator on the seventh day, thereby giving divine sanction for the observance of the Sabbath; moreover, the didactic character of the myth with its repeated refrain is indicative of a liturgy. The closely associated dragon mythology in the "enthronement psalms" accords with the victory of Marduk over Tiamat, interpreted in terms of the vindication of the creative work of Yahweh (Ps. lxxiv, 12–14; cxxxvi, cf. Isa. li, 9), recited doubtless in the Temple at Jerusalem at the annual festival.

The pre-exilic paradise story in Gen. ii, 4–25 is less liturgical and more Palestinian in its cosmology, though it too has Babylonian affinities. In its present form it is a combination of two myths: one concerning the preparation of the world for the use of man, from the southern kingdom of Judah, the other, relating the story of the temptation, from the northern kingdom of Israel. The earth as a barren waste is represented as already in existence, and on it Yahweh-Elohim planted a delectable garden "to the east in Eden," watered by four rivers which included the Tigris and Euphrates (Hiddekel), and by a mist that descended upon the ground. Man was made first from the dust of the soil (*adama*) and into his nostrils the Creator breathed the breath of life. The animals and birds were then created to be his companions, but as they failed to meet his needs a female human partner, Eve, was given to him. Two trees stood in the midst of the garden, sacred and therefore taboo because their fruits had supernatural qualities bestowing divine knowledge and immortality. It is not clear whether the eating of the forbidden fruit at the instigation of the wily serpent, and the subsequent expulsion from Eden, were part of the original myth. The series of events leading up to it have parallels in the Babylonian Adapa and Gilgamesh legends, but the setting is Palestinian, interpreted in accordance with the ethical monotheism of the prophetic movement in Israel. (*See* also ADAM AND EVE; EDEN.)

Iranian Cosmology.—Contemporary with the monotheistic conception of creation held by the Judaic prophets and their priestly successors was that of Zoroaster, initiated probably about the 6th century B.C. He also declared that one all-wise lord and sovereign ruler of the universe (Ahura Mazda) was the sole creator and sustainer of creation. Man was the crowning act of creation, the whole cycle of existence having been called into being to enable him to soar higher and higher, and at last enjoy eternal bliss. Every phenomenon, spiritual and material, was attributed to Ahura Mazda, who determined the path of the stars, upheld the earth and the firmament, caused the moon to wax and wane, and created light and darkness. In him the primal precosmic twin spirits of good, or righteousness, and evil (Angra Mainyu, the Druj, later known as Ahriman) meet in a higher unity. The eternal polarism, however, was not originally a cosmic or absolute dualism of good and evil because the twin spirits had no independent existence apart from Ahura Mazda, and in the end his righteous will was destined to prevail. In later Avestan literature Ahura Mazda is considered to be creator only of that which is good. He is in perpetual conflict with Ahriman, now considered to be creator of all that is evil. Each of their battles was to last 3,000 years and constituted a preordained phase in the history of the universe. The ultimate issue, however, was never in doubt: at the final consummation, the righteous reign of the all-wise lord would be established and the Lie and all his works would be vanquished and destroyed. Then the entire creation would attain the height of perfection in a renovated world, and enter upon a new cycle free from evil, Ahura Mazda becoming all-in-all. In the Sassanian period the Zervanites attempted to mitigate this dualism by again making Ormazd (Ahura Mazda) and Ahriman coeternal emanations from a primeval being, whom they called Zurvan, infinite Time. Their doctrine was rejected as heretical by all orthodox Parsis.

Greek Cosmology.—Unlike the Hebrews and the Iranians, the Greeks never resolved creation into a unified process in relation to the Olympian gods, none of whom assumed the role of creator comparable to that of Yahweh or Ahura Mazda. In the 6th century B.C. the Ionian thinkers broke away entirely from the polytheistic tradition in an intellectual search for a first cause of, and sustaining principle in, the universe and its processes without reference to gods and theogonies. Even Zeus, though called "the father of gods and men" was not originally a creator. Thus, in the cosmology of Hesiod, about the 8th century B.C., he was son of Cronus and the god who was assigned dominion over the heavens, while Poseidon ruled the seas and Hades the nether regions, the earth being their common property. This appears to have been the Greek variant of the Anatolian Kumarbi myth in the Hurrian texts, which were diffused from Asia Minor probably in the middle of the 2nd millennium B.C. The earth was represented as a vast plain encircled by streams (Oceanus) resembling the Egyptian Nun, from which the gods and mankind sprang. When the gods took up their abode on Mt. Olympus they were organized on the model of Indo-European chieftains, but they made no claim to have created the world.

As the Aryan, Anatolian and Aegean elements in the cosmology found a common centre in Zeus as the sky and weather god, the Olympian leader, the "cloud-gatherer," the "thunderer," the rain-giver and despotic ruler, gradually he assumed a cosmic significance. Creation, however, was represented as a process of procreation, Zeus being accredited with a huge progeny of gods and goddesses (*e.g.*, Artemis, Apollo, Athena, Ares and Dionysus). It was not until the middle of the 1st millennium B.C. that he was regarded as the primary being and life force from whom all existence emanated. He was conceived pantheistically by Pindar, Simonides and Bacchydides. He was incorporated in the Orphic cosmogony by being said to have swallowed Phanes, the Protogonos born from the world-egg fashioned by Chronos (time), from whom Zeus created all things anew. Finally, in the 3rd century B.C. in the hymn of Cleanthes he became the transcendental creator in whom all things lived and moved and had their being.

Indian Cosmology.—Indian religions contain a mass of complex and widely differing ideas. In the Vedic period earth, air and sky were personified as gods generated by a female principle Aditi, either spontaneously or in conjunction with Daksa, the male principle or creative force. Daksa was also identified with Purusha, the primal man, from whose body the universe was created after he had been sacrificed by the gods. According to the Satapatha Brahmana the universe was shaped like an enormous egg which contained the continents, the oceans, the mountains, the planets, the gods, the demons and humanity, and which was produced in the primeval waters by Prajapati. Similarly Brahma, the first deity of the Hindu "trinity," the self-created creator of gods and men, deposited in the primeval waters a golden egg, "the egg of Brahma," in which he himself was born again and which he divided into two to fashion the heavens and the earth. In the background of these speculations and traditions is the shadowy figure of the high god, Brahman, and the figures of Vishnu, Shiva and Shakti, whose groups of devotees each maintained the supremacy of its own supreme being, cosmological mythology and cultus. In addition to these cult-gods the Vedic Indra, Varuna and Mitra were assigned universal power in maintaining the universe and the cosmic process.

Celtic Cosmology.—Little is known about Celtic cosmological ideas as no creation myths have survived. From references in Irish folk tales, Druidic and Christian traditions, it has been suggested that the sky was thought to have been supported by pillars or by a tree resting upon the earth, which was surrounded with water in the Semitic fashion. Of myths of human origin nothing is known apart from Caesar's statement about an alleged Druidic myth concerning the descent of the Gauls from a chthonian Celtic god (*De bello Gallico* vi, 18).

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CREATIONISM AND TRADUCIANISM, in Christian theology, are conflicting doctrines regarding the origin of the individual human soul.

Creationism may be defined in the words of Thomas Aquinas as the doctrine "that the intellectual soul is created by God at the end of human generation, and that this soul is at the same time sensitive and nutritive." It can claim the authority of most Eastern Church theologians, of the theological tradition of the middle ages in the west and of John Calvin. Supporters of creationism maintain that it alone is appropriate to the spiritual nature of the soul; for if the soul were transmitted from parents to children as the body is, this would imply that the soul is merely a part or function of man's physical nature. Opponents of creationism argue that it contradicts the statement of Genesis that "on the seventh day God finished his work which he had done"; they urge also that it is inconsistent with the orthodox doctrine that man is conceived and born in original sin.

Traducianism (Lat. *tradux,* "sprout") may be defined in the words of Tertullian as the doctrine that both soul and body "are conceived and formed at exactly the same time, and are born together, and that not a moment's interval occurs in their conception, so that a prior place can be assigned to either." Augustine was inclined to this theory, at least for a time, although finally he was unable to make up his mind either way. Luther also left the question open, but most Lutherans have taught traducianism. Opponents of traducianism find it almost inevitably materialistic, as indeed it was in Tertullian. Modern controversies in both psychology and theology have set the notion of "the total man" in opposition to the traditional idea of a discrete body and soul (*see* Body and Mind), and to this extent the conflict between creationism and traducianism has been transcended.

See, for background and history, J. H. Waszink (ed.), Tertullian *De Anima,* pp. 342–348 (1947). (J. J. Pn.)

CREATIVE EVOLUTION. The French philosopher Henri Bergson (*q.v.*) in his book *L'Évolution créatrice* (1907; Eng. trans., *Creative Evolution,* 1911) propounded a theory of evolution wholly distinct from the evolutionary hypotheses of earlier thinkers and scientists. Whereas the earlier hypotheses had been determinist (mechanistic or teleological, representing evolution as conditioned either by existing forces or by future aims), Bergson envisaged an evolution in which the free emergence of the individual intelligence could be recognized. He based his theory on the distinction between matter and the *élan vital* or life force, the progress of which he saw as a line continually bifurcating or diverging from its course. The evolution of matter is orderly and geometrical; disorder, with free and unpredictable creativity, is the effect of the life force on its material surroundings. The argument is largely conducted by means of striking metaphor and analogy: life, for instance, is compared to a wave spreading outward toward a circumference which is broken down at one point only; and to an artillery shell from which new shells scatter when it bursts.

CREATIVITY. The question concerning the nature of psychic creation is a special aspect of the question of how new forms come into existence in all of nature. Repetition is to be seen everywhere in the natural world, and the perception of one thing as being like another is the basis of ability to avoid unpleasant contingencies and to entertain those that contribute to survival or give pleasure; novelty, from this point of view, offers a threat to our power to anticipate events. Nonetheless, we speak of routine as deadening, and we are happy to think that our day may hold a pleasant surprise; the preacher in Ecclesiastes finds that "What has been is what will be, and what has been done is what will be done; and there is nothing new under the sun," but the thought has little charm for him.

Psychological experiments in the fields of motivation and learning have disclosed the power of novelty as an inducement to action. It has been shown, for example, that primates will learn difficult tasks simply for the reward of being permitted to look out a window or to sit where they can see something happening. Moreover, learning will occur where the reward is stimulation of certain cortical centres by electrical impulses passed into the brain through implanted electrodes. These experiments offer serious challenge to theories that suppose a basic tendency of organisms always to act so as to bring about a condition of psychophysiological equilibrium. They suggest that a more inclusive formulation would posit an essential and continuing tension in higher organisms between, on the one hand, the establishment and maintenance of environmental constancies, inner and outer; and, on the other, the interruption of achieved equilibria in the interest of new possibilities of experience.

The creative process itself embodies this tension, and persons who distinguish themselves in artistic, scientific and entrepreneurial creation exemplify the striving between integration and diffusion, convergence and divergence, thesis and antithesis. Psychological study of highly creative people has led to descriptions of this essential tension in terms of such dualities as intellect and intuition, the conscious and the unconscious, mental health and mental disorder, the conventional and the unconventional, complexity and simplicity.

The counterposing of intuition to intellect by H. Bergson in his theory of creative evolution expresses one of the basic aspects of the tension seen in the creative process. Intellect as Bergson spoke of it is "the geometrizing tendency of mind," finding its purest statement in mathematics, its empirical semimathematical counterpart in science and its everyday form in common sense. Intuition is its opposite; it is nonrational, it "knows" by "feeling," its form of understanding is empathic and immediate rather than analytic and detached. A creative person is usually very intelligent in the ordinary sense of the term and can meet the problems of life as rationally as anyone else can, but he refuses to let intellect rule; he relies strongly on intuition and he respects the irrational in himself and others.

Closely related to Bergson's distinction is Freud's proposed topography of mind, which distinguishes three main systems of mental functioning: unconscious, preconscious and conscious. Conscious thought is largely rational in its operation, and consciousness is both available for criticism and itself the critic. What is unconscious is incorrigible, and an internal censorship bars the way from the unconscious to the preconscious. The ideas in the preconscious, however, are highly motile, can come into contact with one another very rapidly, can readily form a multitude of new combinations and can come to consciousness when they are needed. A certain amount of semantic confusion has resulted from the use of such terms as subconscious and unconscious in theoretical frameworks other than the Freudian, and it is probable that some of the introspective accounts by great innovators and creators in which they speak of influences from the subconscious and the unconscious accord better with the psychoanalytic notion of easy recombinations of ideas in the preconscious.

Whatever the terms used, it seems clear that a creative person is able to find in the developmentally more primitive aspects of his own mental functioning the possibility of new insight that

at first may be only intuitively and dimly apprehended. In brief, he is willing to listen to what is far from the centre of consciousness and rationality in himself; to hold on to his hunches and give them play; to pay attention to vague feelings, which on the grounds of good sense are dismissed by most people, and allow them to have their way with him, even though nothing useful appears to be forming as yet in his conscious mind.

Along with this ability to sustain what may be called preconfigural tensions goes a strong interest in apparent disorder, contradiction and imbalance. Asymmetry and disorder seem to be experienced by creative people as a challenge; by resisting the tendency to reject them prematurely they enrich the world they see, and thus they open the way for an elegant new order more satisfying than the simpler configuration arrived at by omitting contradictory details. Permitting greater complexity leads finally to a grander simplicity, with perplexity a condition to be suffered, or perhaps enjoyed, on the way.

Refusal to be content with the most easily established habits of perception leads creative persons at times to give an impression of psychological imbalance. Indeed, there is reason to believe that many creative persons deliberately invite altered states of consciousness in which the ordinary boundaries of experience are broken. The world may be transcended in mystical states, in feelings of being possessed (as though some higher power were acting through the individual creator), in dreamlike states which bear some resemblance to psychosis and even in psychosis itself. William Blake spoke of a condition in which "the doors of perception are cleansed"; and Aldous Huxley, among others, explored the use of drugs to alter the biochemical factors in personality in the interest of making contact with the primitive substratum of perception which the course of biological adaptation has largely closed. Experimental use, in the study of psychosis, of drugs that produce symptoms resembling those of mental illness has uncovered incidentally some important indications of the way in which psychic regression may contribute to creation and richer integration once mental equilibrium has been re-established.

The question of the relation of mental disturbance to creativity approaches resolution in these observations. Creative persons, far from being psychological cripples or prone to catastrophic breakdown, have exceptionally deep, broad and flexible awareness of themselves. The self is strongest when it can regress (allow primitive fantasies, naïve ideas, tabooed impulses into consciousness and behaviour) and yet return to a high degree of rationality and self-criticism. The creative person is both more primitive and more cultured, more destructive and more constructive, a bit madder and much saner than the average person. In such persons, antinomies find simultaneous expression, leading to resolution and transcendence.

The unconventionality of thought that is found consistently in creative persons is probably in part a resistance to acculturation, which is seen as demanding surrender of one's personal, unique, fundamental nature. This may, although it does not always, result in a rejection of conventional morality, though certainly not in any abatement of the moral attitude.

The psychological conditions that make a society or an epoch creative have been little studied, but it seems likely that social conditions analogous to those seen in individual creativity are important. Freedom of expression and movement, lack of fear of dissent and contradiction, willingness to break with custom, a spirit of play as well as of dedication to work, purpose on a grand scale—these are some of the attributes that a creative society may be expected to have. Creativeness in society is of course a matter of practical concern, since innovation and invention may bring about enormous increases in wealth and power. Man as a species has gained his substantial measure of control over physical forces and over other living things chiefly through his faculties of discrimination, abstraction, adaptiveness through reasoning, and original thought. The importance of originality in human ascendancy can hardly be overestimated.

Particularly among U.S. psychologists, and particularly in the years after World War II when scientific inventiveness became of wide concern, much research has been carried out on the nature, incidence and cultivation of creativity. Among early workers were H. A. Murray and D. W. Mackinnon, whose joint report to the Office of Strategic Services, *The Assessment of Men*, provided a new emphasis for psychology upon the importance of integrative factors in personality functioning, such as resourcefulness, successful response to challenge and the motivation to do well. D. C. McClelland began his studies on the motive to achieve, in individuals and in nations, and A. Roe used the techniques of clinical psychology to study leading American scientists.

A number of leading psychometricians undertook test-development efforts in the general domain of creative abilities. Important contributions were made by J. P. Guilford and his associates; by J. Flanagan in the measurement of ingenuity; by R. B. Cattell, H. G. Gough and F. Barron in the measurement of personality traits relevant to creative achievement; by J. Getzels and P. Torrance in the study of creativity in schoolchildren and the effect of the educational system upon the development of potential creativity; by M. Stein in the appraisal of creativity in industrial scientists; and by J. Holland, C. Taylor and J. McPherson in the development of rating instruments to establish valid criteria of original performance. The National Science foundation of the United States in 1955, 1957, 1959 and 1961 sponsored conferences addressed to the general problem of "The Early Identification of Scientific Talent," which brought together at the University of Utah, Salt Lake City, the psychologists most active in prosecuting research on the topic. The published conference proceedings constituted the most detailed statement of the results of thought and research in the psychology of scientific creativity.

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CRÉBILLON (properly CRAIS-BILLON), **PROSPER JOLYOT,** SIEUR DE (1674–1762), French tragic poet whose reputation rivaled that of Voltaire, was born at Dijon on Feb. 13, 1674. His literary career began in 1705 with *Idoménée*, which was followed by *Atrée et Thyeste* (1707), *Electre* (1708) and *Rhadamiste et Zénobie* (1711). This group of plays established their author's reputation, and although they were followed by two failures *Xerxès* (1714) and *Sémiramis* (1717), he remained pre-eminent among French writers of tragedy until he was challenged by Voltaire. After several years retirement, Crébillon returned to the stage with *Pyrrhus* (1726), and wrote *Catalina* (1748) and *Le Triumvirat* (1754).

Voltaire borrowed the subjects of five of Crébillon's tragedies and published a critical *Éloge de Crébillon* in the year of his rival's death. *Rhadamiste et Zénobie*, considered by contemporaries one of the outstanding tragedies of the period, well illustrates Crébillon's characteristic formula: the evocation of horror, coupled with a superficial appeal to the spectator's sensibility by such devices as mistaken identity and complicated relationships, leading to a recognition scene. His was a thoroughly romanesque kind of tragedy, often verging on melodrama.

After the early death of his wife, and his financial ruin some years later, Crébillon became oppressed with an antisocial melancholy, and lived for a time an irregular, solitary life surrounded by birds and animals that he had befriended. However, in 173 he was elected to the Académie Française; in 1735 he became royal censor; and in 1745 Mme de Pompadour obtained for him

a pension and a post in the royal library. He died in Paris on June 17, 1762.

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CLAUDE PROSPER JOLYOT DE CRÉBILLON (1707–1777), the only surviving son of the above, whose novels depict 18th-century high society, was born in Paris on Feb. 14, 1707, and lived there all his life except for two periods of exile in the provinces which he earned by satirical allusions in his novels. Of completely different temperament from his father, he wrote lighthearted, licentious novels.

The best known are *L'Écumoire* (1734), *Le Sopha, conte moral* (1742, Eng. trans. by B. Dobrée, 1951)—the morality does not extend beyond the title—and *Les Amours de Zéokinizul* (1746). They were appreciated by Sterne, who saw in his writing some of his own inconsequential narrative style. With his friends and brother dramatists, Alexis Piron and Charles Collé, he founded in 1752 the gay society which met to dine regularly at the "Caveau," and he enjoyed a reputation as a wit and storyteller. In 1748 he married Lady Henrietta Maria Stafford. Like his father he enjoyed the patronage of Mme de Pompadour. He died in Paris on April 12, 1777.

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(W. D. HE.)

CRÉCY, BATTLE OF. On Aug. 26, 1346, an English army under Edward III routed the forces of Philip VI of France near the village of Crécy-en-Ponthieu in northern France. After leaving St. Vaast-La Hougue in the Cotentin on July 18, Edward pillaged lower Normandy unopposed, but by the time he reached the Seine, Philip VI had gathered an army. Edward crossed the Seine at Poissy on Aug. 16 and moved quickly north to the Somme, which was forded below Abbeville on Aug. 24. With an unimpeded line of withdrawal to Flanders, Edward now felt ready to risk a battle with the French, who had pursued him for more than a week.

On the morning of Aug. 26 Edward arrayed his army in a defensive position on the forward slope of the downland between Crécy and Wadicourt; it faced southeast across a small valley. Edward seems to have had at most 14,000 soldiers; about 4,000 were men-at-arms and the remainder mainly archers. They were placed in three divisions; on the right was that of the young Prince of Wales (the Black Prince), the earls of Arundel and Northampton commanded the left, and the king's division was held in reserve. Dismounted men-at-arms formed the centre of each division in the front line; and on the flanks, set forward at an angle, were the archers. French scouts located the English during the afternoon, and Philip ordered his van to halt while the troops behind came up and a plan of attack was devised. The French greatly outnumbered the English; according to eye-witnesses, the French had 12,000 men-at-arms and thousands of other troops. Philip could not control the impatience of his men, and toward evening the first of a series of disorganized assaults on the English line began. This ended in confusion when the Genoese crossbowmen, driven back by the fire of the longbows, obstructed the advance of the cavalry. Although they fought bravely, the French never recovered from this chaotic start, and repeated attempts to break the English line failed; the men-at-arms stood firm, and the archers on the flanks wrought havoc with their cross-fire. Fighting continued into the night, and when the French at last withdrew their losses had been heavy. In the morning the bodies of more than 1,500 knights and esquires were found on the battlefield, as well as those of many others. Reinforcements which arrived too late for the battle also suffered badly. English losses appear to have been very small. From Crécy the English moved to Calais to which they laid siege on Sept. 4. The victory did not greatly further English hopes of conquest, but it seriously impaired French morale. It confirmed in France what had lately been shown at Halidon Hill against the Scots: the tactical value of combining dismounted men-at-arms with archers. *See* HUNDRED YEARS' WAR.

See H. B. George, *Battles of English History* (1895); C. W. C. Oman, *A History of the Art of War in the Middle Ages*, vol. ii (1924).
(J. W. SE.)

CREDENCE (CREDENCE TABLE), originally a small side table placed near the high table, in royal or noble houses, for the tasting of food and drink for poisons by an official of the household. The name (Ital. *credenza*, Fr. *crédence*) survived after the disuse of this precautionary ceremony, and the table developed into the buffet.

In the Roman Catholic Church the credence table is a small table of wood or stone, placed near the wall on the south side of the altar, to hold the cruets containing the wine and water, the chalice, acolytes' candlesticks and other objects to be used in the Mass. The use of the credence also has been revived in the Anglican Church and pronounced legal.

CREDI, LORENZO DI (1457–1537), Italian artist, whose surname was Barducci, was born at Florence. He was the least gifted of three artists who began life as journeymen with Andrea del Verrocchio. The other two were Leonardo da Vinci and Perugino, of whom he was the companion and friend. Credi had a respectable local practice at Florence. He was consulted on most occasions when the opinion of his profession was required on public grounds, *e.g.*, in 1491 as to the fronting, and in 1498 as to the lantern of the Florentine cathedral, in 1504 as to the place due to Michelangelo's "David." At rare intervals he produced large ecclesiastical pictures. The greater part of his time was spent on easel pieces, upon which he expended minute and patient labour. But he worked with such industry that numbers of his Madonnas exist in galleries throughout the world. A fine example of his easel roundels is in the gallery of Mainz. In his old age he withdrew on an annuity into the hospital of Santa Maria Nuova, where he died on Jan. 12, 1537. The National gallery, London, has two pictures of the Virgin and Child, and a portrait of Costanza de' Medici by Credi.

CREDIT, a term frequently used in economics to denote the ability of a potential borrower to raise funds. It also denotes the funds borrowed and is thus the counterpart of debt. Credit may be extended by a creditor (lender) to a debtor (borrower) either through the sale of goods to be paid for in the future or through the transfer of cash with the promise of future repayment. The debtor is obligated to make future repayment of the amount borrowed and the creditor normally has the right to receive interest payments over the period of the loan. Credit is frequently but not always evidenced by a credit instrument, which may or may not be transferable. It may have any maturity date agreed upon by both creditor and debtor; some types are payable on demand while others run for many years. (*See* also DEBTOR AND CREDITOR LAW.)

Economic development has usually been accompanied by an increase in the use of credit, particularly for productive purposes. Credit has facilitated the mobilization and expansion of real capital by permitting the transfer of purchasing power from savers to investors. Prevailing types of credit and the extent to which credit is used reflect the economic development of a community. Much of the credit in medieval times, for example, was consumer credit extended to supply the needs of exigent borrowers. Wherever international trade became important in medieval and early modern times, facilities for extending short-term commercial credit developed. The industrial revolution was followed by issuance of long-term bonds to finance the building of railroads and other public utilities and by the expansion of short-term credit for industrial purposes. An important development of the first half of the 20th century was the use of installment credit (*q.v.*) to finance the purchase of consumer goods such as automobiles and household appliances.

Most money now in use consists of claims on either governments or banks. In advanced economies the predominant means of payment is by check (cheque), which is a demand deposit claim on a commercial bank. Deposits may be created in a variety of ways, but for the most part they reflect credit exten-

sion by the banking system. The ability of banks to create money by increasing their loans, however, is limited by the availability of reserves, now generally held in the form of deposits with central banks. (*See* CENTRAL BANK; FEDERAL RESERVE SYSTEM.)

Credit transactions tend to accentuate business cycles (*q.v.*) because they facilitate changes in investment expenditures which may not be accompanied by corresponding changes in the amount that people wish to save. This is particularly true of the lending activities of commercial banks, which are not limited by the current volume of deposits. Central banks, however, are able to influence the credit mechanism so as to moderate cyclical movements.

The traditional means of credit regulation is through general credit measures, which influence the reserve positions of commercial banks. The major instruments used are open market operations (purchases and sales of securities, usually government securities, by the central bank), changes in the discount rate (the rate at which the central bank lends) and changes in reserve requirements (the percentage of deposits that commercial banks are required to hold in the form of reserves). During and immediately following World War II, many governments placed considerable reliance on selective credit controls, which regulated the flow of funds to individual credit markets, but their importance declined after the early 1950s. *See* CREDIT RATING; *see* also references under "Credit" in the Index volume.

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(M. E. D.)

CRÉDIT FONCIER DE FRANCE, a limited company under the supervision of the ministry of finance. It is managed by a governor, assisted by two deputy governors, who are appointed by an order in council (*décret presidentiel*). Founded by a decree of Louis Napoléon in Feb. 1852 under the name of the Banque Foncière de Paris, the Crédit Foncier de France was sanctioned by a decree of March 1852 and in December received authority to act under its present name.

The company was originally set up with the object of granting to owners of urban or rural properties long-term loans on mortgages to be paid off by annual installments, but its activities were gradually extended. Thus it was authorized in 1854 to grant short-term loans without amortization; in 1860, to discount bills from the Sous-Comptoir des Entrepreneurs issued particularly against the representation of credits granted with a view to building; and in 1860 and 1862, to grant loans, even without a mortgage appropriation, to *départements*, communes, owners' trade associations and public bodies. Then, after various decrees, the Crédit Foncier successively extended its activities to Algeria, Tunisia, Morocco and, generally speaking, to the French colonies, protectorates and territories under French mandate. Finally, in 1928, it was authorized to grant loans on mortgage to owners of seagoing or inland navigation vessels.

The Crédit Foncier de France raises the funds necessary for carrying out these transactions by issuing bonds which, like the loans, are of three kinds: land, communal or maritime. The first are specially "pledged" as security by the mortgage claims of the company, the second by the debts owed by the *départements*, communes and public bodies, and the third by the maritime mortgage loans. The amount of bonds issued cannot exceed that of the borrowers' receipts; thus the bonds in circulation are always pledged against at least an equal amount of claims. Furthermore, the bonds have a common guarantee in the registered capital and the whole of the company's reserves.

After World War II, the help of the Crédit Foncier de France, jointly with that of the Sous-Comptoir des Entrepreneurs, was specially enlisted in connection with the solution of housing problems. It was given the task of managing the Fonds National d'Amélioration de l'Habitat (National Fund for the Improvement of Housing) created in Oct. 1945, and a convention with the state (Oct. 1950) entitled it to grant specially favourable loans to owners whose residential buildings were destroyed during the war.

The Crédit Foncier de France and the Sous-Comptoir des Entrepreneurs are able to offer credits or special loans to people wanting to build houses, who have been granted by the state building subsidies convertible into bonus interests. These credits or loans are granted directly by the Crédit Foncier if the borrower does not need the funds until the building is completed, or, more generally, by the Sous-Comptoir if the funds are required while the construction is in progress. These credits are, as a rule, granted for a maximum period of five years, but in most cases, the borrowers are not able to pay back within such a short period; they can then be given, upon request, the assurance that these credits will be replaced, upon expiration, by redeemable long-term loans. The Crédit Foncier insures the financial service of the building subsidies allocated by the state, which are set against the loan charges and thus act as bonus interests. Lastly, the Crédit Foncier accepts discount for the credit operations presented to it by the banks relating to the erection of residential buildings, to the repair and equipment of commercial buildings, to the erection and maintenance of buildings for agricultural development and to the mobilization of stock issued by the Caisse Autonome de la Reconstruction (Autonomous Fund for Reconstruction).

(P. VT.)

CREDIT INSURANCE. This type of insurance affords indemnity to merchants and manufacturers against the risk of loss due to insolvency or protracted default of customers to whom goods are sold on credit. Applied to export credits, the term may embrace facilities outside normal insurance underwriting.

Plans to cover credit risks existed in continental countries during the second half of the 19th century, and in England and the U.S. during the last two decades of the century. The business generally proved expensive to operate and early progress was slow. In its modern technique, credit insurance in England dates from the close of World War I. The depredations of war opened up a vast export field. In consequence, there came into being two credit insurance organizations, the Trade Indemnity company and the export credits department, representing private and state enterprise respectively. At first interested only in bills of exchange, the export credits department extended its activities in 1926 to the guarantee of export credit risks and, in 1931, the department was rationalized on a semicommercial basis and the word "guarantee" incorporated in the title. The service provided by these two organizations in the field of export credits then proceeded on similar lines until 1933, when economic difficulties in many countries brought into play factors which were to have a marked effect on the development of credit insurance in Great Britain. With exchange control on a national basis, additional insurance cover was sought against nonpayment of a debt as a result of transfer restrictions imposed by foreign governments, a form of political risk which it was considered the government organization was in a better position to assess and underwrite than was a private insurance company. Thus occurred a cleavage in underwriting interests which still obtains.

Subsequent development was along two clearly defined paths: the export credits guarantee department, concerned only with export trade; and the Trade Indemnity company, supported by a consortium of insurance companies as shareholders and reinsurers concerned mainly with home trade. Risks inherent in the imposition of currency transfer restrictions, the cancellation of import licences and political risks such as war or revolution cannot lightly be ignored by exporters and, since the government organization is not disposed to cover extraneous and political risks without the normally insurable commercial risk, it is understandable that by far the larger volume of export credits insurance is governmen subscribed. The private company has a monopoly of the equally wide field of domestic credit, scope in the field of export credit to countries with no pronounced political risk involved and insur ance of certain purely foreign business.

World War I crystallized the need for credit insurance in th countries of western Europe. In general, credit insurance in in ternational trade developed on the basis of co-operation betwee

state and private enterprise, and undertakings specializing in credit insurance appeared in all the more important commercial countries of the world. The effective supervision of credit risks on an international basis requires collaboration with credit insurance companies and state organizations operating in the countries concerned, and this is achieved through the International Credit Insurance association of Zürich, founded in 1928, and the Union d'Assurance pour le Controle des Crédits Internationaux of Bern, established in 1934.

The years of greatest expansion in credit insurance followed World War II. As the business expanded the coverage was broadened. It is possible for specific accounts or sections of accounts only to be insured, but it is more usual, both in home and export trade, for a firm to insure all credit sales except those where no commercial risk exists; *e.g.*, when the buyer is an associated company or an official body. The insured is expected to retain a financial interest in the insured transaction, and it is usual in the home trade for the insurance payment to be 75%–85% of losses incurred.

Claims are paid within 30 days of the insured debt being admitted to rank against the insolvent estate or, in the case of "protracted default," within six months thereafter.

The standard facilities of the government organization include short-term contracts and shipments policies, external trade policies, dollar-market and medium-term policies. There are, in addition, policies devised to meet specialized needs. The exporter is required to exercise customary business prudence and to retain some reasonable interest in the transaction. For this reason the extent of the cover is normally 85% of loss through the insolvency of, or protracted delay in payment by, the buyer, 90% of loss arising from any other cause covered by the policy and arising before shipment and 95% of such loss where the cause arises after shipment. Repudiation of a contract or a debt is not in itself adequate grounds for a claim. (P. Ss.)

Credit Insurance in the United States.—Credit insurance in the United States originated as a result of legislation enacted in 1885 and 1886 in New York, New Jersey and Louisiana which authorized the incorporation of companies to write this form of insurance. In 1887 the American Credit Indemnity Company of Louisiana was organized and, in 1888, the U.S. Credit System company was established in Newark, N.J. Neither of these companies enjoyed success and soon withdrew from the field. In 1891 the American Credit Indemnity companies of New Orleans, of St. Paul and of Minneapolis, respectively, were established, but the efforts of these companies were also unsuccessful and they ceased to operate after 1894. In 1892 the London Guarantee and Accident company of London, Eng., created a credit insurance department in the United States, and in 1893 the American Credit Indemnity Company of New York was founded. Both of these companies survived and wrote credit insurance successfully and uninterruptedly; in the latter 1950s they were the only two in the United States writing such insurance. Other companies entered the business after these two but all eventually discontinued the writing of credit insurance. Original credit insurance policies required the insured to sustain an agreed percentage of loss on gross annual sales before the insurer was liable. This percentage, based on the applicant's previous credit loss experience, was termed initial or own loss. The policy was issued in a face amount double the largest individual debtor's limit, and it agreed to pay losses, subject to these limits, in excess of the amount of the initial loss. Amounts of insurance on individual debtors were based on ratings of a mercantile agency selected by the insured when application was made for the policy. The meaning of insolvency was confined to that arising from bankruptcies, receiverships, absconding debtors with no assets or a judgment that the debtor was unable to pay in full. Later the more comprehensive form of policy evolved.

Credit insurance adheres to the principle that it is not designed to cover the insured for losses which can be foreseen or which result from the insured's carelessness. In an effort to apply this principle, the modern policy provides that there will be no coverage for normal bad debt losses inherent in the insured's line of business. This normal loss, often referred to as a primary loss, is fixed by loss experience statistics. It is designated in the policy as a fixed percentage, subject to a minimum amount expressed in dollars. The insurer also uses a so-called coinsurance provision. This is not similar in application to the fire insurance coinsurance clause, but is actually an application of the deductible average principle used in marine insurance. Under the credit insurance coinsurance provision the insured bears an actual percentage of each loss—such as 10% or 20%.

The modern credit insurance policy is designed to protect wholesalers, jobbers and manufacturers against abnormal credit losses resulting from the insolvency or protracted default of a customer to whom goods have been sold on credit. It tends to improve the credit standing of the insured, and through the collection services of the insurer the losses on delinquent accounts may be reduced. There are about nine different forms of policies available and these, in turn, may be divided into two major groups, known as back coverage policies and forward coverage policies. In back coverage policies the insurance company agrees to reimburse the insured for losses occurring during the policy term and, through the use of a back sales rider, covers unpaid accounts receivable in good standing on the insured's books on the day the policy becomes effective. Unless this policy is renewed, the coverage ceases at the end of the policy term. In forward coverage policies the insurance attaches to sales, shipments and deliveries of merchandise made within the shipment period of the policy. Inasmuch as it covers only those transactions made during the policy term, no back sales rider is attached. When this policy expires, the coverage provides for the filing of claims up to 90 days, plus the longest terms of sale after the last day of the shipment period subject to an over-all limit of 215 days.

Diverse forms are issued for varying needs but generally "insolvency" includes bankruptcy or insolvency petition, assignment, receivership, compromise, attachment, execution, death or insanity of sole debtor, chattel mortgage, absconding, confession of judgment, transfer or sale of stock in bulk, a debtor's business taken over by a committee. Besides these insolvency definitions, collection policy forms provide for assigning accounts as insolvent after becoming due and payable under original terms of sale. Under this form accounts can be filed as an insolvency when they become past due on original terms of sale or, at the policyholder's option, within an agreed number of days after original due date.

Original underwriting conditions have greatly improved. Credit insurance companies pooled loss statistics for a period of years, resulting in experience normal loss tables showing average experience on any given sales basis in more than 400 different businesses. The larger proportion of U.S. credit insurance policies cover the policyholder's annual sales volume, but the demand for coverage on individual debtors is met by single credit account policies. Considerable hazard attends credit insurance underwriting, including regional disasters such as floods and crop failures, future business conditions, reasonable expectancy of business depression in cycles, when credit losses reach large proportions, and the especially important factor of moral hazard, the control of the insured hazard being in the policyholder's hands to a greater extent than in other insurances. It therefore demands of underwriters a broad general knowledge of business and of local conditions, acquaintance with different specific hazards and keen judgment of human nature obtained only through wide experience over a number of years.

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CRÉDIT MOBILIER OF AMERICA, a U.S. construction and finance company associated with the building of the Union Pacific railroad, 1865–69. Although its operations were more or less typical of 19th-century railroad building in the U.S., sensational newspaper exposures and congressional investigations in 1872–73 established it as a symbol of post-Civil War corruption. Experience had already taught veteran railroad organizers that more money could be made from construction contracts than from the operation of a completed road. This promised to be doubly true in the case of the Union Pacific, which was supported

by federal loans and land grants but proposed to span a vast unpopulated region between the Missouri river and Great Salt Lake. Crédit Mobilier was part of a complex arrangement whereby Thomas Durant, Oakes Ames and other men in control of the Union Pacific railroad contracted with themselves for construction of the railroad. Chartered in 1859 as the Pennsylvania Fiscal agency and taken over by Union Pacific men in 1864, Crédit Mobilier was itself a contractor for only the first 247 mi. of road. Thereafter it functioned as the guarantor of extravagant contracts awarded to Ames and J. W. Davis and assigned by them to seven trustees chosen from the inner circle of Crédit Mobilier and the Union Pacific. The trustees received payments from the Union Pacific (more often in its stock and bonds than in cash), paid the actual costs of construction, and distributed the profits among holders of Crédit Mobilier stock. These arrangements, while facilitating the disposal of Union Pacific securities and speeding completion of the railroad, enabled the men in control to enrich themselves by converting Union Pacific assets and credit into construction profits. In the process, the railroad itself was overcapitalized and impoverished.

Crédit Mobilier became a public scandal when it was revealed that in 1867–68, Oakes Ames, whose financial responsibilities did not prevent his serving as congressman from Massachusetts, had tried to win friends for the company by selling shares of its stock at discount prices to a number of his colleagues. The house of representatives appointed a committee to investigate these transactions, and after hearing its report early in 1873 censured Ames and Rep. James Brooks of New York, but absolved men like Vice-Pres. Schuyler Colfax and Rep. James A. Garfield who had accepted their favours.

See J. B. Crawford, *The Crédit Mobilier of America* (1880), and the studies of the Union Pacific railroad by Henry Kirke White (1895), Nelson Trottman (1923) and Robert W. Fogel (1960). (D. E. F.)

CREDITON, a market town and urban district of Devon, Eng., lies 8 mi. N.W. of Exeter partly in the narrow vale of the Creedy near its junction with the Yeo. Pop. (1961) 4,442. Area 1.7 sq.mi. Documents of the 13th century mention an east or old town and a west or new town. Crediton (Kirton) is traditionally the birthplace of St. Boniface (*c.* 680), patron saint of both Germany and Holland, who was martyred at Dokkum, Friesland, in 745. The parish church was built (1150) as a collegiate church on the site of the cathedral. The earliest of Crediton's seven charters, now in the Bodleian library, Oxford, is dated 739. The Queen Elizabeth grammar school for boys was founded under the 1547 charter. The wool trade, established by 1249, was at its height in the early 18th century. Agricultural trades with engineering, tin-plating, woodwork and the making of cider and confectionery have superseded the woolen and serge industries. In 1897 Crediton was made the seat of a bishopric suffragan in the diocese of Exeter.

CREDIT RATING, an evaluation of an individual's or business firm's soundness as a credit risk. It is usually based on the three C's of credit: character, capacity and capital. In this sense, character refers to the moral integrity of the person or business firm being rated. Capacity is the business skill or earning power of the credit applicant. Capital is the borrower's over-all financial strength or the collateral that he may be able to provide as security.

Character is important as a factor in determining a credit rating because a credit transaction involves a promise to pay. A person or business firm may have good earning power and own a substantial amount of property but may be a poor credit risk because of excessive spending or failure to pay bills on time. A record of meeting past obligations is the best evidence that the borrower has the character to recognize and meet his obligations. A past record of fraud, fires under questionable circumstances, gambling and repeated suits to collect obligations due indicates that the applicant is a poor risk. Evidence that he is a good moral risk is found in job stability, home ownership, church and civic affiliations, and stable family relationships.

The capacity or earning ability of a business firm is judged by its past record of profitability. It is also evaluated by noting the appearance of the company's property and by observing its business methods. For an individual, capacity is judged by the length of his employment and by the improvement shown in his earning capacity and financial position over the years.

In evaluating the capital or general financial condition of a business firm, three financial ratios are important. (1) The firm's current assets should be substantially greater than its current liabilities (obligations coming due within a year). A rule of thumb widely followed is that a firm should have a current ratio of at least 2 to 1, *i.e.*, its current assets should be at least twice as large as its current liabilities. (2) The firm's existing debt should not exceed the amount of money put into the business by the owners of the firm. The owners, in other words, should have as large a stake in the business as the creditors. (3) The rate of profit earned by the firm should be as high as is customary in its line of business and should not be deteriorating.

The capital position of an individual is judged mainly by the size of his cash holdings and bank accounts; the quality and amount of common stocks, bonds and other investments he may have, and by whether he is a homeowner. If he is a homeowner, the size of the mortgage will indicate the extent of his clear ownership in the home.

Some credit ratings are published by rating agencies and associations; others are simply judgments which may be noted in the files of banks or other business firms from whom credit may be sought. The best-known published credit ratings in the United States are those of Dun & Bradstreet contained in a volume entitled *The Reference Book*, published every two months. The materials in *The Reference Book* are organized by states and within states by cities and towns. Each listing includes the person's or firm's line of business and a two-part credit rating. The first part of the rating gives the financial strength. The rating Aa indicates a financial worth of over $1,000,000. The rating L indicates a financial worth of up to $1,000. The second part of the rating represents a "composite credit appraisal." These ratings run from A1 to 2 for the Aa financial strength rating and from 3½ to 5 for the L financial strength rating. The credit appraisal also has the words "high," "good," "fair" and "limited" associated with the abbreviated rating. Thus a rating of Aaa 1 (triple A—one) represents financial strength of over $1,000,000 with a "high" (which is the best) credit appraisal. A rating of L 5 would indicate a very poor risk—little financial strength with a "limited" credit appraisal.

A large number of credit rating agencies exist and each has its own set of rating symbols. Two well known rating agencies are the National Credit Office and the Lyon Furniture Mercantile agency. Ratings may also be made by trade associations, lawyers and better business bureaus. Credit managers are organized both on local and national levels to exchange information and appraisals.

Information on the vast number of individuals buying at the retail credit level in department stores and elsewhere is compiled and made available by local, privately owned retail credit bureaus. They are associated with other bureaus by membership in the Associated Credit Bureaus of America and the National Retail Credit association. The reports of the credit bureaus supplement the information that the person or firm extending credit obtains for itself. Information may be obtained first of all through a credit application which requests certain kinds of information. The information on the credit application may be supplemented by making inquiries of the applicant's bank and of places of business where he may have obtained credit in the past. The firm's employer and other personal references may also be consulted. The local credit bureau supplements this information by keeping a file on individuals who have used or are seeking credit. Business firms may, in fact, use the information compiled by the credit bureaus so that they do not need to ask for the information or keep a record of it themselves.

The critical aspect of the credit rating always comes back to the rating on character. For this reason, it sometimes comes as a surprise to a firm or person in a strong financial position to encounter difficulty in obtaining credit for the first time. Th

ultimate test of character in credit transactions is a record of hav-ng taken on credit obligations and fulfilled them. If a person or irm has continuously traded on a cash basis, no evidence is avail-ible of performance in meeting credit obligations. Therefore, a trong financial position and a favourable record on the other tems covered by credit reports is not enough. To establish a igh credit rating an individual or firm must engage in credit trans-ctions and develop an unbroken record of responsibility in meet-ng credit obligations.

The concept of credit rating is essentially American but the reat expansion of hire purchase business for consumer goods and he expansion of credit facilities generally in the United Kingdom ave combined to emphasize the need for such an assessment in hat country. This however does not imply that credit facilities re granted in Great Britain without inquiry. The reputation of oth individuals and business firms is subject to scrutiny almost nvariably when credit is required. Inquiries directed to banks nd to any firm with which the party concerned has had dealings s a common practice. There are, moreover, inquiry agencies of vhich Stubbs Mercantile agency is an example of one operating enerally. Some trade associations have their own inquiry or-anization. *See* also CREDIT. (J. F. W.)

CREDIT UNION, an organized group of people who save heir money together and make low-cost loans to each other. hese are usually short-term consumer loans, mainly for auto-obiles, household needs, medical debts and emergencies. In ome countries where economic development lags, credit-union oans are primarily for farm production and small business enter-rise. Each credit union operates under government charter and upervision which limits membership and service to a common-ond group, such as: (1) employees of a business firm or govern-ent agency (*e.g.,* municipal employees, teachers); (2) members f an association, lodge or church parish; or (3) residents of a mall well-defined community. At annual meetings the members lect from their own number the directors, the credit committee nd the supervisory committee.

In its broad outline the credit union self-help movement stems rom societies founded in the middle 1800s by Friedrich Wilhelm aiffeisen in Germany and Luigi Luzzatti in Italy, both of whom wed much to the example of the less idealistic Schulze-Delitzsch ocieties in Germany. The first credit union in the western emisphere, where the greatest development was to take place, as organized in 1900 at Levis, Que., by Alphonse Desjardins, a egislative reporter whose work revealed the misery caused by sury. Desjardins also helped organize the first U.S. credit union, a Manchester, N.H., in 1909. The same year Massachusetts assed the first state credit union act. It resulted from a study ade by Bank Commissioner Pierre Jay and strong legislative-earing support by Desjardins and Edward A. Filene, a Boston erchant who had been impressed by credit co-operatives he had bserved in India, and who foresaw the growing importance of onsumer credit. In 1921, to accelerate U.S. credit union growth, ilene set up and financed the Credit Union National Extension ureau. Under Roy F. Bergengren, later assisted by Thomas W. oig, the bureau provided legislative, organizational and opera-onal services which speeded up the growth of credit unions otably.

In 1934 the Credit Union National association (CUNA), a ederation of credit union leagues, was established by the credit nions themselves to take over the work of the bureau. In the me year the U.S. congress passed the Federal Credit Union act hich was brought up to date by amendment in 1959. The Mutual surance society was formed as a CUNA affiliate in 1935 to pro-de credit union life insurance services and a second affiliate, UNA Supply co-operative, was organized in 1936. Within a w years nearly all the states of the United States and all provinces f Canada had special credit union laws. In 1939 CUNA spread s membership to include the western hemisphere, and in 1958 became a world-wide association. Credit unions made notable ogress in Australia and in many countries of Latin America d Africa. In 1954 the CUNA World Extension department was eated.

By 1962 there were more than 28,000 credit unions, located mostly in the U.S. and Canada. They had more than 15,-000,000 member-owners with $6,000,000,000 in assets. Their sizes ranged from fewer than 100 members to more than 30,000. The typical credit union had 500 members and $100,000 in assets.

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CREDO QUIA ABSURDUM, a current Latin phrase of uncertain provenance, meaning "I believe it because it is absurd." It seems to be derived from a faulty recollection of a passage in Tertullian's *De Carne Christi,* v, in defense of Catholic christology against Marcion's docetism: *Natus est Dei Filius; non pudet, quia pudendum est: et mortuus est Dei Filius; prorsus credibile est, quia ineptum est: et sepultus resurrexit; certum est, quia impossibile* ("The Son of God was born: there is no shame, because it is shameful. And the Son of God died: it is wholly credible, because it is inappropriate. And, buried, He rose again: it is certain, because impossible").

The underlying sentiment is characteristic of fideism (the assertion of Christian faith independent of all rational presuppositions or "preambles"), an attitude which has often been taken by extreme advocates of Augustinian doctrine; *cf.* in this connection St. Augustine, *Confessions,* vi, 5 (7). It is implicit also in the existentialist philosophies, with their specific confrontation of the absurd (however interpreted).

CREE, an Algonkian Indian tribe, or loose aggregation of bands, which formerly held a large territory south of Churchill river and from Hudson bay west into Manitoba and Assiniboia in Canada. The name is an abbreviation from Cristineaux or Kinisteneaux. Essentially a forest people, as shown by the resemblance of their dialect to Ojibwa (*q.v.*), part of the Cree became bison hunters and have been known as Plains Cree. When the Assiniboin broke away from the Dakota, they moved into Cree territory, with the result that the two groups became allied against the Dakota and Blackfoot, the latter ancient relatives of the Cree. The culture of the Cree is essentially of eastern woodland type, but lacking the maize agriculture which their habitat forbade. At mid-20th century there were about 15,000, including mixed breeds, which was probably about their number in 1776. *See* also ALGONKIAN TRIBES. (A. L. K.)

CREED, a brief summary, fixed in language and officially authorized by the church, of essential articles of Christian belief. In origin and use creeds belong to the liturgy, and although the desire to refute heresy and safeguard orthodoxy was increasingly present in them their primary motive was to set forth saving truths.

Later ages attributed the first creed to the apostles and identified it with one of the three formularies examined below. It is intrinsically improbable, however, that any creed in the strict sense existed in their day, and a study of the New Testament reinforces this conclusion. Nevertheless the ground was already prepared for the emergence of creeds. From the start the church possessed its distinctive gospel or *kerygma* ("proclamation"), and this had a definite dogmatic outline. As early as the apostolic age it was beginning to crystallize in conventional slogans (*e.g.,* "Jesus is Lord": *cf.* Rom. x, 9; I Cor. xii, 3), and longer semistereotyped confessions with a credal ring (*e.g.,* I Cor. xv, 3 ff.; Rom. i, 3 ff.). The pattern and content of these latter were determined by the particular situations in the church's life (baptism, Eucharist, catechetical instruction, etc.) which prompted Christians to declare their faith. In the 2nd century, for example, as Irenaeus and Tertullian testify, a loosely worded, flexible epitome of essential doctrine modeled on the trinitarian scheme was in use for catechetical purposes and was known as the "rule of faith."

Creeds proper took their rise, in the 2nd century if not earlier, in the baptismal liturgy, which by its very nature demanded a formal affirmation of faith (*cf.* Acts viii, 37, not part of the original text but a very early insertion reflecting 2nd-century practice); hence their form, beginning with the words "I believe . . ." (Lat.

credo). As the accounts of Justin and Hippolytus suggest, the practice was for the candidate to be asked about his belief in Father, Son and Holy Spirit respectively. The basic pattern was dictated by the Lord's baptismal command (Matt. xxviii, 19), and the three questions were in effect a creed in interrogative form. Their content corresponded closely with the statements about the three persons in the "rule of faith." In the 3rd century the instruction before baptism was greatly elaborated, its final stage consisting in a close study of the creed, and the custom arose of requiring the candidate to rehearse it in a declaratory form to the bishop immediately before the actual baptismal service. Henceforth, while the questions at the moment of baptism continued to have crucial importance, the rite had prefixed to it an affirmative creed of the type familiar today. The name "symbol," applied in the 3rd century to the baptismal questions and answers either because they seemed to symbolize the Triune Godhead or because baptism was regarded as a contract (*symbolum* could mean a contract or pact), was transferred to the declaratory creeds which were thereafter commonly known as symbols. Many baptismal creeds, from east and west, have survived from the early centuries. The western ones, while theological in implication, confine themselves largely to reciting the facts of the *kerygma*, and, for reasons explained below, all belong to one family. Eastern creeds differ widely from each other, and are more obviously theological, stressing, for example, the oneness of God, the Son's precosmic birth and the saving purpose of the incarnation.

With the dawn of the 4th century creeds began to be used as proofs, or alternatively tests, of orthodoxy. At the Council of Nicaea (325), for example, the church historian Eusebius of Caesarea handed in his local creed to clear himself of the charge of heresy; and, much more significantly, the council itself promulgated a creed specifically designed to condemn Arianism, and required all present to sign it. Its example was eagerly imitated, and for some decades, until the practice fell into disrepute through abuse, synods vied with each other in drafting creeds reflecting the latest nuances of orthodoxy. A further development took place in the early middle ages, when creeds found their way into the church's liturgical worship. Thus in the 6th century, both in the east and in Spain in the west, the so-called Nicene Creed began to be chanted at the Eucharist. Charlemagne adopted the practice, perhaps as a counter to adoptionism (*q.v.*), thus assuring it of still wider currency, and about 1020 Pope Benedict VIII, at the insistence of the emperor Henry II, sanctioned it at Rome. Meanwhile the Apostles' Creed established itself in the daily office in the west.

Church councils after the 4th century issued their doctrinal conclusions as statements of fact rather than of belief; for instance the Council of Chalcedon (451) promulgated as a definition the doctrine of the two natures of Christ, instead of including it in a creed as an article of belief. Hence those dogmas of the Christian faith that received formal definition from the 5th century onward are not enshrined in creeds.

From the numerous credal formularies of the early church three stand out as having attained a unique position and are regarded as possessing special authority. These are the so-called Apostles', Nicene and Athanasian creeds. For this reason, and because of the light they throw on the evolution of creeds generally, they merit closer examination.

Apostles' Creed.—The most venerable is the Apostles' Creed, which in English (Latin is its original language) runs:

> I believe in God the Father almighty, creator of heaven and earth; and in Jesus Christ, his only son, our Lord, who was conceived by the Holy Spirit, born from the Virgin Mary, suffered under Pontius Pilate, was crucified, dead, and buried, descended to hell, on the third day rose again from the dead, ascended to the heavens, sits at the right hand of God the Father almighty, thence will come to judge the living and the dead. I believe in the Holy Spirit, the holy catholic church, the communion of saints, the remission of sins, the resurrection of the flesh, and eternal life.

This confession is familiar as the baptismal creed of the west; it is also used in the daily offices of the Roman Catholic and Anglican churches and in the services of several leading Protestant churches. It has no official recognition in the Orthodox churches. Scholarship has shown conclusively that the received text given above (T) is an elaboration of the baptismal creed (R) of the Roman church in the 3rd and 4th centuries. The text of the latter has been recovered in Latin from Rufinus' commentary on the Apostles' Creed (*c.* 404) and in Greek from a letter sent by Marcellus of Ancyra to Pope Julius I in 340. The fact that the Greek almost certainly represents the original is a testimony to its antiquity. The following is a translation of Rufinus' text:

> I believe in God the Father almighty; and in Christ Jesus, his only Son, our Lord, who was born from the Holy Spirit and the Virgin Mary, who under Pontius Pilate was crucified and buried, on the third day rose again from the dead, ascended to the heavens, sits at the right hand of the Father, whence he will come to judge the living and the dead; and in the Holy Spirit, the holy church, the remission of sins, the resurrection of the flesh.

Owing to Rome's immense liturgical influence this speedily became the universal baptismal creed of the west, but local centres did not hesitate to introduce their own variations and additions. It is possible to reconstruct creeds used in the early centuries in Spain, France, Italy, North Africa and the Balkans, and it is clear that, while R is always their basis, they all exhibit characteristic differences. T represents the most mature and sophisticated of these developments. A text almost exactly identical with it appears in the treatise *De singulis libris canonicis scarapsus* written about 710–724 by the Benedictine missionary Priminius, and all the evidence suggests that it reached its final shape in southwestern France in the late 6th or 7th century.

It remains a mystery how this provincial variant of R ousted all the other local versions and eventually displaced R at Rome itself. There is no doubt, however, that Charlemagne, with his interest in liturgical uniformity and his policy of using the creed as an educational instrument, played a decisive part. Once T was established in his dominions, its spread throughout Europe was assured; and since Rome was increasingly exposed from the 9th to the 11th century to the influence of the Frankish liturgy it is easy to surmise how it finally came to adopt the Frankish text of the baptismal creed. Its principal divergences from R either were commonplaces, like the addition of "creator of heaven and earth" and "catholic," or introduced ideas popular in medieval piety, such as the descent to hell and the communion of saints.

Attempts have been made to get behind R and explore the beginnings of western creeds. One certain conclusion is that, while R is not identical with Hippolytus' interrogative creed, it is closely related to it. The following, according to his *Apostolic Tradition*, is the questionnaire employed at baptism about 200, if not earlier:

> Dost thou believe in God the Father almighty? Dost thou believe in Christ Jesus, the Son of God, who was born by the Holy Spirit from the Virgin Mary, who was crucified under Pontius Pilate and died, and rose again on the third day living from the dead, and ascended to the heavens, and sat down at the right hand of the Father, and will come to judge the living and the dead? Dost thou believe in the Holy Spirit in the holy church?

R is obviously a development of this, recast affirmatively, or possibly (since the idea of one credal text for each church was anachronistic at that time) a variant of the same basic stock in use at Rome side by side with it. A second conclusion seems equally certain. The Christology in the central section of R, it has been observed, is easily detachable from its setting; and if this is done, there remains a simple three-clause formulary covering belief in the three Persons. Numerous similar three-clause creeds can be produced from the early centuries (*e.g.*, the interesting one in a papyrus fragment found in 1907 at Der Balyzeh in Egypt). There is also abundant evidence, beginning with the New Testament, that from earliest times a confession of Christ alone existed side by side with Trinitarian confessions. These tended to become attached to Trinitarian formularies, either being inserted bodily into the second article or tacked on at the end. In the light of this it seems clear that R, as also Hippolytus' questionnaire, originated as the result of the conflation, somewhere in the middle of the 2nd century, of a simple triadic formulary with a fuller Christ confession. (For the Christology of the creed, see further JESUS CHRIST: *The Picture of Christ in the Early Church: The Apostles' Creed.*)

Nicene Creed.—The formulary generally known as the Nicene, more correctly as the Niceno-Constantinopolitan, Creed is the only symbol enjoying ecumenical recognition; it is regarded as authoritative by east and west alike, including the leading Protestant churches. Its principal liturgical use is in the Eucharist in the west and in both baptism and Eucharist in the east; in modern ecumenical discussions it has been accepted as an indispensable standard of belief in any reunited church. The original Greek may be translated:

I believe in one God, the Father almighty, maker of heaven and earth, of all things visible and invisible; and in one Lord Jesus Christ, the only-begotten Son of God, begotten from the Father before all ages, light from light, true God from true God, begotten not made, of one substance with the Father, through whom all things came into existence, who because of us men and because of our salvation came down from heaven, and was incarnate from the Holy Spirit and the Virgin Mary and became man, and was crucified for us under Pontius Pilate, and suffered and was buried, and rose again on the third day according to the Scriptures and ascended to the heavens, and sits at the right hand of the Father, and will come again with glory to judge living and dead, of whose kingdom there will be no end; and in the Holy Spirit, the Lord and the life-giver, who proceeds from the Father, who with the Father and the Son is together worshipped and together glorified, who spoke through the prophets; in one holy, catholic and apostolic church. I confess one baptism for the remission of sins, and look forward to the resurrection of the dead and the life of the world to come.

In the western church the clause "proceeds from the Father" was expanded in the middle ages to "proceeds from the Father and the Son" (*see* below).

Until the early 20th century it was universally assumed that this creed (for convenience designated C) was an enlarged version of the famous creed promulgated at the Council of Nicaea (325). It was further assumed that this enlargement had been carried out at the Council of Constantinople (381) with the object of bringing the latter up to date in regard to heresies about the incarnation and the Holy Spirit that had arisen since the Council of Nicaea. A translation of the Greek text of the creed of Nicaea, usually referred to as N, runs as follows:

We believe in one God, the Father almighty, maker of all things visible and invisible: and in one Lord Jesus Christ, the Son of God, begotten from the Father, only-begotten, that is, from the substance of the Father, God from God, light from light, true God from true God, begotten not made, of one substance [Gr. *homoousion*] with the Father, through whom all things came into existence, things in heaven and things on earth, who because of us men and because of our salvation came down and became incarnate, becoming man, suffered and rose again on the third day, ascended to the heavens, and will come to judge the living and the dead; and in the Holy Spirit.

The following anathemas are appended:

But as for those who say, There was when he was not, and, Before being born he was not, and that he came into existence out of nothing, or who assert that the Son of God is of a different hypostasis or substance, or is created, or is subject to alteration or change—these the catholic church anathematizes.

The clauses "that is, from the substance of the Father," "begotten not made" and "of one substance with the Father" were manifestly framed so as to exclude the Arian teaching that the Word is no true Son of the Father but is a creature totally different from and inferior to him in nature. The anathemas are also aimed at specific points in the Arian theology. The anti-Arian clauses, it would seem, have been inserted into a typical Eastern baptismal creed, and the formerly fashionable theory was that this was the old baptismal creed of Caesarea. Eusebius of Caesarea, it will be recalled, had handed in his local creed at the council, and his letter reporting this used to be interpreted as implying that his motive had been to provide a basis for the council's new formulary. The discovery early in the 20th century of the fundamental documents of the synod held at Antioch earlier in 325 set the whole affair in a completely new light. It became evident that Eusebius had been temporarily excommunicated at Antioch because of allegedly unsound teaching, and that his production of his creed at Nicaea was inspired by the desire to secure rehabilitation. There is thus no need to assume any connection between N and the Caesarean creed; and indeed a meticulous, word-for-word comparison of the two formularies confirms that there is none. On the other hand, scholars have noted that there is a marked resemblance between N and symbols of Syro-Palestinian provenance. It seems clear, therefore, that the committee responsible for drafting N selected some such formulary as its basis, simply interpolating the anti-Arian slogans and attaching the anathemas. The insertion of the key word *homoousion* ("of one substance") was, according to Eusebius, prompted by Constantine himself; it had been previously agreed by the council's steering committee at Nicomedia.

Such being the origin of N, what is to be said of the traditional theory of the relationship of C to it and to the Council of Constantinople? As regards the former question, C undoubtedly takes account of post-Nicene heresies—*e.g.*, of Apollinarianism in "from the Holy Spirit and the Virgin Mary" and of the teaching of Marcellus of Ancyra in "of whose kingdom there will be no end"—and advances a full doctrine of the Holy Spirit's divinity and personality in the third section in moderate language designed to mollify the hesitant. But it is certainly not an enlargement of N. An exhaustive comparison of the two texts reveals convincingly that C's omissions, and equally additions, of numerous words and clauses, often of little or no significance, and also the striking differences between C and N in word order and sentence construction, are impossible to explain on the assumption that the former is the latter expanded. The two are related, but to no greater extent than any other pair of Eastern formularies.

The second half of the traditional theory has been keenly discussed during the 20th century. The suggestion that C was the symbol of the Council of Constantinople (381), it should be pointed out, was first explicitly made at the Council of Chalcedon (451), when it was introduced at the third session as "the faith of the 150 fathers" (*i.e.*, of the Council of Constantinople), but difficulty has been found in accepting it. Criticism has fastened in the first place on the lateness of the evidence. It dates from 70 years after the Council of Constantinople, during which period no hint, it is argued, of any connection between the creed and Constantinople is discernible. Further, no reference to C is discoverable either in the canons of the Council of Constantinople or in the surviving reports of its proceedings. All the contemporary evidence indeed indicates that the 150 fathers confined themselves to ratifying "the Nicene faith," a phrase which has been generally taken to mean restoring the Nicene Creed (N) as the church's standard after the attacks made on it by Arians and others. These doubts seemed clinched by the argument that C must have been in existence well before 391 since it apparently featured in the text of Epiphanius' *Ancoratus*, written in 374.

Such considerations might seem fatal to the traditional hypothesis, but they themselves suffer from serious weaknesses. They fail for example, to explain satisfactorily the attitude of the Chalcedonian fathers. Although C was clearly unfamiliar to the majority when produced, no one ventured to question its claim to be the publication of the Council of Constantinople. Their acceptance of it is incredible unless they were satisfied, and since it was rehearsed by the archdeacon of Constantinople they could refer to the archives of the imperial city. The critics admit that C must have had some connection with Constantinople, but their attempts to show what this was do not bear examination. Again, it now seems established that N, not C, stood in the original text of *Ancoratus* 118; and attention has been drawn to several passages dating from the period 381–451 which suggest that the 150 fathers were understood to have made alterations in N. For these and other reasons opinion has swung in favour of the traditional hypothesis, which has been reinforced by an observation which goes far to meet the chief objection against it. In the 4th and 5th centuries, it has been pointed out, "the Nicene faith" did not denote the Nicene Creed as such, but the characteristic Nicene teaching embodied in the creed. It is thus quite consistent with the contemporary evidence to infer that the work of the Council of Constantinople consisted in reasserting the Nicene doctrine of the *homoousion*, and in doing so either composed or at any rate ratified C. The latter seems more probable, for C does not seem an artificial compilation but has the balance and rhythm of a liturgical piece. The fathers may well have taken over some

existing formulary, touching it up to suit their purposes. It coheres well with this account that the section about the Holy Spirit, while definite, is also cautiously worded, for the aim of the council was conciliatory.

Filioque Clause.—The clause "and from the Son" (Lat. *filioque*) began to find its way into the creed in the west in the 6th century. Western theology had been feeling its way toward the doctrine of the double procession (*i.e.*, from both the Father and the Son) of the Holy Spirit ever since Tertullian, but it was Augustine who first formulated it explicitly. Through his influence it soon became universally accepted in the west. The interpolation was first made in Spain, at or soon after the third Council of Toledo (589), and it rapidly spread over Europe. While accepting the doctrine, the popes long rejected the *filioque* from the creed. It was probably Benedict VIII who admitted it, on the occasion when he also agreed to have the creed sung at Mass (*c.* 1020), and it is retained by the Western churches (Roman Catholic, Anglican and Protestant). It has always been rejected, however, by the Eastern churches and deeply resented both as, in their view, contrary to the truth and also as an unauthorized addition to a venerable document.

Athanasian Creed.—This creed, often called the *Quicunque vult* from its opening words, is an exposition of orthodox teaching on the Trinity and the incarnation in some 40 verses. It begins and ends with stern warnings that unswerving adherence to the catholic faith is indispensable to salvation. The first and longer section expounds the doctrine of one God in Trinity and Trinity in unity, affirming both that the threeness of the persons in no way divides the divine substance and that the substantial unity does not lessen the reality of the personal distinctions. It also asserts the double procession of the Spirit. The second section teaches that Jesus Christ, while indissolubly one in person, is simultaneously fully divine and fully human, his humanity comprising a rational soul as well as a body. The unity of these two disparate elements, divinity and humanity, in his single person is as complete as the unity of body and soul in a human individual. The creed is entirely western, being unknown in the east until the 12th century at earliest. It is regarded as authoritative in the Roman Catholic, Anglican and leading Protestant communions, and has a limited use in the offices of the two first named.

Since the 17th century there has been general agreement that the *Quicunque vult* is not by Athanasius. It is a Latin document, all existing Greek texts being late and palpably translations; no early evidence links it with Athanasius, and it presupposes doctrinal developments later than his time. Many hypotheses have been advanced for its true date and provenance. Most scholars are satisfied that it must be posterior to Augustine, since much of its language echoes his, while its Trinitarian teaching seems dependent on his *De trinitate*. In 1909, however, H. Brewer argued for Ambrose as its author, pleading that Augustine may well have borrowed from it, and his thesis won widespread acceptance. It has to meet the objections, however, that the creed's Trinitarian teaching is more mature and sophisticated than Ambrose's, that the Christological section almost certainly envisages Nestorianism, which arose after Ambrose's day, and that Ambrose never explicitly taught the double procession and never used the unity of body and soul in man as an analogy of the unity of divinity and manhood in Jesus Christ.

A growing body of opinion looks to south France and the middle or second half of the 5th century for the origin of the Athanasian Creed. The earliest witness to its existence is Caesarius of Arles (d. 542), who prefixed it to a collection of his homilies. Its influence in the 6th and 7th centuries seems to have been largely in Spain and southern France, which were closely linked ecclesiastically and liturgically. The hypothesis received valuable support when the lost *Excerpta* of Vincent of Lérins (fl. 440) came to light in 1940. This is a collection, strongly anti-Nestorian in tone, of extracts from Augustine's writings intended to expound the true doctrine of the Trinity and the incarnation. In it much of the language of the creed, particularly of the Christological section, is verbally anticipated. The likeliest conclusion is not that Vincent was himself its author but that it was composed between 450 and 500 by some admirer of his, probably also belonging to the school of Lérins, who drew freely on his writings.

See also CONFESSIONS OF FAITH, PROTESTANT.

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CREEK, an important American Indian tribe originally living in Georgia and Alabama. The language of the Creek proper is Muskogee, of the Muskogean family of the Gulf linguistic stock (*see* MUSKOGEAN INDIANS). When they became well known to Europeans in the 18th century, the Creeks were the dominant people in the Creek confederacy, which also included speakers of other Muskogean languages (Hitchiti, Alabama-Koasati) and of non-Muskogean languages (Yuchi, some Natchez and Shawnee). At that time the confederacy consisted of about 50 towns with a total population of perhaps 20,000.

The most important unit of Creek society was the town, consisting of scattered family homesteads associated with a square-ground where they met for important occasions, especially the annual busk or green-corn ceremony. The matrilineal clans of each town were grouped into two parties (moieties), which were important for town government. All the towns of the confederacy were themselves grouped into the white (peace) and red (war) divisions, confederate political organization being modeled on that of the town. Ball games between towns of opposite divisions were conceived of as a substitute for intraconfederacy warfare, and a town defeated in four successive matches transferred to the victors' division.

Creek economy was based on maize-bean-squash agriculture. Hunting was also important, especially during the winter. With increasing European contacts in the 18th century, the Creek confederacy came to occupy a crucial position between the English (and later U.S.), French and Spanish settlements, and vast quantities of diplomatic gifts had an important effect on the economy, as did increasing trade with Europeans (especially for tanned deerskins). Several important political leaders—notably Alexander McGillivray (*q.v.*)—developed during this period, confederacy organization was modified and strengthened, and many European customs such as agricultural practices, Negro slaveholding, house types, loom weaving, etc., were adopted.

As United States power and expansionist policies developed, the Creeks lost their independence, being defeated in the Creek war of 1813–14, and were finally deported to Indian Territory (present Oklahoma) in the 1830s. There they maintained a semi-autonomous Creek nation, with a republican form of government, until 1907 (*see* FIVE CIVILIZED TRIBES).

In 1950 about 20,000 Creeks were living in Oklahoma, many of them entering fully into the life of the state and remaining Creek only by formal affiliation. Others were more conservative, preserving the use of the Creek language, traces of the ancient town organization, and some aspects of Creek religion such as the busk. A remnant remained in southwestern Alabama, where their descendants numbered about 500 in 1950, having lost the Creek language and almost all traces of Creek culture. The Seminole (*q.v.*) are an offshoot from the Creek confederacy of the 18th and early 19th centuries.

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CREEL, GEORGE EDWARD (1876–1953), U.S. journalist and author who directed publicity for his government during World War I, was born Dec. 1, 1876, in Lafayette county, Mo. He began as a newspaper reporter, became the publisher of a weekly magazine and served as editor of Denver's *Rocky Mountain News*. He was an active supporter of Woodrow Wilson, and when the president in 1917 established a wartime committee on public information Creel was appointed civilian chairman. His services were further utilized as Wilson's personal representative to a number of important conferences.

Although he served in several other public positions, his time after 1919 was chiefly devoted to writing books and magazine articles. Creel died in San Francisco, Calif., Oct. 2, 1953.

(H. J. Sg.)

CREEVEY, THOMAS (1768–1838), English M.P. and placeman, whose friendship with the Whig leaders and consequent inside knowledge of contemporary politics and society enabled him fully to indulge his talent for gossip. He was born in Liverpool in March 1768, allegedly the son of William Creevey, a local merchant, but he is believed by some to have been the illegitimate son of Charles William, 1st earl of Sefton. He went to Queen's College, Cambridge, and graduated as seventh wrangler (1789). He became a student at the Inner Temple, transferred to Gray's Inn (1791) and was called to the bar (1794). He entered parliament, through the duke of Norfolk's nomination, as member for Thetford (1802), and married Mrs. Eleanor Ord, a widow with six children and a comfortable income. A close friend of Charles (afterward earl) Grey and a follower of Charles James Fox, Creevey was made secretary to the board of control in the brief ministry of "all the talents" (1806). He was defeated at Thetford in 1818 and sat for Appleby from 1820 to 1826; he was appointed treasurer of the ordnance when his party next came into power (1830) and Lord Melbourne made him treasurer of Greenwich hospital (1834). He died suddenly on Feb. 5, 1838, in his lodgings in Jermyn street, London.

Creevey had a shrewd political sense and in opposition in the house of commons he was highly effective. His parliamentary gifts were the subject of an admiring portrait by Thomas Barnes, editor of the *Times* from 1817 to 1841 (*Parliamentary Portraits* published anonymously, 1815). He also had an unrivaled capacity for giving pleasure in social life. Lord Sefton's daughter said of him "he has added to all the pleasures and diminished all the sorrows of my life," and many contemporaries would have echoed her words. *The Creevey Papers* include many of his letters which, as lively and as cheerful as his personality and characterized by an almost Pepysian outspokenness, give a valuable picture of the political and social life of the late Georgian era. His correspondence was treasured by his wife's family.

See Sir H. Maxwell (ed.), *The Creevey Papers* (1903); J. Gore, *Creevey's Life and Times* (1934). (R. T. B. F.)

CREFELD: *see* KREFELD.

CREIGHTON, MANDELL (1843–1901), English historian, and bishop successively of Peterborough and London, whose scholarship and administrative ability ensured him a lasting reputation in both capacities, was born at Carlisle on July 5, 1843. He was educated at Durham and Merton college, Oxford, of which he became a fellow in 1866, and later a tutor, and was largely responsible for starting the intercollegiate system of lectures in history. In 1872 he married Louise von Glehn, herself later the author of several historical textbooks. In the following year he was ordained to the priesthood and in 1875 became vicar of Embleton, Northumberland. He proved an excellent pastor and administrator, and assisted in the foundation of the new diocese of Newcastle upon Tyne, of which he was made honorary canon in 1883.

Meanwhile he maintained his academic connection by examining in the history finals and by serving as select preacher at Oxford. He also began to write history. In 1875 appeared his *History of Rome*, and in 1876 *The Age of Elizabeth* and *Life of Simon de Montfort*. At the same time he undertook the editorship of two series, *Epochs of English History* and *Historical Biographies*, writing for the former a short inaugural volume, *The Shilling History of England*. He also began work on his *magnum opus, History of the Papacy*, the first two volumes of which appeared in 1882. In 1884 he was appointed first Dixie professor of ecclesiastical history at Cambridge. He infused new life into historical studies there by showing himself to be both a popular lecturer and a learned conductor of seminars. He was appointed residentiary canon of Worcester in 1885 and became the first editor of the *English Historical Review* in 1886. He also continued his own writing, producing the third and fourth volumes of the *History of the Papacy* (1887), *Cardinal Wolsey* (1888) and *Carlisle* (1889). In 1877 he began editing a new series of textbooks, *Epochs of Church History*.

In 1890 he was nominated to a canonry at Windsor, but before he could be installed was called to the bishopric of Peterborough (1891). His six years there showed afresh his powers of administration and negotiation. In education, while supporting the principles of the 1870 act, he furthered the cause of the denominational and voluntary schools. He took an active interest in social and industrial concerns, and helped to secure the compromise that ended the strike (1895) in the Leicester boot factories. These new responsibilities necessarily curtailed his historical studies, but he became the first chairman of the Church Historical society in 1894, and in 1896 published *Queen Elizabeth* and delivered the Romanes lecture on "The English National Character."

In 1897 he was translated to the exacting see of London. There his determined Anglicanism, combining attachment to the liturgical traditions of the church with a scholar's readiness to welcome new light from every quarter, enabled him to exercise a steadying influence in the ritualist controversies of the day. He supported archbishop Frederick Temple's able summary of the situation in the Lincoln judgment of 1899 and did much to draw the disputants together in his round table conference on the doctrine of Holy Communion in 1900. Throughout he tried to establish that the distinctive characteristic of the Church of England was "the appeal to sound learning." Worn out by his labours he died on Jan. 14, 1901.

See *Life and Letters of Mandell Creighton* by his wife, 2 vol. (1904) and articles in *Dictionary of English Church History*, 2nd ed. (1950) and in *Dictionary of National Biography*, First Supp. (1901).

(J. W. C. W.)

CRELLE, AUGUST LEOPOLD (1780–1855), German mathematician and engineer, who sponsored the work of many young scientists of his day, was born at Eichwerder, Wriezen, on March 11, 1780. Crelle was a man of many interests and great organizing ability, and worked for the advancement of the exact sciences. By profession he was a civil engineer in the service of the Prussian government, and he built the first railroad in Germany.

Crelle was more interested in educational matters, however, and in 1828 he left the technical institute in which he was employed to take up service with the ministry of ecclesiastical affairs and public education. He published a considerable number of textbooks, and his multiplication tables have been used widely and reprinted many times, but his great service to mathematics was the founding of the *Journal für die reine und angewandte Mathematik*, now known as *Crelle's Journal*. Niels Abel and Jakob Steiner encouraged Crelle in this venture, and were the chief contributors to the first numbers; Karl Jacobi was another early contributor.

Without Crelle's generous encouragement, some of Abel's greatest work might never have been completed and published. Crelle also founded the *Journal für Baukunst*. He died on Oct. 6, 1855, at Berlin.

CREMATION. Cremation is the reduction of human remains to ash. There is ample evidence that cremation was widely practised in the ancient world. The Romans copied it from the Etruscans and the Greeks, and cremation was the fashionable mode of disposal throughout the Roman empire among the aristocratic classes. In Europe cremation ceased to be common with the growth of the Christian doctrine that attached considerable importance to the resurrection of the physical body. But the practice remained common throughout the eastern world: thus the Indians and the Japanese have always been cremationists, as have the

Burmese. The Chinese, however, have never adopted cremation since it is the desire of every Chinese to be buried in the soil of his country, no matter where he may die.

The modern development of cremation dates from 1874, when the queen's surgeon, Sir Henry Thompson, published a book entitled *Cremation: the Treatment of the Body After Death.* In this book he said that the proposal to adopt cremation in recent times originally proceeded from Italy. Papers on the subject had appeared in 1866, and two Italian scientists had experimented over the intervening period. It was in 1873 that Thompson had seen a model of one of these experimental furnaces at the Great exhibition in Vienna and, with memories of the appalling conditions of cemeteries in Britain, was attracted to the idea of the sanitary disposal of the dead by this Italian method. He consequently took steps to organize what he called the Cremation Society of England; its leading supporters were outstanding writers, artists and scientists of the period: Sir John Tenniel and Anthony Trollope and Sir John Millais were closely associated with Thompson and were signatories to the document that brought the Cremation society into existence. The purpose of this society, according to the statement drawn up on Jan. 13, 1874, was to propagate the idea of cremation since the promoters "disapproved of the present system of burying the dead and wished to substitute some method which would rapidly resolve the body into its component elements by a process which could not offend the living and would render the remains perfectly innocuous."

Although Thompson's book and his subsequent writings roused great interest, the new society met with considerable opposition and prejudice and four years elapsed before the group was able to obtain a suitable site at Woking, Surrey, for establishing a crematorium. Even then it was impossible to proceed because of opposition of the church and the home secretary. It was not until 1883 that the attempt in south Wales by Dr. William Price to cremate the body of his infant child resulted in a legal action, producing in 1884 the judgment that cremation was a legal process provided it did not cause a nuisance. Fortified by this judgment the society proceeded to advertise that cremation was available at its Woking crematorium, but it was many years before cremations were offered regularly. In the early days the cremations were carried out according to principles laid down by the council of the Cremation society and, despite many efforts to introduce legislation in the house of commons to regulate the process, it was not until 1902 that the first Cremation act was passed and regulations were drawn up under that act. In the meantime, six other crematoria had been established in various parts of the country. Nevertheless progress was slow until the close of World War II, when local authorities, faced with the difficult problem of finding the necessary land for all the social needs of their citizens, concluded that it was no longer possible to maintain the burial system, which was wasteful of land, and that every effort should be made to encourage the adoption of cremation. The result is seen in the great growth not only in the number of crematoria and in the number of cremations carried out but also in the percentage of cremations in relation to total deaths. Thus, by the second half of the 20th century there were in Great Britain about 200,000 cremations annually, representing about one-third of the total deaths, and there were more than 160 crematoria in operation. Considerable advance was made in every aspect of the subject after World War II. Much thought was given to the architectural aspects involved and the development of the "gardens of remembrance" attached to each crematorium where the ashes of the dead may be buried or scattered. At the same time the technical aspect was not neglected, so that the process by which the dead body is reduced to ash is carried out in a speedy and seemly manner considerably beyond the original conception of Thompson and his friends.

This increasing acceptance of the idea of cremation is observable in many parts of the world. In the Scandinavian countries and in all the countries of Europe where there are cremation societies, crematoria are established in most of the densely populated areas and there is an ever-increasing number of cremations. Progress was even more marked in Australia and New Zealand where, in each case, the cremations exceed 30% of the total deaths.

The law differs widely, however, in various countries. In Britain the process is controlled by the Cremation acts of 1902 and 1952 and by the regulations of the home secretary drawn up under these two acts, which require that the medical practitioner in attendance at death shall complete a form in which he certifies the cause of death and that a second and impartial medical practitioner shall confirm this finding. Although the law is not so rigid in most other countries, the general principle is to ensure that cremation shall not be a means of concealing crime and that proper safeguards shall be established in the public interest.

In the United States the cremation movement did not progress in quite the same measure as in Europe. Its beginning as an established practice can be traced back to 1876, when F. J. Le Moyne of Washington, Pa., built a rather rudimentary crematorium that consisted almost wholly of a furnace, without embellishments, and carried out a cremation there. He himself was also cremated there a short time later. The practice of cremation nevertheless made progress. According to the figures produced by the Cremation Association of America there were more than 230 crematoria in operation throughout the United States by the second half of the 20th century and during 1954–59 approximately 300,000 cremations were carried out.

After 1937, the national cremation societies throughout the world combined for consultative purposes in the International Cremation federation, with headquarters in London; the federation holds triennial congresses and seeks to promote cremation as a universal practice.

See Funerary Rites and Customs; *see* also references under "Cremation" in the Index volume.

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CRÉMAZIE, (JOSEPH) OCTAVE (1827–1879), Canadian poet who may justly be called the father of French-Canadian poetry, was born at Quebec April 16, 1827, and was educated at the Seminary of Quebec. An extraordinarily learned man, he started in 1848 a bookshop which became the centre of a literary circle including among others F. Garneau and Louis Fréchette (*qq.v.*) and Étienne Parent. In 1860 Crémazie and his friends founded the first literary school of Quebec and in 1861 began issuing a monthly magazine, *Les Soirées Canadiennes*, with the object of perpetuating the folklore of French Canada before it was forgotten. Crémazie also published poems in the *Journal de Quebec* from about 1854 onward. He became involved in business difficulties and to escape their consequences departed in 1862 for France, where he spent the rest of his life in great poverty under the assumed name of Jules Fontaine. During that time he wrote the gloomy poem "Promenade des trois morts," which remained unfinished, and a journal *Siege de Paris*, describing the siege of 1870, which he witnessed. His poetry was characterized by a patriotic love of Canada and Canadian nature, shown especially in the "Chant du vieux soldat canadien." His "Drapeau de Carillon" (1858) almost became a national song of Canada. Crémazie died at Le Havre Jan. 16, 1879. In 1906 Philippe Hébert erected a monument in St. Louis square, Montreal, to his memory. His *Oeuvres Completes* were collected by his friends in 1883.

See P. G. Roy, *Autour de Crémazie* (1945); S. Marion, *Octave Crémazie, Précurseur de Romantisme Canadien-Français* (1946). (C. Cy.)

CRÈME DE MENTHE. A peppermint liqueur, water-white in its natural state but usually of a beautiful dark-green colour when sold, since pure vegetable colouring is then added. Its strength is normally 29% alcohol by volume. Mint is a natural digestive and the essence of a species of garden mint is obtained by distillation; when it is completely free from fusel oils, or vegetable impurities, it is used to flavour a natural spirit. For the best crème de menthe, cognac is used. Originally the finest mint

vas obtained from beds in Mitcham, Surrey, Eng., but these have been abandoned. Unlike such liqueurs as chartreuse and Benedictine, crème de menthe can be made by any distillery and is produced in several countries. (C. C. H. F.)

CREMER, SIR WILLIAM RANDAL (1838–1908), English trade unionist and pacifist who won the Nobel peace prize for his advocacy of international arbitration, was born at Fareham, Wiltshire, on March 18, 1838. He was apprenticed to a carpenter and, going to London in 1852, became interested in politics and trade unions. In 1860 he was one of the founders of the Amalgamated Society of Carpenters and Joiners. Cremer was secretary of the British section of the first international (*see* INTERNATIONAL, THE) but resigned because of dissensions with Robert Applegarth. In 1870–71 he formed a workingmen's committee for the advocacy of neutrality in the Franco-German War. This committee developed, after the war, into the Workmen's Peace association, of which Cremer was secretary until his death in London on July 22, 1908. At the general elections of 1868 and 1874 he stood unsuccessfully for parliament as a workingmen's candidate, but he was elected as a "Lib.-Lab." in 1885 and was a member until 1895 and from 1900 to 1908. At the 1906 general election neither the parliamentary committee of the Trades Union congress nor the Labour Representation committee would endorse his candidature. In 1903 Cremer won the Nobel peace prize, and of the £8,000 awarded he gave £7,000 in trust to the International Arbitration league. He was knighted in 1907.

See Howard Evans, *Sir Randal Cremer* (1911). (A. BRI.)

CRÉMIEUX, (ISAAC) ADOLPHE (1796–1880), French lawyer and statesman, responsible for the *Décret Crémieux* of Oct. 24, 1870, which enfranchized the Jews in Algeria, was born at Nîmes on April 30, 1796, of Jewish parents. After practising at the bar at Nîmes, he became an advocate at the supreme court of appeal in Paris, where in Dec. 1830 he defended Martial de Guernon-Ranville, one of Charles X's former ministers. Elected deputy for Chinon in 1842, he played a prominent part in the revolution of 1848, becoming minister of justice in the provisional government. He at first supported the candidature of Prince Louis Napoleon for the presidency, while voting with the extreme left, but later withdrew his support and was imprisoned after the *coup d'état* of Dec. 2, 1851. On his release he returned to the bar until 1869, when he was elected a deputy for Paris. Minister of justice in the government of national defense (1870–71), he represented Algiers in the national assembly from 1871 till 1875, when he was elected a senator for life. He died in Paris on Feb. 10, 1880.

See S. Posener, *Adolphe Crémieux,* 2 vol. (1933–34).

CREMONA, LUIGI (1830–1903), Italian mathematician and pedagogue, was born at Pavia. He fought as a volunteer in the abortive north Italian uprising of 1848–49, and after studying under Francesco Brioschi at the University of Pavia became elementary mathematical master at the gymnasium and lyceum of Cremona, and afterward at Milan.

In 1860 he became professor of higher geometry at Bologna, and in 1866 professor of higher geometry and graphical statics at the higher technical college of Milan. In 1873 Cremona became professor of higher mathematics at Rome, where he organized the college of engineering. His reputation was by that time European. In 1879 he became a corresponding member of the British Royal society and a senator of the kingdom of Italy. His life was devoted to the reform of higher mathematical teaching in Italy.

Cremona was a prolific contributor to mathematical journals of Italy and Europe, and some of his books were translated into English; *e.g.*, his manual on *Graphical Statics* and his *Elements of Projective Geometry* (trans. by C. Leudesdorf). His reputation mainly rests on his *Introduzione ad una teoria geometrica delle curve piane,* which proclaims him a follower of the Steinerian or synthetical school of geometricians.

CREMONA, a city in Lombardy, Italy, on the north bank of the Po river and capital of Cremona province, lies in the fertile Lombard plain 85½ km. (53 mi.) S.E. of Milan by road and 98 km. (61 mi.) by rail. Pop. (1957 est.) 70,506 (commune). No large towns stand on the banks of the Po downstream from Cremona, which by the 1960s had expanded far beyond its old walls.

The main centre of Cremona is the cathedral square, almost wholly surrounded by ancient buildings. The cathedral (consecrated 1190) is a finely proportioned Romanesque basilica notable for frescoes by Cremonese and other north Italian painters (Boccaccio Boccacino, generally regarded as the founder of the Cremonese school of painting; Antonio and Bernardino Campi; Altobello da-Melone; Gian Francesco Bembo; Girólamo Romanino; Giovanni Pordenone). It is connected by a double arcade, the Loggia della Bertazzola, by Lorenzo Trotti (1493–1505), with the Torrazzo (1284), reputedly the highest bell tower in Italy (397 ft.), commanding a magnificent view. Nearby the octagonal baptistery dates from 1167. Other buildings of the middle ages are the Loggia dei Militi (1292), the churches of S. Michele, S. Vincenzo, S. Lorenzo and S. Bassano, and the Gothic city hall (1206–45). Renaissance buildings include the Raimondi, Affaitati, Vidoni, Fodri and Stanga palaces, adorned with terracotta mouldings characteristic of the Cremonese style. The church of S. Sigismondo in the east of the town is notable for frescoes by Camillo Boccacino and the Campi family; that of San Pietro al Po in the south has paintings by Bernardino Gatti and A. Campi; that of Sant' Agostino has frescoes by Bonifacio Bembo; that of Sta. Margherita was built and painted by Giulio Campi (*q.v.*). Neo-classicism is represented by the façade of the church of Sant' Agata (1848) and by the Mina, Barbò and Pallavicino palaces, and modern architecture by the vast National Insurance building (1935) fronting the Piazza Roma, a small park in the town centre.

Cremona is linked by rail with Treviglio and Brescia to the north and with Fidenza to the south; the large iron bridge across the Po was destroyed in World War II and by the early 1960s had been partly rebuilt. A separate suspension bridge (1953) carries the natural gas pipeline leading from Cortemaggiore, 18 km. (11 mi.) S.S.W.

As the centre of a rich farming district Cremona is an important market for cattle and for dairy and other produce; an International Dairy Cattle fair is held. Manufactures include food products, agricultural machinery, bricks and pianos. Nougat has long been a speciality of the town's confectioners but the supreme Cremonese products were the violins made in the 16th–18th centuries by the Amati family and their pupils Guarnieri and Antonio Stradivari (*qq.v.*). The School of Violin and Viola Makers has a museum of antique stringed instruments, including some by the Cremonese masters, in the Palazzo dell' Arte. The university school of musical paleography is unique in Italy and the municipal museum contains collections illustrating local and national culture from Roman to modern times.

History.—Cremona was founded by the Romans on the site of an earlier Gallic village of the Cenomani in about 219 B.C. Virgil, who was born at Andes near Mantua, was sent to school at Cremona; hence his *Mantua, vae! miserae nimium vicina Cremonae* ("Mantua, alas, too near the unhappy Cremona"). This was quoted by Jonathan Swift on seeing a violin whisked off the table by a lady's mantle. In the dark ages the town was repeatedly sacked by the Goths and Huns before being rebuilt by the Lombards in the 7th century. In 1098 it became an independent commune covering a wide area; it was threatened by Milan and therefore sided with Frederick Barbarossa, but finally joined the Lombard league in 1167. It came within the orbit of the Visconti family (*q.v.*) of Milan in 1334, and within that of the Sforzas (*q.v.*) when Bianca Maria Visconti married Francesco Sforza (1441). After repeated attacks by Venice, Cremona was taken into the Venetian republic 1499–1509, coming under Spanish domination soon afterward and under that of Austria in 1707. Thereafter its history was that of Lombardy.

Cremona province, bounded on the west approximately by the Adda river, south by the Po and on the northeast and east approximately by the Oglio river, has a population (1961) of 350,818. Area 1,756 sq.km. (678 sq.mi.). The province, which has a network of irrigation canals, is almost wholly arable land and pasture, less than 5% being forest and woodland. Dairy farming and stock raising are important and the chief crops are rice, wheat, corn (maize) and flax; some raw silk is produced. The chief towns

are Cremona; Crema and Soresina between Cremona and Milan; Soncino in the northeast; and Casalmaggiore on the Po river in the southeast. Cremona is an episcopal see in the archdiocese of Milan. (A. Pu.)

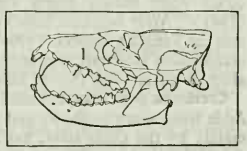
CREMORNE GARDENS, formerly a popular resort by the Thames in Chelsea (*q.v.*), London, Eng. Thomas Dawson, created Viscount Cremorne in 1785, held Chelsea farm, a riverside estate, which he converted into Cremorne gardens. In the mid-19th century the gardens were a resort for Londoners. They were closed in 1877 and built over. The name survives in Cremorne road, which crosses the former gardens, and the Cremorne housing estate between Cheyne walk, by the river, and the King's road.

CREODONT, any of the extinct omnivorous and flesh-eating mammals comprising a group that is usually considered a suborder of the Carnivora. The creodonts were the principal flesh-eating animals of the northern continents during the Paleocene and Eocene (extending from about 40,000,000 to 70,000,000 years ago). Although they included a number of families of diverse or partly parallel specialization, they were all distinguished by certain primitive characters: a small brain; separate scaphoid and lunar bones of the carpus; and lack of ossification of the tympanic bulla. They lacked the dental specialization of modern land carnivores: instead of having the carnassials, the shearing teeth of typical carnivores, creodonts had other teeth enlarged and specialized. They differ from Insectivora and resemble the modern Carnivora in the enlargement of the canines into powerful tearing teeth, in the heavier muzzle and jaws with strong zygomatic arches, and in a number of other skeletal characters.

The oldest family referred to the Creodonta is the Arctocyonidae of Paleocene and Early Eocene times. These evidently omnivorous forms had primitive tritubercular teeth and subequal molars. The arctocyonids show many resemblances to the earliest hoofed mammals (*Protogonodon* to the phenacodontid condylarths; *Deltatherium* to the Pantodonta, etc.). These resemblances have been regarded as supporting evidence for the view that carnivores and hoofed mammals had a common ancestry. The possibility exists, however, that the Arctocyonidae, or at least many of the forms currently placed in the family, should be regarded as belonging to the great hoofed mammal group, the Ungulata.

The latest Paleocene and Eocene Oxyaenidae (sometimes considered a subfamily, Oxyaeninae, of the Arctocyonidae) included a variety of truly predaceous types: *Oxyaena* resembled a wolverine; *Patriofelis* reached the size of a bear with massive hyena-like teeth; and *Palaeonictis* had more feline characters.

The related Hyaenodontidae included many and various types in North America, Europe, Asia and Africa. In the earliest forms, *Sinopa, Proviverra* and *Tritemnodon,* of the Early and Middle Eocene, the teeth were tuberculosectorial, the molars not very different in size, and the skull was long and slender. The proportions of body and limbs were like those of the modern viverrids (civet family) except for the very long and heavy tail. *Limnocyon* was analogous in teeth, proportions and probable habits, to modern weasels and martens. In *Pterodon* and *Hyaenodon* of the Late Eocene and Oligocene, the teeth were more completely sectorial and the body was larger; the proportions of skull and limbs were more like those of wolves. The subfamily Machaeroidinae forms an interesting branch of the family. The known genera, *Machaeroides* and *Apataelurus,* of the Eocene of North America, were remarkably similar to the later sabre-toothed tigers. Hyaenodontids were widespread in the Late Eocene and Oligocene and late survivors occurred in the Miocene of Africa and the Pliocene of India.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

SKULL OF HYAENODON, A CREODONT OF EARLY TERTIARY AGE, WHICH IN SIZE AND STRUCTURE WAS SOMEWHAT SIMILAR TO THE WOLF

The most peculiarly specialized family of the creodonts, the Mesonychidae, were distinguished by the absence of any shearing action of the teeth; the cusps of the teeth were high, round and blunt-tipped. The muzzle and jaws were elongate, the limbs and feet in some species slender and cursorial as in the wolf. Some species attained the size and massive proportions of the larger bears; the toes were tipped with flattened hoofs instead of claws. These creodonts are found in the Eocene rocks of western North America, western Europe and central Asia. Several of them equaled or exceeded the largest living Carnivora in size of skull. In the Late Eocene rocks of Mongolia is found the gigantic *Andrewsarchus* with a skull three feet long; this is the largest known carnivorous mammal, even allowing for the probability that the skull was relatively large in proportion to the skeleton.

It is perhaps open to question whether the creodonts are really referable to the order Carnivora. The earliest true carnivores, which date from Middle Paleocene time, were by then already fully recognizable as carnivores; no connection has yet been established between them and any of the creodont families.

See also CARNIVORE.

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CREOLE (French *créole;* Spanish *criollo*), a term used originally (16th century) to denote persons born in the West Indies of Spanish parents, as distinguished from immigrants direct from Spain, Negroes and Indians. It has come to be used by and with reference to descendants of non-Indian peoples born and settled in the West Indies and on the American continents in some areas of Spanish, Portuguese and French colonization. In the United States the term is used chiefly to designate the French-speaking descendants of the early French and Spanish settlers in Louisiana (*see* LOUISIANA: *History;* NEW ORLEANS: *Population Characteristics*). The patois dialects founded on French and Spanish are referred to as Creole languages (*see* PIDGIN).

The concept Creole has undergone many modifications during the four centuries of cultural and social development and racial mixture in the new world. It has both biological and cultural connotations with respect to which there is considerable local (national, regional, ethnic, class) variation in significance. In a very general way, Creole may be used to identify a non-European and non-Indian way of life and set of values associated (in Latin America) in a fairly complex manner with different segments of the mestizo (culturally and racially mixed) population. The Creole way of life is symbolized by distinctive work patterns, leisure activities, modes of dress, habits of speech, food preferences and the like. This symbolism defies facile generalization, however, from one Latin American country to the next and even varies with respect to special segments of the population within a single nation. An idea of the complexity of association may be had by selecting one country, such as Peru, as a concrete example.

In Peru the word *criollo* is used both as a noun and an adjective, with sharply different meanings. As a noun, the word is used to classify persons of predominantly Spanish descent who have family roots in the colonial period. Most of these Creoles are members of "high society" (*alta sociedad*), some stemming from old-line families (*familias de abolengo*) and others from the land-hungry element who fought successfully for Peru's independence from Spain and who thereby acquired wealth and social position. These upper-class Creoles constitute a very small segment of the population. They are members of the oldest and wealthiest families in the provincial capitals, identified with the preservation of an elegant colonial tradition, or members of wealthy families of Lima who, however, tend to identify with modern European and North American cultural norms. Bordering on the adjectival use of the term is the manner in which Creole is used to distinguish coastal people (*costeños*) from highland Indians (*serranos*). This usage emphasizes two different ways of life and geographical provenience, regardless of the class membership or family heritage of the *costeño.*

As an adjective, *criollo* is not a class-bound concept, although it has most significant associations with the lower classes of the Peruvian coast—social and economic categories comprised of

nestizos and Negroes. Important expressions of the Creole way f life are the ability to turn a situation to one's advantage; speak vittily and persuasively on a wide range of subjects; be masculine *macho*) in the sense of a successful and promiscuous lover; and elish well-seasoned (*picante*) foods associated mostly with ple- eian taste. Hard work, often field labour, is part of the Creole vay of life among the lower classes; but work is avoided when ossible and leisure is handsomely exploited in fiestas, where the *narinera* and the *vals criollo* are danced and copious amounts of *isco* are drunk. Fiesta life has its roots in the hacienda system, nd occasions members of *alta sociedad* (hacienda owners and heir friends) to mingle with their workers and local townsmen on aints' days, etc., when they return to play the traditional role of *atrón* and, participating in the revelry, may become *muy criollo* very creole). In a larger sense, creolism (*criollismo*) signifies ving life with a special gusto involving a national orientation, ride in country and a vigorous identification with Peru's present nd future. *Criollismo* is an adaptive concept within the limita- ions of the Creole "spirit." Foreign ideas are reworked into the reole pattern of life, acquiring new significance. This malleabil- y indicates the process, in all societies having Creole segments, hereby numerous special adaptations have been made in the reole tradition.

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CREON, the name of two figures in Greek legend. (1) Creon, on of Lycaethus, was king of Corinth and father of Glauce or reüsa, the second wife of Jason, for whom Jason abandoned Iedea. (2) Creon, the brother of Jocasta, was successor to edipus as king of Thebes (*see* ANTIGONE).

CREOSOTE. The term creosote is applied loosely to two en- irely different substances, coal-tar creosote and wood-tar creosote. n commerce creosote refers to coal-tar creosote, a complex mix- ure of organic compounds, largely hydrocarbons, obtained by the istillation of coal tar (*q.v.*). In pharmaceutical circles creosote nvariably refers to wood-tar creosote, a mixture of phenolic com- ounds extracted from a distillate of wood tar.

Coal-Tar Creosote, an oily distillate of coal tar, is a complex ixture of organic compounds. Most of the coal-tar creosote pro- uced is used for the prevention of the deterioration of wood by lants, insects and marine animals. The decay of wood is caused y minute plants, called fungi; these parasitic plants attach them- elves to the wood, use it for food and thereby destroy it. Of the rge number of insects which destroy wood the termites (*q.v.*) re responsible for the largest part of the wood destruction caused y this biological group. The mollusks (shipworms) and the rustaceans are the two groups of wood-boring marine animals hich damage wood submerged in the salt waters of the tropical nd temperate regions; they are more abundant in the warmer aters but even in the colder regions are a serious menace; usually ood submerged in fresh water is not attacked by the borers.

Coal-tar creosote was an important fuel in the British Isles dur- ng World War II. In a substantial manner it replaced the petro- eum fuels which had to be imported. Coal-tar creosote was itself sed as a fuel and it was blended with coal-tar pitch to make other quid fuels. Some coal-tar creosote is used in the manufacture f lampblack or carbon black (*q.v.*), a carbon of a particular and eculiar kind. Lampblack is made by burning creosote oil with in- omplete combustion. The volume, speed, temperature and hu- idity of the air are adjusted for the desired grade of lampblack.

Wood-Treatment Processes.—To prevent the deterioration of ood by organisms, the wood is impregnated with coal-tar creosote. he most satisfactory way to inject the creosote into the wood is y means of pressure. The pressure treatment of wood is by either f two processes: the full-cell process, in which the cells in the reated portion of the wood remain either partially or completely lled with creosote; or the empty-cell process, in which the cell alls in the treated portion of the wood are coated with creosote, he cell itself being empty or only partially filled. The wood is loaded onto steel cars, the cars are run into a steel pressure cylinder, usually 6 ft. or more in diameter and 100 ft. to 150 ft. in length, and the cylinder is closed.

The next step in the treatment depends upon which of the two pressure processes is used. In the full-cell (Bethell) process, the cylinder is evacuated and without first breaking the vacuum it is filled with creosote oil, previously heated to about 200° F. and maintained at this temperature during the treating period. The pressure in the cylinder is then raised to about 190 lb. per square inch and is maintained at this pressure until the wood has absorbed the desired amount of creosote. The creosote is then pumped out of the cylinder, the cylinder is again evacuated and the wood is removed from the cylinder.

In the empty-cell (Rueping) process, instead of evacuating the cylinder before filling it with creosote oil, compressed air is introduced and the air pressure is maintained in the cylinder while it is being filled with the creosote. After the cylinder is filled with creosote the operations are the same as in the full-cell process.

The amount of creosote oil retained by the wood is usually expressed in terms of the number of pounds per cubic foot of wood. The amount desired to be retained depends upon the use to which the wood will be put. Building lumber is usually given an 8-lb. treatment, telegraph poles an 8-lb. to 12-lb. treatment, piling a 16-lb. to 24-lb. treatment, railroad ties a 6-lb. to 10-lb. treatment, creosoted block flooring about a 6-lb. treatment. Records show that pressure-creosoted wood may be expected to give a service life of 50 years or more. The post-office department in England has creosoted poles still in service 70 years after erection.

In addition to treatment by the pressure process, wood is impregnated with coal-tar creosote by a hot- and cold-bath open-tank process. In this process the wood is heated for one or more hours in the creosote oil at a temperature of from 180° F. to 220° F., whereby the moisture and air in the wood expand and are partially driven out. Then the wood is quickly transferred to a tank of creosote having a temperature of about 100° F. It is left in this tank for one hour or more; the plunging of the warm wood into the cool creosote oil causes the air and moisture in the wood to contract and thereby suck in the creosote oil. The hot- and cold-bath process is used for the butt treatment of posts and poles.

The dipping process is another way of injecting creosote into wood. In this process the wood is submerged in creosote oil and heated at from 200° F. to 220° F. for about 15 minutes or more. This allows the creosote oil to fill all the checks and defects in the wood, but the penetration of the oil into the wood is only slight.

Sometimes wood is merely given a brush treatment or painting with the creosote.

Coal-tar creosotes vary considerably in their composition and therefore in their preservative value. Considerable attention has been given to the relative preservative qualities of low-residue creosote oils (*i.e.*, those oils which have only a small amount of the fraction distilling above 355° C.) and of high-residue creosote oils (the oils have a large amount of the fraction distilling above 355° C.). The facts indicate that a well-balanced coal-tar creosote oil consisting of both low-boiling and high-boiling distillates is the superior wood preservative.

Chemistry.—Coal-tar creosote consists largely of aromatic hydrocarbons (naphthalene, methylnaphthalenes, fluorene, anthracene, pyrene, etc.) but also contains some tar acids (phenols, cresols, xylenols, naphthols, etc.) and some tar bases (pyridines, quinolines, acridines, etc.). Because of its complex and variable chemical composition, it is necessary to rely on its physical properties to characterize coal-tar creosote.

The specific gravity of coal-tar creosote at 38° C. compared with water at 15.5° C. is not less than 1.03; the specific gravity of the fraction of creosote distilling between 235° C. and 315° C. is usually not lower than 1.025 at 38° C. to 15.5° C.; the fraction distilling between 315° C. and 355° C. usually has a specific gravity not lower than 1.085 at 38° C. to 15.5° C. Ordinarily, coal-tar creosote does not have more than 5% of a fraction distilling up to 210° C. and not more than 25% of a fraction distilling up to 235° C.; the amount distilling above 355° C. varies from about 10% to about 40%.

Wood-Tar Creosote is a specially refined part of the alkali-soluble constituents of a fraction of distillate oil obtained from hardwood tar, usually beechwood tar. (*See* TARS, LOW-TEMPERATURE.) It is an oily liquid which distills over the approximate range 203° C. to 220° C. It is composed largely of a mixture of monohydric phenols (phenol, cresols, xylenols) and the methyl ethers of dihydric phenols (guaiacol).

Beechwood creosote was once used extensively for pharmaceutical purposes. Medicinally, it has been used only to a limited extent, mainly in the treatment of respiratory infections such as bronchitis. (F. E. Cl.)

CREOSOTE BUSH (*Larrea tridentata*), a North American shrub of the caltrop family (Zygophyllaceae), called also greasewood, native to and characteristic of the sparse scrubby vegetation of desert plains in the southwestern United States and adjacent Mexico. It is an evergreen, strong-smelling, tangle-branched shrub, 2–5 ft. high, with brittle stems and very leafy branches. The small, olive-green, resinous leaves emit a tarry odour. The bright yellow flowers, a half-inch across, appearing in early spring, are followed by small, white, densely woolly globose seed capsules.

At low altitudes and sometimes up to 3,000 ft. the creosote bush forms, in the Mohave, Colorado, Gila and similar deserts, a characteristic zone of vegetation called the *Larrea* belt. The plant is cultivated as an ornamental in desert gardens.

CREPE, a family of fabrics of various constructions and weights but all possessing a crinkled or granular surface. The surface effects are achieved through weaving variations, chemical treatment or embossing. The weaving method usually employed is to weave the fabric with crepe yarn, a hard-twist yarn produced either with a higher number of twists per inch than ordinary yarn or with alternate "S" and "Z" twists. In the "S" twist the twist of the yarn resembles the centre part of the letter "S"; in the "Z" twist the resemblance is to the centre part of the letter "Z." Another weaving variation is to leave out certain risers (interlacings of warp over filler threads) present in plain weave in order to increase the float of yarn from one to three. The fabric is made from all of the major fibres, natural or man-made. Surface textures range from fine, flat crepes to pebbled and mossy effects; some surfaces resemble tree bark.

Popular crepes include Canton, crepe-back satin, crepe de Chine, Georgette, marocain, faille, lingerie, mossy, romaine and rough. The family name is derived from the French *crêpé,* meaning crisped, frizzled or wrinkled. The original spelling in English was crape. (G. E. L.)

CREPE DE CHINE, a very light and fine plain woven dress fabric produced either with all-silk warp and weft or else with a silk warp and hard-spun worsted weft. A crepe de Chine texture has a slightly crepe character, a feature produced by the use of weft yarns spun with the twist running in reverse directions and known as right-hand and left-hand twist, respectively. During weaving, the picks of weft are inserted in the order of "two-and-two" (*i.e.,* with two picks of weft with a right-hand twist and two picks with a left-hand twist). Hence, during the finishing operation, owing to the abnormal amount of twist in the picks of weft, these tend to untwist and recover their normal condition. They thereby cause the characteristic effect of typical crepe de Chine. Crepe de Chine textures of artificial silk are now common and are often difficult to distinguish from the true silk.

CREPUSCULAR RAYS are shafts of light which are seen just after the sun has set and which extend over the western sky radiating from the position of the sun below the horizon. They form only when the sun has set behind an irregularly shaped cloud or mountain which lets the rays of the sun pass through a cloud in bands. The radiating appearance of the bands is caused by perspective, as demonstrated by the fact that when on rare occasions the rays extend across the entire sky, they appear to converge again on the eastern horizon. The name is sometimes applied to shafts of sunlight seen when the sun shines through cumulus clouds, from which phenomenon arises the erroneous popular expression "the sun is drawing water."

The derivation of the word (Latin *crepusculum,* "twilight") indicates that it should be applied only to the after-sunset occurrence. *See* also TWILIGHT. (H. R. B.)

CRERAR, JOHN (1827–1889), U.S. philanthropist who endowed the library named after him in Chicago, Ill., was born in New York city on March 8, 1827. In 1862 he went to Chicago, where he directed a plant that manufactured railway equipment; he became one of the original members of the Pullman Palace Car company when it was incorporated in 1867. He was also a bank and railroad director and served as president of the Chicago and Joliet Railway company. Crerar died a bachelor in Chicago on Oct. 19, 1889.

His bequest for a statue of Abraham Lincoln led to the creation of Augustus Saint-Gaudens' seated figure of Lincoln in Chicago. Crerar did not specifically provide in his will for a library devoted to the sciences and technology, which the John Crerar Public library became, though he expressly wished to exclude certain novels and works that he felt undermined morals. The library contains special collections in the various sciences and in medicine and the history of medicine.

CRES (Ital. CHERSO), a Yugoslav island in the Adriatic sea, in the Quarnero group, lies off the east coast of Istria. In 1945 Cres and the adjoining island of Losinj (Lussino), previously Italian, passed to Yugoslavia. Pop. (1953) Cres 4,938; Losinj 5,335; and the adjoining small islands 2,235.

Cres, 64 km. (40 mi.) long and 12.8 km. (8 mi.) wide, has a total area of 336.1 sq.km. (130 sq.mi.). It is separated from Losinj by a navigable channel which is believed to be an artificial one made by the Romans. Both islands are structurally a part of the Karst plateau of Istria. The most interesting feature is Lake Vrana with drinking water 63 ft. below sea level. Wine, olive oil and fruits are produced in both islands but Cres is chiefly devoted to sheep raising. (V. De.)

CRESCAS, HASDAI (*c.* 1340–1412), Jewish philosopher, who played a prominent part in Jewish communal affairs, was born at Barcelona, Spain, a protégé of the royal house of Aragon. His principal work is the *Or Adonai* ("The Light of the Lord"), which, in opposition to Maimonides and Gersonides, seeks to free religion from intellectualism and stresses the love of God as the only way to eternal bliss.

Again opposing his predecessors, he interprets creation as the eternal and necessary emanation of existence from God. His critique of Aristotelian physics foreshadowed a new conception of the universe and influenced Pico della Mirandola and possibly Giordano Bruno. Spinoza mentions Crescas in a letter and seems to owe something to him.

Unlike his Jewish predecessors, Crescas rejects the doctrine of absolute free will. He distinguishes, however, between predestination in the sense of fatalism and causal determination and admits that the human will, though free to choose, is determined by the causality of motives. His view goes back to Averroes, to Avicenna and to the Stoics.

Crescas wrote a *Refutation of the Cardinal Principles of the Christians* in Spanish. (A. An.)

CRESCENT (Lat. *crescens,* "growing"), a word used particularly of the moon and applied to the moon's shape in its first quarter. It was a religious symbol from the earliest times and figured, for example, in the worship of Astarte. Later it became the symbol of the Byzantine empire, supposedly because the sudden appearance of the moon saved the city from a surprise attack. It once was thought that the Ottoman Turks adopted the crescent for their own flags after capturing Constantinople in 1453, but in fact they had been using the symbol for at least a century before that, as it appeared on the standards of their infantry under Sultan Orkhan (*c.* 1326–*c.* 1360). In that case, however, the crescent may have been of different origin, formed by the base-to-base conjunction of two claw or horn amulets, as on horse brasses. Whatever its origin, the crescent became closely associated with the Ottoman empire (appearing on military and naval standards and on the tops of minarets), its successor states and the world of Islam in general. It may be seen today, as a white crescent with from one to five stars, on the national flags of Turkey, Pakistan, the Federation of Malaya (and its component states), Tunisia, Libya and the Maldive Islands, and in red as

the symbol of the Red Crescent, the Muslim equivalent of the Red Cross organization.

The Fertile Crescent comprises Iraq, the northern and coastal areas of Syria and Lebanon and Israel, forming a crescent-shaped belt of fertile land.

In heraldry the crescent was originally a mark of great honour adopted by many returned crusaders, particularly in France. In England, with the horns vertical, it became an honourable ordinary. With the horns turned to the dexter it was known as "increscent," and to the sinister as "decrescent." In modern heraldry it is used as a difference to indicate second sons of a family and their descendants. In western chivalry there have been two orders of the Crescent, the first founded in 1268 by Charles I of Naples, the second in 1448 by René d'Anjou. Neither of these, nor Selim III's order, was very long-lived.

In architecture a crescent is a street or place built as the arc of a circle. A common street name in England, it was first used of the Royal crescent in Bath in the 18th century. (A. D. A.)

CRESCENTII (Crescenzi), a Roman family which played an important part in the history of Rome and the papacy from the middle of the 10th to the beginning of the 11th century. Its extensive possessions were situated mainly in the Sabina. The Crescentii *a Caballo Marmoreo* and the Crescentii *de Theodora* may both be descended from one Crescentius recorded in 901. It is doubtful whether Pope John XIII belonged to the former. Crescentius (I) *de Theodora* (d. 984?) led a revolt in 974 against Benedict VI who was imprisoned in the Castel S. Angelo and then assassinated; but the antipope Boniface VII did not prevail against the new "imperial" pope, Benedict VII, under whose pontificate (974–983) the Crescentii seem to have suffered a political setback. After the emperor Otto II's death their fortunes revived, and John, probably Crescentius' son, assumed the title of *patricius* of Rome and appears to have controlled the election of the new pope, John XV, in 985. In 996, Crescentius, probably John's brother, led a rising against Gregory V, whose cousin the emperor Otto III reinstated him in 998; after being besieged by Otto in the Castel S. Angelo, Crescentius was executed on April 29, 998. His son John (II) was the last of the family to wield political power in Rome: after Otto's death (1002), he became *patricius* and henceforth practically governed the city; he died in 1012. After that, the Stefaniani branch, descended from Stefania, sister of Crescentius (I) *de Theodora*, declined; the Ottaviani, descended from John (II)'s brother-in-law Octavianus, retained the rectorate of the Sabina until the beginning of the 12th century.

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CRESILAS (fl. 5th century B.C.), a Cretan sculptor who worked mostly in Athens. He was a contemporary of Phidias, and the sculptor of an Amazon in the competition at Ephesus about 440 B.C. His Amazon was perhaps the figure, of which copies are extant, represented as drawing back her chiton from a wound under the right breast. Another work of Cresilas of which copies appear to survive is the portrait of the Athenian statesman Pericles. This portrait confirms the statement of ancient critics that Cresilas was an artist who idealized and added nobility to noble men. Copies of a statue of Diomedes are probably also derived from Cresilas.

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CRESOLS or Methyl Phenols. A mixture of the three isomeric cresols (ortho-, meta- and para-) is obtained from coal tar and also from cracked petroleum naphthas. The formula of the cresols is $CH_3.C_6H_4OH$. The o-cresol is separated quite readily and fairly completely from the other two isomers. The boiling points of *m*-cresol and *p*-cresol are so close together (*see* Coal Tar) that it is not practical to separate them by fractional distillation; the separation may be accomplished by chemical means. Cresylic acid, a mixture of the three cresols containing some phenol and various amounts of xylenols (dimethylphenols), is an important commercial chemical. It is used in the manufacture of phenol-formaldehyde resins, tricresyl phosphate and in disinfectants.

In 1956 a multimillion-pound-per-year plant was erected in the U.S. for the synthesis of *p*-cresol. The process used involves the oxidation of *p*-cymene (*p*-isopropyltoluene) to the corresponding hydroperoxide, and the latter is then hydrolyzed to *p*-cresol. (F. E. Ci.)

CRESPI, DANIELE (1590/92–1630), Italian mannerist painter, was born at Busto Arsizio, near Milan, in 1590/92. He was a pupil of G. B. Crespi and of G. C. Procaccini, and became an exponent of that form of mannerism which is characterized by extreme elongation of the figures and especially the limbs. He worked exclusively in Lombardy, and there are works by him in many Milanese churches, including the Certosa di Garegnano, near Milan, in which are his scenes from the life of St. Bruno, generally reckoned his masterpiece. Other works are in the Certosa of Pavia, and in the Brera gallery, Ambrosiana and Castello Sforzesco in Milan. He died in Milan, of plague, in 1630. (P. J. My.)

CRESPI, GIOVANNI BATTISTA (called Il Cerano) (1575/76–1632), Italian painter, who was influenced by Gaudenzio Ferrari and Camillo Procaccini but whose own style is important in the development of Lombard realism before Caravaggio, was born at Cerano near Novara and died in Milan about Oct. 23, 1632. (In the register of deaths his age is given as 56, so he must have been born about 1575/76 and not, as formerly believed, *c.* 1557.) He studied in Rome and Venice and returned to Milan under the patronage of Federigo Cardinal Borromeo, who made him head of the painting section of the Accademia Ambrosiana in 1620. His most celebrated works are a series of ten pictures of the life of St. Charles Borromeo in Milan cathedral (1602–10). He was also active as a sculptor and architect. (P. J. My.)

CRESPI, GIUSEPPE MARIA (called Lo Spagnuolo) (1665-1747), Italian genre painter, was born in Bologna on March 16, 1665. He was a pupil of Domenico Canuti but formed his style principally on the example of the Carracci and on the study of the Venetians Barocci and Correggio, seen during his extensive travels. He was, however, unique in his employment of strong chiaroscuro and in his interest in genre subjects; both these interests were to be taken up in the 18th century in Venice by G. B. Piazzetta and Pietro Longhi. His famous series of the "Seven Sacraments" (Dresden gallery) shows both his preoccupations to advantage. Other works by him are in Bologna. His son, Luigi Crespi, wrote his life in his *Vite de' pittori bolognesi* . . . (1769). He died on July 16, 1747, in Bologna. (P. J. My.)

CRESS, a common name for many plants of the mustard family (Cruciferae; *q.v.*) whose sharp-flavoured basal leaves are often used in salads, seasonings and garnishes. Water cress is probably the best known (*see* Water Cress), but other edible cresses include garden cress (*Lepidium sativum*), a peppergrass (*q.v.*); upland or winter cresses (*Barbarea verna* and *B. vulgaris*), often weedy herbs; and bitter cress (*Cardamine* species). Among several ornamental plants called cress are rock cress (*Arabis* species; *see* Arabis) and Indian cress, the common garden nasturtium (*Tropaeolum majus; see* Nasturtium).

CRESSENT, CHARLES (1685–1768), French furniture maker, sculptor and metalworker, who occupied a prominent position in 18th-century European art and whose works are among the most beautiful pieces of French furniture of the period, was born at Amiens on Dec. 16, 1685. Grandson of the cabinetmaker Charles Cressent and son of the sculptor François Cressent, he practised both professions. It is not known when he went to Paris, but it was probably about 1710. At first he worked for the son of the cabinetmaker André Charles Boulle, came under the influence of the designer G. M. Oppenordt and the painter Antoine Watteau and formed a friendship with the sculptor François Girardon. As early as 1715 he was appointed official cabinetmaker to the duc d' Orléans, regent of France, and later he occupied the same position for his son. In 1719 he became a member of the Académie de Saint-Luc, an eminent situation that brought Cressent important orders. He made furniture for foreign courts

(Portugal, Bavaria) and for the houses of the wealthy in France but does not seem to have worked for Louis XV. For the regent's son he made one of his masterpieces, the famous medal cabinet (in the Bibliothèque Nationale, Paris). Cressent was also an experienced collector. Having developed his taste in the world of art, he formed a fine collection of pictures and *objets d'art*, which, however, he voluntarily dispersed. He died in Paris on Jan. 10, 1768.

Cressent not only designed the models and made the furniture himself, but he also carved magnificent mountings of gilded bronze for them. In this respect his skill was comparable to that of his contemporary, Jacques Caffieri. The cabinetmakers' corporation instituted proceedings against Cressent, who, although a cabinetmaker and in spite of his privileges, had not the right to work bronzes on his premises, and they were seized in his workshop.

The total absence of signatures makes it difficult to date Cressent's production, so recognizable by his personal style. The first works, still very much in the manner of Louis XIV, have affinities with Boulle's work. In the following period (about 1730–50) his artistry is balanced, retaining its elegant strength and avoiding the excess of rococo; from this period can be dated the charming *espagnolettes* (female figures generally fixed to the corners of tables), most characteristic of Cressent's style. Finally, after 1750, his work was inspired by a return to the antique.

The Louvre (Paris) and the Wallace collection (London) are specially rich in furniture by Cressent.

See M. J. Ballot, "Charles Cressent," *Archives de l'art français*, vol. x (1919); F. de Salverte, *Les Ebénistes français du XVIIIe siècle* (1953).
(S. Gr.)

CRESSY, HUGH PAULIN (in religion SERENUS) (*c.* 1605–1674), English Benedictine historian, apologist and spiritual writer, was born at Thorpe-Salvin, Yorkshire, and educated at Merton college, Oxford. He became chaplain to Sir Thomas Wentworth (later earl of Strafford) and subsequently to Lucius Cary (later Lord Falkland); he was also dean of Leighlin, Ire., and canon of Windsor. In 1646 he joined the Roman Catholic Church, partly owing to the writings of Father Augustine Baker, and became a monk of St. Gregory's, Douai, in 1649. Returning to England after the Restoration he was appointed chaplain to Queen Catherine of Braganza at Somerset house. He died at East Grinstead on Aug. 10, 1674. His *Exomologesis*, an account of his conversion, appeared in Paris in 1647; he also wrote a large *Church-History of Brittany* [*i.e.*, Britain] . . . *to the Norman Conquest* (part i, 1668; part ii, discovered in 1856, is still unprinted) and several controversial tracts. His chief significance, however, is as editor of the mystics Walter Hilton (1659) and Julian of Norwich (1670) and, above all, as the skilful compiler, from manuscript material left by Father Baker, of the spiritual classic *Sancta Sophia* (1657). He thus presented to his generation and to posterity the traditional ascetical and mystical teaching of medieval England, developed and completed by the saints and mystics of the Counter-Reformation.

See J. Gillow, *Bibliographical Dictionary of English Catholics*, vol. i, pp. 592–596 (1885). There is a sympathetic portrait of Cressy in J. H. Shorthouse's novel *John Inglesant* (1902). (M. D. K.)

CRESTON, PAUL (1906–), U.S. composer, whose modernistic style is made accessible and effective through rhythmic vivacity and harmonic euphony, was born in New York city, Oct. 10, 1906, in an Italo-American family; his real name is Joseph Guttoveggio. He studied organ but was self-taught in composition. Among his works are five symphonies (1940, 1944, 1950, 1951, 1955), some of them with programmatic connotations (the third symphony is subtitled *Three Mysteries*); *Two Choric Dances* for orchestra (1938); *Threnody* for orchestra (1938); saxophone concerto (1941); piano concerto (1949); *Walt Whitman*, symphonic poem (1951); *Invocation and Dance* for orchestra (1953); chamber music for various combinations; sacred vocal pieces, and piano music. Creston was also active as a lecturer and conductor. In 1956 he was elected president of the National Association for American Composers and Conductors. (N. Sv.)

CRESWELL CRAGS, a ravine about 500 yd. long cutting through a localized ridge of Permian limestone near Creswell in northeastern Derbyshire, Eng. Its precise geological history is not known, and the rivulet it carries would have been quite incapable of erosion on the scale seen. Two parallel walls of cliffs on either bank rise to about 50 ft. in height in places. Both escarpments are dissected by gullies and pierced at several points by considerable caves. The latter contained important deposits of the Upper Pleistocene Age, whose excavation has yielded one of the most important series of extinct vertebrate faunal remains accompanied by the implements of Paleolithic hunters known in Britain.

The earliest recorded scientific excavations of these deposits took place in 1875 and were continued for a number of years by Sir William Boyd Dawkins. Further excavations were undertaken by A. L. Armstrong in 1924 and subsequently, and his work was followed in 1959 and 1960 by detailed investigations undertaken by R. V. S. Wright and C. B. M. McBurney.

The principal sites examined were Robin Hood's cave, Pin Hole, Mother Grundy's Parlour and Church Hole. The best-attested human occupation in all of these belongs to the so-called Creswellian culture, now widely regarded as a provincial variant of the later Magdalenian culture of southwestern France and assigned to the final episodes of the last or Würm glaciation. On the evidence of radiocarbon analyses, this last glaciation is believed to have fallen between the 13th and 9th millennia B.C.

Traces of earlier Paleolithic stages include Mousterian artifacts from Pin Hole, Robin Hood's cave and less certainly from the other two.

Well-characterized implements of the British variant of the Proto-Solutrean are also available from Church Hole. The accompanying mammalian fauna includes reindeer, woolly rhinoceros, mammoth and wild horse.

An earlier faunal assemblage, presumably of the Last Interglacial or Riss-Würm Age, from Mother Grundy's Parlour includes *Hippopotamus major* and *Rhinoceros leptorhinus*, both indicative of temperate conditions. A quartz industry claimed to be associated with this assemblage has not been confirmed.
(C. B. M. McB.)

CRETACEOUS SYSTEM, in geology, a vertical sequence of rocks deposited toward the end of the Mesozoic era, or time of intermediate forms of life following the Jurassic period and immediately preceding the Cenozoic era—the era of recent or modern life. Many rocks of Cretaceous age are of notable economic importance and are used for a variety of purposes: building stones, ceramic products, glass sand and cement. The most important products, however, are oil and gas and coal and water. Oil deposits are widespread in North America, South America and northern Africa. Thick coal deposits in North America cover an immense area (100,000 sq.mi.) and are also found in Germany, Japan and New Zealand. It is mostly of bituminous and lignitic

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
	CENOZOIC ERA		
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
	MESOZOIC ERA		
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Triassic		Appearance of dinosaurs	200,000
	PALEOZOIC ERA		
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400,000
Cambrian		Marine invertebrates	500,000
	PRE-CAMBRIAN TIME		
		Few fossils	3,500,000–4,000,000

uality. Porous Cretaceous sandstones are locally important ources of artesian water.

The Cretaceous was a period of dramatic change in the distribu- ion of land and sea on the earth and in the plants and animals that nhabited it; it was the time of the much discussed extinction of he dinosaurs and other groups of animals; and toward the end f the Cretaceous the flowering plants became the dominant vege- ation cover of the land areas of the world. The Cretaceous period asted approximately 75,000,000 years, beginning about 130,000,- 00 to 140,000,000 years ago; it was characterized by notable nountain-building activity and by vast inundations of continental reas by the sea. Volcanic activity was lively at times along the najor submarine depressions, the geosynclines that ringed the Pa- ific ocean and extended in approximate east-west direction across orthern South America, the Mediterranean area and from there iagonally toward Australia to form an ancient sea called the 'ethys. The climate of the Cretaceous is generally considered to ave been warm to temperate even in the higher latitudes.

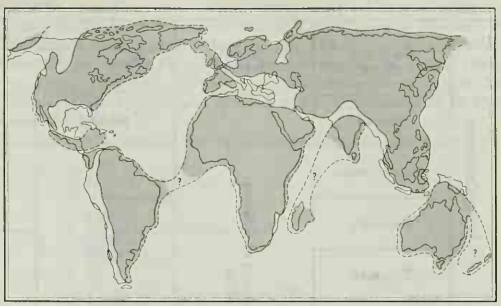
The Cretaceous Rocks.—The name Cretaceous (as *Crétacé,* rom Lat. *creta,* "chalk") in its present application was suggested y Omalius d'Halloy in 1822. It refers to a characteristic rock de- osited during late Cretaceous time over much of northwestern urope where, exposed along the English channel, it forms a fa- iliar landmark (the white cliffs of Dover). Chalk, however, is ot the predominant type of rock formed during this period. On he land thick deposits of sandstone, shale, coal and conglomerate ere accumulated; in the seas (besides chalk) mudstone, limestone nd some thick beds of material of volcanic origin were formed. he vertical sequence of these rocks is usually divided into two ortions, the Lower and the Upper Cretaceous sequences. In order o compare the relative ages of rock sequences the world over, a tandard of named stages representing succeeding time intervals as established for the European sequence, beginning with the eocomian (the oldest) and ending with the Danian. The chart hows in much simplified form the relative age of Cretaceous rock eposits in various parts of the world. Age correlation of Creta- eous beds in geographically separated parts of the world is based, n the case of marine sediments, largely on widely distributed pecies of ammonites which are among the more reliable guide or ndex fossils of the period. In the continental deposits plant as- emblages and dinosaurs have been used to identify and correlate he beds of rocks. (*See* FOSSIL.)

PHYSICAL HISTORY

Mountain-Building Activity.—Sedimentary rocks are the roduct of destruction by erosion of highlands and mountain anges. During the Cretaceous period many ancient mountain sys- ems and old uplands as well as mountain ranges formed during he latter part of the Jurassic were severely dissected or virtually eveled; fresh movements of the earth's crust occurred in many arts of the world and at different times during the period, and any of the mountain ranges thus formed were likewise reduced o peneplains. This explains the vast quantity of Cretaceous de- osits. Local mountain-building activity occurred at the very eginning of the Cretaceous period in extreme western North merica, in Europe and in the far east (Japan), and again at the nd of the Lower Cretaceous. In North America the end of the retaceous coincides with very profound crustal movements (Lar- mide revolution) that gave rise to the Rocky mountains.

Distribution of Land and Sea.—The distribution of water nd land in the early part of the Cretaceous period was notably ifferent from what it is today (*see* figs. 1 and 2). The North merican continent was partially covered by advancing seas both n the north and in the south. The Caribbean area was an island. arge parts of western Europe and the Mediterranean area east o the Caspian sea were covered by the Tethys and the ancient orth sea. An eastern extension of the Tethys geosyncline sepa- ated peninsular India from the Asiatic continent.

A long arm of the Arctic ocean penetrated deeply into the Rus- an plain. Toward late Cretaceous time the transgression of the eas over former land areas reached its maximum extent. North merica became completely bisected by an immense, shallow sea



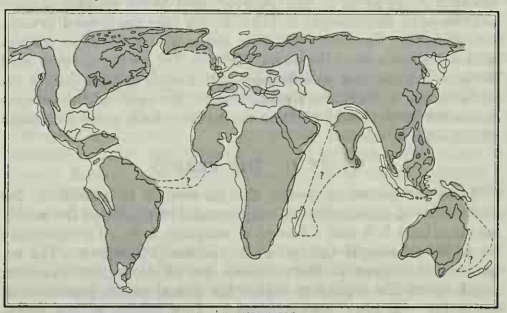
DRAWN FOR "ENCYCLOPÆDIA BRITANNICA" BY MAIDI WIEBE

FIG 1.—DISTRIBUTION OF LAND AND SEA DURING LOWER (EARLY) CRETACEOUS TIME

that spanned the continent lengthwise from the Gulf of Mexico to the Arctic ocean. The continent of Africa likewise became divided into two land masses with a very shallow, lagoonal sea arm connecting the Tethys with the South Atlantic. Almost all of western Europe, except for a few islands and the Scandinavian shield, as well as large areas of the Asiatic continent lay covered by the expanding Tethys. While the picture of land and water distribution during the Cretaceous is generally one of gradually increasing surface area of the seas, the opposite trend, regressive movements with emergence of land areas, occurred locally in a number of places and at various times. A striking example of this is seen in the long sea arm that extended from the Arctic ocean across the Russian plain toward the Caspian sea. It was formed in the late Jurassic period and existed until just prior to Aptian time in the Cretaceous, when it was replaced by an arm of the Tethys entering the Russian plain from the south. The fossil faunas enclosed in the sediments of these sea arms are thus of strikingly different nature, one belonging to the cool arctic province, the other to the subtropical Tethys.

Volcanic Activity.—It has long been recognized that volcanic activity accompanies major crustal disturbances of the earth, and that volcanoes usually are arranged in lines that follow the edges of structurally active geosynclinal troughs. In Cretaceous time (as was true in earlier periods) such major geosynclines ringed the Pacific ocean and were an outstanding feature of the Tethys sea. Volcanic activity occurred all through the Cretaceous period along these synclinal basins, but not everywhere at the same time or with the same intensity.

In the early phase of the period, volcanic activity centred primarily around the Pacific where by Danian or late Cretaceous time it became very active along the eastern fringe of the Asiatic continent. Activity along the geosynclines of the Tethys occurred with varying intensity during the late Cretaceous; it was particularly notable along the southern edge of the Asiatic continent (Indochina, peninsular India, Black sea area) and around the Car-



DRAWN FOR "ENCYCLOPÆDIA BRITANNICA" BY MAIDI WIEBE

FIG. 2.—DISTRIBUTION OF LAND AND SEA DURING UPPER (LATE) CRETACEOUS TIME

Cretaceous Sequences

	European stages	Alpine region	North America: Southern U.S.	North America: West central U.S.	North America: West coast U.S.	India	Australia
Upper Cretaceous	Danian	Rudistid limestones of different areas	? missing	Lance Fm.	Chico series	Niniyur	? missing
	Maestrichtian		Gulf series	Montana group		Ariyalur	
	Senonian						Gingin chalk
	Turonian			Colorado group		Trichinopoli	? missing
	Cenomanian					Utatur	Winton series
Lower Cretaceous	Albian		Comanche series		Shasta series	? missing	Tambo series
	Aptian		Coahuila series	Inyan Kara group			Roma series
	Neocomian	Aptychenkalk (E. Alps) Biancone (S. Alps)		? missing			Walloon series (part)

ibbean land mass. It must be noted that the edges of the shallow epicontinental seas are devoid of volcanic activity because these basins did not form by crustal buckling and sinking as did the active geosynclines.

Climates.—The climate of the Cretaceous is considered to have been temperate to warm with a mean annual temperature (at 40° to 90° N. latitude) above 50° F. (E. Dorf, 1957). There is no evidence to suggest the presence of polar icecaps, and vegetation of temperate- or even subtropical-zone character is recorded from high latitudes (Greenland, Alaska). However, at the beginning of the period the climate was somewhat cooler and it rapidly deteriorated at the very end, although by comparison with the present-day climate it must still have been rather mild. The fact that vast land masses and mountain ranges were leveled by erosion and the presence, locally, of a dense, lush cover of vegetation that produced extensive coal deposits indicate that there was a great deal of rainfall; hence the climate was probably not only warm, but moist as well. While it is possible to characterize the climate of a given period in general terms applicable to the world as a whole, it must be kept in mind that the climate of any given locality is determined to a notable extent by local factors such as mountain ranges, marine currents and wind patterns. For example, the climate of extreme western Europe up until mid-Neocomian time was no doubt influenced in the north by the relatively cool North sea that washed the shores of Scandinavia and the British Isles southward to eastern England. Parts of France, on the other hand, lay in contact with a shallow arm of the warm Tethys. The narrow strip of land between the two seas vanished by Aptian time and the waters became mixed; it seems very probable that the effect of this process was a tendency toward climatic moderation both north and south of the original barrier.

LIFE OF THE PERIOD

As in the preceding period, the Jurassic, it is possible in the Cretaceous to distinguish two major faunal belts around the world: an equatorial belt and a boreal or northern belt. To these may be added an austral (australian or southern) province. The organisms that lived in these regions are of distinctive character much as are the organisms within the faunal or life provinces of today (*see* GEOLOGY: *Paleontology*). To a notable extent, paleogeographic maps, such as those illustrated, are based on the nature of the faunal assemblages preserved in rock sequences; for example, it is faunal evidence that permits the conclusion that the epicontinental sea covering much of the Russian plain was connected with the Arctic ocean in the early Cretaceous, but with the Tethys by Aptian time.

The history of the organisms during this period contributes a fascinating chapter to the over-all history of life on the earth. Certain organisms became plentiful and varied whereas others evidently reached an evolutionary climax and became extinct.

Vegetation.—At the beginning of the Cretaceous period the predominant vegetation cover of the land consisted of primitive vascular plants or gymnosperms (*q.v.*): scouring rushes, abundant conifers, ferns, cycads and their relatives and ginkgoes. The true flowering plants (angiosperms) were on the scene but they constituted a minor element in the floras of this time, at least in the fossil record. Since the periodic shedding of the foliage coupled with a resting phase and the evolution of durable seeds in the angiosperms are very probably adaptations to seasonal and fairly rigorous climatic conditions, it has been suggested that they might have inhabited the highlands (where the chances of their preservation as fossils would have been extremely limited). Toward the middle of the period, however, fossil angiosperms are known in increasing numbers and in the late Cretaceous they replaced the gymnosperms as the dominant vegetation cover on all continents. In fact the flora assumed, by this time, a distinctly modern character with such familiar trees as beech, sassafras, fig, magnolia, poplar, oak, maple, walnut and many other well-known trees and shrubs, grasses and vegetables. Thus viewed from the fossil record it would seem that the flowering plants underwent rapid evolutionary radiation during the Cretaceous period. This may be so, but it is at least possible that the fossil record merely documents the fact that the angiosperms, already present in great variety, expanded their range into the lowlands (where their chances for preservation in rapidly accumulating sediments were better) in the course of Cretaceous time and replaced to a large measure the earlier gymnosperm vegetation cover.

Animal Life.—Among the microorganisms the Foraminifera one-celled animals with minute calcareous skeletons, occur in vast abundance and variety. In late Cretaceous time the skeletons of these tiny creatures, settling to the sea bottom after death of the animals, formed thick deposits of chalk, especially in western Europe. In recent years these animals have been studied in great detail because of their usefulness, especially to the oil industry, in

the correlation of rock samples from well cuttings (*see* FORAMINIFERA). Sponges and corals were locally abundant in parts of the Tethys sea and elsewhere, but they and the brachiopods never played a major role in the faunas of this period. Of the echinoderms it was the sea urchins that populated the Tethys waters in rather large numbers, and some species were sufficiently widespread to serve now as guide fossils. The sea lilies (crinoids), on the other hand, were rare. The most abundant and varied invertebrate animals of this period were the mollusks. To the historical geologist they are of great interest because many species evolved rapidly and thus persisted for only a brief time while achieving wide geographic distribution—two requirements that make an organism a useful guide fossil. Among the lamellibranches (clams and relatives) the most characteristic types were the rudistids, massive sessile shells that formed reeflike masses and were typical members of the warm-water faunas especially abundant in the Mediterranean section of the Tethys. Oyster beds, likewise, were of notable importance. The marine gastropods (snails), whose anatomy is unknown except for the shapes of their shells, were locally common and many of them had characteristic shapes and ornamentations. While the clams and snails survived the end of the Cretaceous period, most of the cephalopods (relatives of the squids and *Nautilus*) did not. Nor did the belemnites (squidlike animals with long clublike backward projections from their internal skeletons) and the unusually varied group of the ammonites, distant relatives of the living *Nautilus*. Both these groups were very conspicuous elements of the Mesozoic faunas and both died out at the end of the Cretaceous.

Among the vertebrates the fishes present a picture similar to that of the plants in the sense that the earlier ganoid (*q.v.*) or garlike fishes were largely replaced by the modern bony fishes, the teleosts. What little is known of the amphibians suggests that modern types were already present in the early phase of the period.

For the reptiles, in contrast, the Cretaceous brings to a close their rule on the earth. The dinosaurs, the most conspicuous land animals, gradually died away until only the ceratopsians (horned dinosaurs) were left and they, too, did not survive the end of the period (*see* DINOSAUR). In the sea the ichthyosaurs (fish reptiles), the plesiosaurs and the marine lizards, the mosasaurs, all highly successful predators of the oceans, vanished, as did the flying reptiles (pterosaurs). Only the turtles, lizards and snakes, the crocodiles and the rhynchocephalians survived to the present. Little is known of the birds of the period and the mammals, although present since the end of the Triassic, were small and rather inconspicuous creatures.

Numerous possible causes have been suggested to account for this dramatic faunal upheaval during late Cretaceous time, but no single factor could have been responsible. It would seem clear, however, that the world-wide structural disturbances resulting in intense orogenic or mountain-building and volcanic activity toward the close of the period resulted in profound environmental alterations that required physical adaptability greater than that of the highly specialized reptiles and ammonites.

For further information *see* PALEOBOTANY; PALEONTOLOGY; GEOLOGY.

See also references under "Cretaceous System" in the Index volume.

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CRETE (Gr. KRITI; KRETE), the largest island of Greece and, after Sicily, Sardinia, Cyprus and Corsica, the largest island in the Mediterranean, is situated between 34° 55′ and 35° 41′ N. latitude and between 23° 30′ and 26° 19′ E. longitude. Its northeastern extremity, Cape Sidero (Akra Sidheros), is distant about 110 mi. from Cape Krio (Akra Krios) in Asia Minor, the interval being partly filled by the islands of Karpathos and Rhodes; its northwestern extremity, Cape Vouxa (Akra Vouxa, also called Grabusa), is about 60 mi. from Akra Malea in the Morea (Peloponnese). Crete thus forms the natural southern boundary of the Aegean. The island's area is 3,218 sq.mi. Its population in 1961 was 483,258.

This article contains the following sections and subsections:

I. Physical Geography
  1. Geology and Structure
  2. Physiography
  3. Climate
  4. Vegetation and Animal Life
II. Archaeology
  1. Excavations
  2. Sites
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  4. Egyptian Contacts
  5. Origins and Development
  6. Palatial Architecture
  7. Minoan Towns
  8. Sanctuaries
  9. Tombs
  10. Painting
  11. Sculpture and Modeling
  12. Metalwork
  13. Seals
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  15. Later Periods
III. History
  1. Ancient History
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  4. Union With Greece
IV. Population and Administration
V. The Economy
  1. Agriculture
  2. Mining and Industry
  3. Communications

I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—The island of Crete is a remnant of a range of mountains which formerly linked the chains of the Peloponnese with those of southwestern Turkey. This range was thrown up, like those of the Greek mainland, during the earth movements of Tertiary times and took the shape of a wide arc, of which the east-west trending range of Crete is the most southerly section. Subsequently this mountain range was broken by rifts and dislocations and much of it foundered beneath the sea. In what is now Crete, these fractures left the four main mountain masses standing above three fallen sections which, after being covered by the sea in late Tertiary times, are now isthmuses composed of Pliocene sediments. During the process of rifting, the residual mountain masses of Crete were upheaved and tilted toward the north and northeast, with the result that while on the south they fall abruptly into the sea along a straight coast line, they descend more gradually to the north in a series of natural steps, to meet a more indented and gently shelving shore.

The very porous limestone rocks of Crete rest on the impervious basement beds of the island and springs of water are commonly found at their junction. The basement rocks are chiefly found in the extremities of the island, especially in the western districts around the Gulf of Kisamos (Kolpos Kisamou) and Palaiokhora (Selino Kastelli). There the topography is much more gentle and rounded and surface streams are far more common than in the limestone regions with their precipitous slopes and underground drainage. These metamorphic rocks of western Crete, which are largely Triassic in origin, form a series about 9,000 to 10,000 ft. in thickness and include gypsum, dolomite, conglomerates, phyllites and a basic series of eruptive rocks (gabbros, peridotites and serpentines).

Resting on these basal formations are sedimentary rocks several thousand feet thick of Jurassic, Cretaceous and Eocene age, consisting largely of unstratified gray and black limestones but including some sandstones and conglomerates. At the western foot of the Psiloriti (Idhi; ancient Ida) massif calcareous beds with corals and brachiopods (*Rhynchonella inconstans*, etc.) have been

found, the fossils indicating the horizon of the Kimeridge clay. Lower Cretaceous limestones and schists, with radiolarian cherts, are extensively developed; and in many parts of the island Upper Cretaceous limestones with *Rudista* and Eocene beds with nummulites have been found. The arrangement of these series is complicated by a great thrust plane which has brought the Jurassic and Lower Cretaceous beds upon the Upper Cretaceous and Eocene beds. The Miocene marine beds (with *Clypeaster*) lie almost undisturbed upon the coasts and the low-lying ground, especially in the isthmuses of Ierapetra and Rethimnon. They are largely composed of conglomerates, though they include also some marls, chalks and sandstones, which have weathered into a low rolling landscape. With the Jurassic beds is associated an extensive series of eruptive rocks (gabbro, peridotite, serpentine, diorite, granite, etc.) which outcrop at the eastern end of the Asidheroto range and to the south of the Lasithi (Dhikti) mountains. They are chiefly of Jurassic age, but the eruptions may have continued into the Lower Cretaceous. The small plains of alluvial Upper Tertiary and Quaternary deposits, in particular those of Mesara and Canea (Khania), include some of the most fertile districts of Crete.

2. Physiography.—The island is of elongated form; its length from east to west is 152 mi., its breadth from north to south varies from 35 to 7½ mi. The northern coast line is much indented. On the west the Gulf of Kisamos is formed by two narrow mountainous promontories, the western terminating in Cape Vouxa (ancient Corycus), the eastern in Cape Spatha; beyond the Bay of Canea (Kolpos Khanion) to the east, the rocky peninsula of Akrotiri shelters the magnificent natural harbour of Suda (Kolpos Soudhas, 8½ sq.mi.), the only completely protected anchorage for large vessels which the island affords. Farther east are the bays of Candia (Kolpos Irakliou) and Mallia (Kolpos Mallion), the deep Mirabella gulf (Kolpos Merabellou) and the Bay of Sitia (Limin Sitias). The south coast is less broken and possesses no natural harbours, the mountains in many parts rising almost like a wall from the sea.

The greater part of the island is occupied by ranges of mountains which form four principal groups. In the western portion rises the massive range of the Levka Ori (White mountains), directly overhanging the southern coast with spurs projecting toward the west and northwest (highest summit, Pachnes, 8,045 ft.). In the centre is the smaller, almost detached mass of Psiloriti culminating in the Stavros (8,058 ft.), the highest summit on the island. To the east are the Lasithi mountains with Afendis Khristos (7,024 ft.) and farther east the mountains of Sitia with Thrifti Oros (4,757 ft.). The Asterusia (4,039 ft.) mountains separate the central plain of Mesara (Pedhias Mesaras) from the southern coast. The isolated peak of Iouktas (2,661 ft.), nearly due south of Iraklion (Candia), was regarded with veneration in antiquity as the burial place of Zeus. The principal groups of mountains are for the greater part of the year covered with snow, which remains in the deeper clefts throughout the summer; the intervals between them are filled by connecting chains which sometimes reach the height of 3,000 ft. The largest plain is that of Monofatsion and Mesara, a fertile tract extending between Mt. Psiloriti and the Asterusia range, about 15½ mi. in length and 8½ mi. in breadth. The smaller plain, or rather slope, adjoining Canea and the valley of Alikianou, through which the Platanias (ancient Iardanos) flows, is of great beauty and fertility. A peculiar feature is the level upland basins which furnish abundant pasturage during the summer months; the more notable are the Omalos in the Levka Ori (about 3,445 ft.) drained by subterranean outlets, Nida in Psiloriti (about 4,396 ft.) and the Lasithi plain (about 2,657 ft.), a more extensive area, on which are several villages. Also characteristic are the deep narrow ravines bordered by precipitous cliffs, which traverse the mountainous districts; into some of these the daylight scarcely penetrates. Numerous large caves exist in the mountains; among them are the famous cave of Ida in Psiloriti, the caves of Melidhonion in Milopotamos and Sarchu in Malevizion, which sheltered hundreds of refugees after the insurrection of 1866, and the cave of Dicte in Lasithi, which disputes with Ida the honour of being the birthplace of Zeus. The so-called Labyrinth, near the ruins of Gortyna, was a subterranean quarry from which the city was built. The principal rivers are the Ieros and the Anapodharis, which drain the plain of Mesara and enter the southern sea west and east respectively of the Asterusia range; the Platanias, which flows northward from the Levka Ori into the Bay of Canea; and the Milopotamos (ancient Oaxes) flowing northward from Psiloriti to the sea east of Rethimnon.

3. Climate.—In summer Crete lies in the path of the very regular etesian winds, which blow steadily from the north. The air is dry and hot, especially in the interior plains like that of Mesara, which do not experience the daily sea breeze.

In winter, by contrast, the winds are more tempestuous and variable. If the eastward-moving cyclones pass to the north of the island, they give rise to southerly winds, while if they pass to the south, they draw in winds from the Aegean. In either case they cause rain or snow, and Crete receives almost all its precipitation in the torrential showers of the winter months, particularly between November and January. Iraklion has an average annual rainfall of 20 in., 5 in. more than Athens. Snow lies through the winter at altitudes above about 1,600 ft., but in general winter in Crete is much milder than at comparative altitudes on the mainland because of the tempering influence of the winds from the sea, and the average January temperature at Iraklion (54° F.) is 5° higher than that at Athens. The south coast in particular suffers from frequent gales in the winter season; the north wind descending from the mountains causes severe squalls which are a danger to navigation, while the southerly winds also often meet the exposed coast at gale force. If these last winds continue into late spring, they bring very hot and dry air from north Africa, which may damage the ripening crops.

The mountains are not only colder and wetter than the plains, but they also receive much more rain in summer, mainly from thunderstorms.

4. Vegetation and Animal Life.—The flora of Crete, as might be expected in view of its geological history, is similar to those of the Peloponnese and Asia Minor. It includes also a few Cyrenaican plants. The forests of Crete have almost completely disappeared as a result of reckless felling, overgrazing and soil erosion. The woods of wild cypress (*Cupressus sempervirens* var. *horizontalis*) of western Crete now only survive on the slopes of the Levka Ori, while the Aleppo pine forests, once common in the eastern districts, are represented by a few scattered copses, for example on the southern slopes of the Lasithi mountains. The largest remaining stand of holm oak (*Quercus ilex*) is on the eastern slopes of the Lasithi range, and on the lower hills by the south coast the Spanish chestunt (*Castanea sativa*) is occasionally found.

Brushwood of carob or locust tree (*Ceratonia siliqua*), strawberry tree (*Arbutus unedo*), wild olive and juniper and, along the streams, of plane and willows is less common in Crete than the low shrubby communities of prickly plants like the burnet (*Poterium spinosum*), broom (*Genista acanthoclada*) and rockrose (*Cistus villosus* var. *creticus*) which exudes labdanum (used in perfume manufacture). Grassland is very scarce, but there are numerous colourful herbaceous plants such as pinks and milkworts, and such bulbous species as the asphodel.

Bones of the elephant and pigmy hippopotamus were found in geologically recent cave deposits, and the deer only became extinct in historic times. In the 1960s there were fewer than 20 species of mammals on the island, 9 of which were endemic. Of these species the largest is the *agrimi* or wild goat (*Capra aegagrus*) which is found in the Levka Ori and the Psiloriti mountains. There is also a Cretan variety of dog, a large variety of weasel and a light-coloured hare. The wildcat is found, along with the marten, badger and mouflon or wild sheep. There are no poisonous snakes and no wolves on the island. (Wm. C. B.)

II. ARCHAEOLOGY

The archaeological importance of Crete lies chiefly in its prehistoric remains, which have revealed the development in the island during the Aegean Bronze Age of a culture comparable in artistic and material achievement with the contemporary civilizations of Mesopotamia and Egypt. This Cretan culture extended in its maturity to the whole of Greece and exercised considerable

erial view of Canea (Greek Khania), capital of Crete and of Khania *nomos* (depart-ent)

Section of the harbour at Iraklion (Candia), an important port noteworthy for its Venetian buildings and fortifications (fortress in the background)

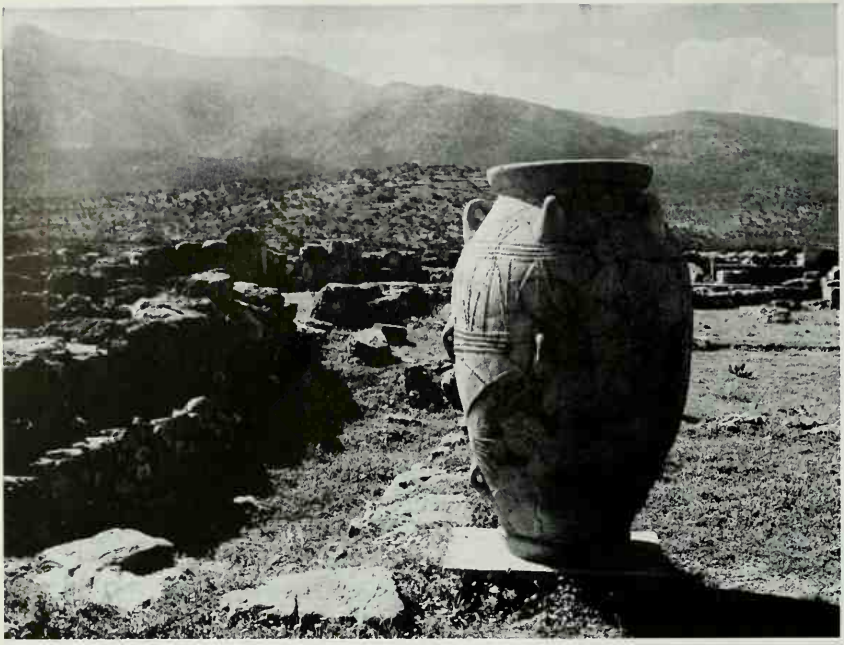
Church of St. John the Hermit in Khania *nomos;* one of the first churches in Crete, it was originally a cave used for Christian assemblies

Magazine in the ruined palace of Knossos (2000–1400 B.C.) showing vats and cists used for storage

SCENES IN CRETE

PHOTOGRAPHS, TONI SCHNEIDERS

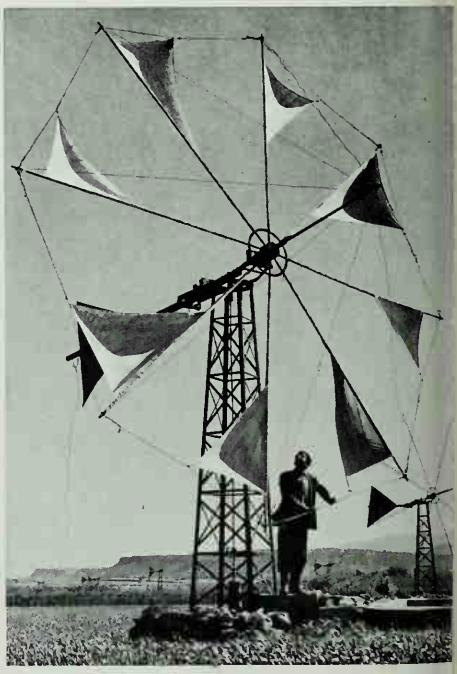
CRETE



A pithos or large earthenware jar, a relic of Cretan civilization, standing among the ruined foundations of the Minoan palace at Mallia, northeast of Iraklion

VIEWS IN CRETE

A view of Rethymnon with the Psiloriti (Mt. Ida) in the background



Windmills on the Lasithi tableland. Thousands of these windmills ar used by Cretan farmers to pump ground water for irrigation

PHOTOGRAPHS, TONI SCHNEIDER

influence in more distant regions of Europe. (*See* AEGEAN CIVILIZATION.) Ancient literary references to Crete as the source of many elements in Hellenic culture and religion had led several scholars to expect there the origins of the Mycenaean art which Heinrich Schliemann (*q.v.*) and others had discovered in mainland Greece in the second half of the 19th century, but the disturbed political condition of the island at that time was an obstacle to methodical excavation.

1. Excavations.—Schliemann visited Crete in 1886 and was attracted to Knossos where casual explorations had revealed the existence of large prehistoric buildings. But he was prevented from indulging his enthusiasm in the excavation of that complex site by administrative and personal objections. An Italian expedition supported by the Archaeological Institute of America had explored and excavated in southern districts of the island since 1884, but with no special interest in any particular period of antiquity.

The first investigator who worked in Crete with the purpose of defining its place in Aegean civilization was A. J. (later Sir Arthur) Evans (*q.v.*) of Oxford university. He made his first visit in 1894, in search of a class of seal stones engraved with pictographic characters which he had identified as Cretan, and in the same year he acquired ownership of part of the site of Knossos. But it was not until 1899, when the provisional Greek government was established, that he was able to complete the purchase and begin his excavation. In the same year in the southern plain (Mesara) the Italian expedition began the excavation of the palace of Phaistos. A smaller palace at Ayia Triada between Phaistos and the southern sea was also discovered and explored. The American Exploration society, affiliated with the University of Pennsylvania, sent an expedition in 1901, under Harriet Boyd of Smith college, which excavated town sites at Gournia and Vasiliki. The work was continued after 1905 by Richard Seager. With the support of U.S. universities and museums and of the American School of Classical Studies at Athens Seager excavated towns and tombs on the islands of Mochlos (Mokhlos) and Psira in the Gulf of Mirabella and tombs at Pakhia Ammos on the isthmus of Ierapetra. Other important cemeteries on the two limestone hills of Sphoungaras and Vrokastro in the same district were explored by the American School. The British School of Archaeology at Athens excavated houses and tombs at Knossos, cave sanctuaries at Psikhro in Lasithi (ancient Dicte) and Kamares on Mt. Ida (Psiloriti) and towns at Palaiokastron and Zakros on the east coast. The French School at Athens excavated the third large palace known in Crete, at Mallia on the north coast east of Knossos. A small palace or large house west of Ida at Monastiraki was excavated by Germans during their military occupation of Crete in 1942.

The field work of the Greek authorities has been active and important, but the government has liberally permitted foreign workers to undertake the more extensive excavations, using its own resources mainly to deal with the numerous accidental finds of tombs or buildings and the rapid accumulation of material in the Cretan museum at Iraklion (Candia). The nucleus of that unique collection had been formed by the local archaeological society, the *Syllogos,* in the days of Turkish rule. The first Cretan ephor of antiquities and director of the museum that was built in 1908 was J. Khatsidakis, who had been president of the Syllogos. He excavated a large house at Tylissos, west of Knossos, and began the exploration of Mallia. His successor, S. Xanthoudides, excavated houses at Khamaizi and Nirou Khani and an important series of early tombs in the Mesara.

2. Sites.—The prehistoric sites explored are those of towns, royal palaces, large houses, sanctuaries and tombs. Towns are best represented at Gournia, Palaiokastron, Psira, Mochlos and Vasiliki. The great palaces at Knossos, Phaistos and Mallia were centres of civic life, but continuous habitation in historical times has largely destroyed the prehistoric cities. The large buildings now isolated at Ayia Triada, Tilissos, Monastiraki and elsewhere may have been administrative centres of small communities, like that of Gournia, or religious establishments: not temples but priestly residences. Several such houses built in close proximity to the palace at Knossos indicate that these elaborate structures need not have been royal. The sanctuaries are either walled enclosures on hilltops, as at Mt. Iouktas near Knossos and Petsofa near Palaiokastron, or mountain caves, of which the best known are those of Ida and Dicte. Most of these caves have produced evidence of Neolithic habitation; they were next used as communal burial places; and finally as receptacles for votive offerings to divine or chthonian powers. Later burials, communal and single, were made in built or dug tombs of great variety. There is no evidence of cremation during the Bronze Age in Crete.

3. Nomenclature and Chronology.—In order to make the distinction between the original Cretan art and its derivative Mycenaean forms, which contained in their mature and later developments many mainland (Helladic) elements, Evans proposed the name Minoan for the Cretan Bronze Age. He defined three principal epochs, Early, Middle and Late Minoan, distinguished by the successive phases of decoration of pottery viewed as an index of artistic development. Each main epoch was divided into three numbered periods on the principle of the rise, maturity and decline of each ceramic style. The names of the nine periods are usually abbreviated to their initial letters and numbers, E.M. I, etc. Absolute chronology rests upon reciprocal contacts with Egypt, where dates are fairly well established. The sequence and synchronisms of the prehistoric Cretan periods are as follows:

Crete	Egypt	Years B.C.
Neolithic	Pre- and protodynastic	*c.* 4000–3000
E.M. I	2nd–3rd dynasties	3000–2800
E.M. II	4th–6th dynasties	2800–2500
E.M. III	7th–11th dynasties	2500–2200
M.M. I	11th–12th dynasties	2200–2000
M.M. II	12th–13th dynasties	2000–1750
M.M. III	14th–17th dynasties	1750–1580
L.M. I	18th (to Tuthmose III) dynasty	1580–1475
L.M. II	18th (to Amenhotep III) dynasty	1475–1400
L.M. III	18th–19th dynasties	1400–1200
Sub-Minoan	20th–22nd dynasties	1200–1000

Closer study of the pottery and its stratification has made possible a further division of the M.M. and L.M. styles into earlier and later phases, M.M. Ia, M.M. Ib, etc., and in L.M. III three phases are recognized, a, b and c. It has also become evident that there were local variations in ceramic decoration and particularly that two styles which are characteristic of the periods M.M. II and L.M. II at Knossos were not produced at other centres. Some confusion arises from the use of the same names for the chronological periods, which must be fixed, and for the ceramic styles, which tend to be variable in time and place. It is desirable to keep the names that were originally applied to the pottery, as Vasiliki ware for the distinctive eastern fabric of E.M. II and III, Kamares ware for the Knossian polychrome style of M.M. I and II, the Palace style for that of L.M. II, and to name the periods only in dating the styles.

4. Egyptian Contacts.—Fragments of pre- or protodynastic stone vessels were found in a Late Neolithic stratum at Knossos. The technique of stone vases found in E.M. burials at Mochlos is manifestly derived from Egypt, and many of their shapes are imitations of those of the Old Kingdom. Signets of E.M. III are also imitations of Egyptian work, the models being seals and devices of the First Intermediate period. Scarabs of the 11th and 12th dynasties have been found in M.M. I burials. The inscribed base of a diorite statuette of the early 12th dynasty was found in a M.M. II stratum at Knossos, and M.M. II pottery has been found in Egypt in 12th dynasty deposits at the Pyramid of El Lahun and Harageh and in a tomb at Abydos (al-'Arabat al-Madfuna). An alabaster lid bearing the cartouche of the Hyksos Pharaoh Khyan was found in an early M.M. III context at Knossos. Wall paintings in Egyptian tombs of the early 18th dynasty show Minoan envoys bearing vessels of L.M. I forms; in the latest of these (tomb of Rekhmire, minister of Tuthmose III) the envoys wear the kilt which first appears at Knossos in frescoes of L.M. II. A seal of Tiy, queen of Amenhotep III, comes from an L.M. II tomb at Ayia Triada. Aegean pottery found in Egypt after that time seems to be of mainland (Mycenaean) style and fabric; the synchronisms with Crete are therefore indirect, but

not less certain. Many shards of the Mycenaean style parallel to that of L.M. IIIa were found at Tell-el-Amarna in the city founded by Ikhnaton (Amenhotep IV) and abandoned after his death. Relations between the Aegean world and Egypt became hostile during the 19th dynasty and no material contacts with Crete are visible before the end of the Bronze Age, when a few beads and seals of the 20th–22nd dynasty types appear in Proto-geometric burials at Vrokastro.

5. Origins and Development.—The earliest Neolithic artifacts found in Crete are considerably advanced in character and indicate that their makers were immigrants. Since access to the island was easy from the east and south, and the Stone Age settlements were mainly in the eastern and central regions, it seems likely that the people came from the shores of Africa or Asia Minor or both. The first foreign material that is identifiable is obsidian in flakes and cores from the island of Melos; but the Cyclades seem not to have been inhabited at that time. Contact with Egypt, probably through Libya, is seen in fragments of stone vases found in the latest Neolithic strata at Knossos. The large knoll on which the palace stands is topped with about 24 feet of deposit from Stone Age habitation. The conjectural date of 4000 B.C. for the beginning of the Neolithic Age is based upon an estimate of about 1,000 years for the accumulation of so much refuse; the lower date is supplied by the Egyptian stone vases. Neolithic deposits elsewhere are mostly found in caves and rock shelters, but this does not mean that the Cretans of the Stone Age did not build houses. Stone footings of house walls are associated with a rock shelter at Magasa near Palaiokastron, and complexes of rectangular rooms with fixed hearths were found below the Minoan court at Knossos. The Cretan material shares the general character of the Neolithic culture that was prevalent in coastal regions of Syria and Egypt. The earlier pottery is generally dark-faced, often decorated with modeled pellets, punctuation or simple linear incision. Its development was technical rather than artistic, as better firing produced clear or mottled surfaces. There is no connection with the contemporary painted wares of mainland Greece. But steatopygous female figures and small animals modeled in stone or clay and implements of polished stone resemble those of all adjacent regions.

Artistic progress began toward the end of E.M. I with painted linear decoration in black glaze on a light clay surface. This period was the beginning of the Copper Age. Bronze was not made before M.M. I. But the use of metal and contact with its sources led to rapid advance in E.M. II and III. Most notable in E.M. II is a series of stone vases found at Mochlos. These reproduce some Egyptian shapes but their brightly coloured materials, veined marbles and mottled breccias are Cretan and obviously initiated the style of polychrome painting that is characteristic of M.M. ceramic art. Short copper daggers appear in E.M. II and the production of engraved seals and gold jewellery was begun. In E.M. II the surfaces were sometimes covered with ferruginous pigment on which accidents of firing produced irregular variation (Vasiliki ware). In E.M. III the fired decoration was replaced by painted designs of white and red stripes and curves, including spiral coils. The most remarkable products of E.M. III are ivory and steatite signets carved in animal forms and engraved with devices which often imitate Egyptian patterns. Polychrome pottery painted with formal designs in red and white on the black glazed ground reached its highest point of development in M.M. I and II (Kamares style). That was also the time of the first Minoan writing, the hieroglyphic script.

The first elements of the palaces belong to M.M. I. The mound of Knossos was cleared of earlier buildings and its top was leveled for the central court. The new buildings were more or less isolated structures around the court. At the end of M.M. II there seems to have occurred one of the destructive earthquakes to which Crete is still liable; destruction is visible on all sites and some were not reoccupied. But the damage gave opportunity for extensive reconstruction of the palaces, the final plans of which were mainly determined at the beginning of M.M. III. An apparently new feature was the addition of colonnades to the courts. The elaborate fresco paintings which belong to this period were not a new process but there are no earlier examples of the naturalistic style which was perfected in M.M. III. Its influence on the minor art of ceramic decoration is seen in the replacement of formal polychromy by white on black designs incorporating simple motifs drawn from floral and marine life. Human and animal figures were not admitted to the ceramic repertory but were freely exploited in fresco painting and seal engraving. The hieroglyphic symbols were replaced by a linear script in M.M. III.

At the end of the period there was another destructive earthquake, followed at most sites by rebuilding. This was the moment at which the arts and influence of Crete began to be extended to mainland Greece where they were further and strongly developed as Mycenaean. It is a remarkable and unexplained fact that there was no significant contact between Crete and the mainland before L.M. I, although the two cultures met in the midway island of Melos early in the M.M. period.

Most of the external details and internal decoration of the palaces date from L.M. I. A complete change of technique in ceramic painting seems to have been due to need for clearer expression in representing natural subjects, which were, however, still restricted to plant and marine life. The designs were painted in the black-glazed medium on the light-yellow surface of the clay, which was also lustrous. This was the technique of Mycenaean pottery in the Late Helladic periods of mainland Greece. Much of the pottery of L.M. II at Knossos was decorated in a formal and grandiose manner which is appropriately called the Palace style. Another peculiarity at Knossos in this period was the replacement of the first linear script (A) by an enlarged version (B). Script B has been found on numerous clay tablets, precisely similar to those of Knossos, at Pylos and Mycenae, and the language written with it has been recognized as Greek. (See *Scripts* below.) Knossos must therefore have passed into Hellenic control at least two generations before the destruction of what Evans called the "Last Palace" which occurred at the end of L.M. II (*c.* 1400). Since all the towns and palaces of Crete were destroyed or damaged by fire at the same time, it is evident that the destruction was caused by enemy action. The enemies could only have been the Mycenaean powers of mainland Greece, which did, in fact, replace the Minoans in Aegean relations with Egypt and Syria in L.M. III.

The general catastrophe did not destroy Minoan prosperity, but seems to have reduced Crete to a subordinate position in the Aegean world. A notable sequel, if not a consequence of the destruction, was the extension of settlement toward the west of the island in L.M. III. The only considerable western establishment that is known before that time is the M.M. house at Monastiraki. The palaces were not rebuilt nor fully reoccupied, but a curious feature was the installation of small and rather primitive religious shrines in most of them toward the end of L.M. III. The only new palatial building of L.M. III date was a large megaron of Mycenaean type imposed upon the Minoan ruins at Ayia Triada. The period of transition from the Bronze to the Iron Age is called Sub-Minoan. It was a time of stress and turmoil in the Aegean world, following the fall of the Hittite empire and the attacks made upon the Syrian and Egyptian coasts by the Peoples of the Sea. It was marked in Crete by retreat from coastal sites to mountain fastnesses and great loss of population. The new settlements were represented at Kavousi and Vrokastro, where buildings were few and poor, and burial excavations show the intrusion of fibulae and large pins indicating new fashions of dress, iron weapons and the funeral rite of cremation. No Aegean material of this period has been found in Egypt, but a few hieroglyphic seals and beads from Vrokastro may be as late as the 22nd dynasty.

6. Palatial Architecture.—Palaces and palatial houses are the most remarkable Minoan monuments; their magnificence may have been partly due to the fact that in the absence of temples they were centres of religious cult as well as of royal or civic administration. The most important palaces, at Knossos, Phaistos and Mallia, had the same general plan and similar architectural details. Their buildings surrounded large rectangular courts of practically identical shape and size. Their mean measurements were precisely those of the court at Phaistos, 56 by 25 yd. Two sides of the central court of Mallia, at least one at Phaistos and

robably at Knossos were bordered with colonnades which seem to ave been fenced with timber between the pillars. These provi- ions and the fixed dimensions suggest that the courts were in- ended for some common purpose, and it has been plausibly laimed on this and other evidence that they were the arenas of he bull-leaping performances, which certainly had religious signifi- ance. There was a monumental shrine in the centre of the west ide of the Knossos court, and doubtless similar structures in the thers. The irregularities of Cretan sites were ingeniously ex- loited by the architects and wide flights of steps leading from one evel to another were designed as decorative features. The prin- ipal entrance to the palace at Phaistos was a flight of 12 steps 5 ft. wide. Similar long steps set at right angles to each other n the so-called theatral areas of the outer courts seemed to have erved as stands or seats for spectators at public functions. A reg- lar design in entrances from the courts to upper floors was a epped porch with a central column.

Knossos.—The site at Knossos is a large knoll which slopes own sharply to the Kairatos (Katsaba) river on the east and to ie deep bed of a tributary torrent on the south. When space was eeded on the eastern slope for extension of the palace in M.M. II, ie ground was cut down 25 ft. vertically and the domestic apart- ients were built in two stories below the central court and ap- roached by a monumental staircase. These buildings were pro- ected by their position from destruction by fire and earthquake nd were filled up in the course of time by debris from the higher evels, which held their stone floors and steps in place until the xcavators dug them out and replaced the original supporting tim- ers with steel and concrete. Each flight of stairs was carried y wooden columns standing on the stone balustrade of the flight elow. These two stories and the four flights of the grand stair- ase leading down to them are unique examples of construction nd design. Since the inner wall was necessarily windowless, be- ig backed by solid earth, air and light were supplied to the stair- ase and adjoining rooms through small open courts or light wells. he large rooms opened on these through heavy colonnades, and ieir inner walls were pierced with wide doorways with jambs laced in the lines of the columns and recessed to conceal the oors when opened. This was a regular and effective feature of ternal planning. Interior columns were made of wood and were t on ornamental stone bases. Shafts have left impressions of ieir cylindrical or tapered shapes on earth or plaster in which they ere subsequently embedded. They were also decorated with oncave, convex or spiral flutes, which must have been applied in aster.

The large series of open courts and terraced roofs presented rainage problems which were ingeniously met at Knossos by the onstruction of stone-built conduits and clay water pipes, which ere also used for sanitation. Since there was no source of water n the palace hill, the flushing system could only have been effec- ve in the rainy season, for a small part of the year, and the ad- nced ideas of sanitation that have been recognized there must ave been backward in performance.

The administrative and ceremonial quarters at Knossos were on e west side of the central court. Most remarkable was the throne om, which still contains the high-backed gypsum chair of the ng. Stone benches were built along the walls, which were deco- ted with a painted frieze of griffins. The room was connected ith a sunk lustral area entered by two flights of steps with a col- nned balustrade like those of the great staircase. The lustral eas existed in all the palaces and in some of the large houses. hey were at first thought to be baths, but since they were found be lined with gypsum, which is not waterproof, and had no ovision for drainage, they must have served some other purpose, obably lustration with oil or water in religious rites. The ritual ay have been directed to the propitiation of divine powers con- olling earthquakes, a cult that is reflected also in pillar crypts, llars or basement rooms containing main supporting piers over hich were the columns of the upper rooms. Some of the piers ere marked with the sign of the double axe and some of the ypts contained sacred furniture. The administrative quarters all the palaces were marked by series of long narrow basements which were evidently built and used as magazines for stores and treasure. There were 22 of these in the west wing at Knossos. Some still contain large earthenware jars for corn or wine or oil, and cists sunk in the stone floors and sometimes lined with lead retained fragments of gold objects that had been secured in them. The walls of the long corridor which led to this part of the palace from the southwest entrance were painted in the last period of Minoan grandeur (L.M. II, to which the throne room also belonged) with a processional frieze of many life-size figures. The well-known "Cupbearer," one of the first things found at Knossos, was one of these.

The approach to the palace from the south was carried up the steep slope of the torrent bed in a long stairway with a roof supported on columns. The road of which this was the northern end led across the island to Phaistos and a port on the southern sea at Komo, through which traffic passed with Libya and Egypt. At the Knossian end was an elaborately built inn or resthouse (the "Caravanserai"), which was amply supplied with water for men and beasts and decorated with fresco paintings. The road was carried along the edge of the ravine on a massive viaduct of which the stepped piers remain. Several other buildings must have been dependencies of the palace. The largest, the Little Palace, and the Royal Villa on the bank of the Kairatos seem to have served religious uses; others were merely residences, but were built in palatial style. (*See* also PRE-HELLENIC ARCHITECTURE: *Minoan Crete.*)

7. Minoan Towns.—The best example of these is at Gournia. It lies on a small hill in a valley near the sea, but was not a seaport and may not have been so near the sea in ancient times. Several other towns in eastern Crete, at Vasiliki, Palaiokastron, Zakros, Mochlos and Psira, have been partially destroyed by coastal subsidence or only partly excavated. Their houses and building methods were similar to those at Gournia, though the plans were complicated there by the steep slopes on which the town was built. The remains show no signs of formal planning. Rooms were rectangular but various in size and number and had the appearance of complexes built or enlarged as space or other means allowed. The walls were constructed with small stones laid in clay or sun-dried bricks on stone footings and were stiffened and tied with wooden posts and beams. Internal surfaces were smoothed with hard plaster which was painted in plain colours. The richer houses doubtless had figured frescoes. A fragment of painted plaster relief comes from Psira, but none was found at Gournia. Roofs were probably flat and made of clay rolled hard over reeds and joists. The outward appearance of ordinary town houses on the site is represented in a series of coloured faïence plaques from Knossos. These show small buildings of two or three stories marked with squares or bands or disks as if to distinguish construction in cut stone from brick or rubble reinforced with beams; the disks are the beam ends. Windows were few and mostly in the upper floors; the roofs were flat. At Gournia the cross streets are stepped in many places, climbing the slopes with the houses, and the main streets leading through the town were not more than five feet wide. Streets at Palaiokastron, a larger seaport town, were wider, and all were paved with stone.

The highest point at Gournia was occupied by the palace, a direct though modest imitation of those in the royal cities. It covered about 12 times the space of the ordinary town house. The whole town occupied about the same area (6 ac.) as the palace at Knossos.

8. Sanctuaries.—The ritual furniture found at Knossos and Mallia shows that the palaces were centres of religious cult. A fresco painting at Knossos with a picture of an edifice or frontage composed of baetylic pillars standing between sacred horns is believed to represent a shrine which stood on the west side of the central court. A furnished shrine belonging to the late reoccupation period (L.M. IIIb) was found intact in the palace. The only public sanctuaries that have been found are in walled enclosures on hilltops and in mountain caves. Sacred groves left no material records, but such woodland places of worship are shown in seal engravings. A gold ring signet shows a woman praying at a tall post to which a young god descends in response to the prayer. Minoan deities are represented in the forms and dress of men and

women, and it is not always possible to distinguish between human and divine figures, nor can it be known if the latter represent a single god and goddess in various aspects or several of each sex. The hilltop sanctuaries at Iouktas and Petsofa contained ashes from sacrificial or other fires and votive offerings of pottery vessels and human and animal figures modeled in clay. Numerous caves which had served for habitation in the Stone Age and for burials in E.M. times were subsequently used for deposits of votive offerings, fine pottery at Kamares on Mt. Ida, small bronze objects in the cave of Dicte, bronze swords and votive axes at Arkalokhori. The large cave of Ida, celebrated in historical times as the birthplace of Zeus, does not seem to have been a sanctuary until the last Minoan period.

9. Tombs.—Cave burials were succeeded in E.M. times by communal burial in large stone-built enclosures which may or may not have been roofed. In the east of Crete they were rectangular, in the southern district of the Mesara plain, circular. These were at first believed to be the lower courses of *tholos* or beehive tombs such as were built much later in mainland Greece. But the walls, so far as they are preserved, are vertical, and their construction was not solid enough to support a heavy dome; they may have had thatched roofs. Valuable offerings were buried with the dead: ivory and stone signets, gold jewels and copper weapons. The brilliant stone vases of Mochlos came from E.M. tombs. Single burials in earthenware coffins or large inverted jars are found in E.M. and M.M. graves, but communal burial or votive offerings at such burial places persisted into M.M. times. Next come the chamber tombs, artificial caves cut in soft rock on hillsides. These seem to have been family burial places, and since they were easily accessible and repeatedly used, valuable tomb furniture is seldom found in them. Transition from the rock-cut chamber to the built tomb of masonry was easy and attractive in an age of monumental architecture; but there were probably not many of these. A magnificent example was the so-called royal tomb at Isopata near Knossos, which was destroyed during World War II. It consisted of a forehall and an inner chamber built underground but roofed with a keel or barrel vault which would have risen above ground and was probably covered with a mound. The latest burial was in L.M. II, but the structure seems to have belonged to L.M. I. The temple tomb at Knossos, the last discovery made there by Evans, must have been a royal tomb. It was an elaborate two-storied structure, mainly above ground, leading to a rock-cut burial chamber. The plan was unique in the Minoan world. Although the architecture is Minoan, the idea of deification or worship which it suggests may have been adopted from Egypt or Caria. Shaft graves covered with stone slabs were frequent at Knossos in L.M. I and II, but burial in earthenware chests or baths in chamber tombs was the usual L.M. practice. Built beehive tombs with burials earlier than the middle of L.M. III were not found in Crete until the mid-20th century and those were not of the normal mainland form but had square chambers under circular vaults. But an elaborate *tholos* of earlier date and regular Mycenaean form was discovered at Knossos in 1955. It had been constantly re-used in L.M. times and there were no identifiable remains of the original interment. The structure, however, is certainly no later than the beginning of L.M. I and perhaps as early as the end of M.M. III. Burials of the transitional Sub-Minoan period are best known from Kavousi, Mouliana and Vrokastro. At Kavousi the funeral rite was inhumation, at Vrokastro cremation, and tombs in both cemeteries produced fibulae and iron weapons. A small built *tholos* at Mouliana, east of Mirabella, probably belonging to one family, contained two burials, an earlier inhumation with bronze fibulae and weapons and a slightly later cremation with remains of an iron sword.

10. Painting.—The master art of Minoan Crete was fresco painting. Its influence is visible in the pictorial character and content of the minor arts of ceramic decoration, embossed metalwork and seal engraving. Interior wall surfaces were necessarily plastered in rubble-built houses; some red-painted fragments at Vasiliki belonged to E.M. II. But the material was too fragile to survive rebuilding to any considerable extent. The later frescoes that have been found had fallen from standing walls and are extremely fragmentary; the pieces seldom illustrate more than details of the work. The earliest designs seem to have been painted reproductions of structural elements covered by the plaster, grained timber beams and rows of coloured disks representing ends of logs. The polished stone veneers of palatial walls were also imitated in paint, as coloured veins of marbles were reproduced on M.M. polychrome pottery. Some figured plaster fragments of M.M. II date at Knossos are printed with impressions of a sponge, and whether these were meant to reproduce mottled stone or were regarded as decorative devices in themselves is not clear. These formal patterns were used in later paintings for dadoes or frames of pictorial scenes. The earliest pictures that exist belong to M.M. III, but their mature development shows that they were not the first of their kind. They were mostly landscapes and seascapes enlivened with animals and fishes. A cat stalking a pheasant and deer leaping among rocks and flowers come from Ayia Triada. Fragments from a house at Knossos show blue monkeys prowling over rocks, a bird in flight and apparently a jet of water in a garden. Scenes from marine life, such as a picture of brightly coloured fish swimming among rocks and sea urchins from the domestic apartments at Knossos, are highly naturalistic. The handling of human subjects was realistic and vivid. Most notable is a series of miniature frescoes from Knossos illustrating public festivals. One of them depicts elaborately dressed ladies engaged in lively conversation beside a pillar shrine, around which a crowd of people is represented by massed heads drawn in outline and enlivened with white eyes and necklets and some waving arms. The only subjects from the living world that were stylized decoratively and thus adopted by ceramic painters were creatures of the sea: a large pottery jar from Pakhia Ammos has painted pebbles at its foot, swimming dolphins on the body and spray and bubbles at the top. Men and animals had no place in ceramic painting until the latest Minoan times; birds began to appear in L.M. II, perhaps as Mycenaean innovations. The marine designs characteristic of L.M. II pottery were not pictures but patterns. They were sometimes based on the single figure of the octopus, sometimes formed with grouped nautiluses and shells, rocks and seaweed. The Knossian Palace style of that period preferred large formal schemes of flowers modeled on the Egyptian papyrus. These and the architectural elements in the designs mark them as excerpts from wall paintings. Egyptian or Mycenaean influence seems also to be reflected in the large processional scenes that were the latest decorations at Knossos. The long corridor leading from the southwest entrances to the palace was painted with large numbers of life-size figures, boys and girls, priestesses or goddesses carrying or receiving ritual instruments. No L.M. III wall paintings are known in Crete, but to the beginning of that period or the end of L.M. II belongs a painted stone sarcophagus which was found at Ayia Triada. This bears detailed pictures of a sacrifice performed at the grave of a dead man. The ritual consists of libations of blood drawn from the throat of a slaughtered bull and offerings carried to king or hero who stands in graveclothes outside his tomb. It is an instructive illustration of the personal worship that is indicated in the construction of the temple tomb.

11. Sculpture and Modeling.—Sculpture in the round was not an art in which the Minoans excelled, unless it was on a small scale and in material such as ivory and steatite which could be carved easily in fine detail. This technique is represented at its best by the ivory statuette of a goddess holding gold snakes (in the Boston [Mass.] Museum of Fine Arts), and by the figure of a leaping boy from Knossos. No statues have been found, but there are many statuettes in clay, faïence and bronze. They provide the earliest records of Minoan dress, men's loincloths worn with tight belts and women's long voluminous skirts and bodice exposing the breasts. In L.M. I or II a short kilt was adopted by the men (*see* DRESS: *The Aegean*). Lively but summary clay figures came from the M.M. I sanctuary at Petsofa. Coloured faïence statuettes of goddesses or priestesses, furniture of a M.M. III shrine, were found at Knossos. Cast bronzes are late but their technique is generally imperfect and the detail coarse. One of the most successful is the figure of a man with arms raised in prayer (in the museum of Leiden, Netherlands). Animal sub-

jects, as in painting, were more congenial to the Minoan artist. A magnificent bull's head in black steatite comes from the Little Palace at Knossos, and there are similar ritual vessels in alabaster and silver. Large plaster friezes of bulls among olive trees decorated the northern entrance to the palace. But the masterpieces of sculpture in relief are three small black steatite vases from Ayia Triada which bear ritual scenes, of boxing and bullfighting, a sacrificial offering to the king, and a procession of 27 people engaged in an agricultural ceremony. This exquisite miniature work, of which there are several fragmentary examples, was closely related to reliefs in metal.

12. Metalwork.—The finest examples of Minoan metalwork are a pair of embossed gold cups which were found in the Vaphio tomb in Laconia, and bronze dagger blades inlaid with pictorial designs in gold and silver from the shaft graves at Mycenae. The scenes on the cups are contrasted episodes in the handling of wild and domesticated cattle. Few rich graves have been found in Crete and inhabited sites do not retain much treasure. But some large bowls and ewers of bronze and silver, extremely well designed and ornamented with formal patterns, have come from houses and tombs at Knossos. Shapes of early pottery vessels are largely metallic in origin, but very few examples of the prototypes have survived. The earliest and best is an elegant silver goblet from Gournia. Simple gold jewellery was found in E.M. burials at Mochlos; it is composed of flowers and leaves cut from foil and linked together with delicate wire chains. A remarkable M.M. I gold jewel from Mallia has the form of two bees holding a finely granulated disk, and there are other early examples of granulation and filigree. An exceptionally large bronze sword with gold-plated hilt and crystal pommel was found in the palace at Mallia and has been assigned to M.M. I; but weapons of early date are rarely found for the same reason that jewellery is scarce, because successive burials in chamber tombs gave opportunity for removal of valuable furniture. Most tombs produced a few gold beads that escaped the activities of the removers. These were often in the shapes of nautiluses or shells or flowers; strings of such beads are represented in paintings and reliefs, which also showed that much jewellery was worn. The king on the small steatite vase from Ayia Triada has bracelets, armlets and a triple necklace and carries a dagger in his belt.

Shaft graves at Knossos of L.M. II date have produced many long swords with embossed gold-plated hilts like those from the shaft graves at Mycenae. Gold ring signets have also come from tombs. They usually have long oval bezels on which a device is engraved and broad beaded or ribbed hoops. These seem to be too small for a finger and were probably designed to be worn as pendants. Most of the engraved designs are pictorial, but a ring from Knossos has a circular bezel engraved spirally with linear script.

13. Seals.—The first Minoan seals were Egyptian in material and design, being made of ivory and engraved with linear patterns, lattices, scrolls or spiral coils. Some of them can be dated in E.M. II but the great age of seal engraving began in E.M. III, when the soft native stone, steatite, came into general use beside imported ivory. The earliest forms were cylinders, not like the oriental roll seals but short sections of tusk with devices cut on the two circular ends. A pointed section made a stamp seal with a handle, which was also carved in natural forms of seated monkeys, lions, birds or heads of animals. Simple pictorial subjects were among the devices of that time, disks and prism beads were added to the shapes. The three- or four-sided prism was the form adopted for the new hieroglyphic inscriptions of M.M. I; the Egyptian scarab was known but not chosen for this purpose. Hard stones, cornelian, agate, crystal, chalcedony or jasper, came into use for hieroglyphic seals, and pictorial devices, usually representing animals, were frequent in M.M. II. In M.M. III, which was also the great age of painting, human and animal activities were freely illustrated, and the displacement of hieroglyphs by linear script, which was not suitable for seals, left an open field for pictorial development. New forms were invented for these larger pictures; flattened cylinders, oval amygdaloids and circular lentoids replaced the disks and prisms. Many of the engraved devices are known from large deposits of stamped clay sealings, which seem to have been made for official reference, at Knossos, Ayia Triada and Zakros. Those from Zakros are largely fantastic or comic in character, with figures or faces of imps and bogies. They may be related to a class of amuletic gems which were engraved with summary representations of sacred horns and branches, gabled doorways or similar structures. Gold and silver stamp seals were replaced in M.M. III and later by ring signets with large bezels of amygdaloid shape. Most of those that have been found belong to L.M. I and were engraved with elaborate cult scenes. The lentoid stone tended to displace the amygdaloid in this period and the next, apparently because its circular field invited the contorted attitudes in which the Minoan artist liked to pose his living subjects. These are the common motives of L.M. III gems: cows suckling calves, lions or men struggling with bulls or animals writhing by themselves. A few cylinder seals which belonged to the end of this last period were probably Mycenaean innovations, for the oriental roll cylinder, like the Egyptian scarab, was a form that the Minoans had known and rejected.

14. Scripts.—The hieroglyphic script, which appears first on M.M. I seal stones, is Egyptian in character and contains a few Egyptian signs, but seems to be otherwise an independent system. Most of the signs are summary representations of common objects, human figures and limbs, animals, birds, insects, tools, weapons and the like. They have not been interpreted. A clay disk impressed on both sides with pictographic signs in spiral sequence was found in an M.M. III context at Phaistos, but this is generally believed to be from Asia Minor. The Minoan hieroglyphs were incised on clay bars and labels in M.M. II as well as being cut on seal stones. This development was completed in M.M. III, when a linear script appears on small rectangular clay tablets and round labels. This was incised with a sharp point; it was also written in ink and cut in stone. About a third of the known characters are derivatives from the hieroglyphs. This script, now known as Linear A, was in general use, but comparatively few tablets have been found. Most of them (about 150) come from Ayia Triada and about 10 from Knossos. The duration of the A script has not been everywhere determined, but it was superseded at Knossos in L.M. II by the Linear B script. This is similarly incised on thin clay tablets, which have been found in large numbers (nearly 2,000) in the palace but not elsewhere in Crete. Determinative signs which accompany the texts, representing men, women, horses, chariots, weapons and other commodities, and numerical notations indicate that the documents were mostly inventories. Script B is evidently an enlargement of A and about half the known characters of A are found in B. Both scripts are syllabic. When these tablets were excavated at Knossos no similar documents were known in mainland Greece, but after 1939 more than 1,000 had been found at Pylos and Mycenae in chronological contexts which are not earlier than the end of the 13th century (L.M. IIIb). The recognition of verbal inflections in B which are not found in A points to a difference of language, and that of the B (Mycenaean) texts has been identified as Greek. It is surprising to find the Greek language in Crete so early as the end of the 15th century, but it would be surprising not to find it on the mainland so late as the end of the 13th. Interpretation of the texts is not a straightforward process. The script comprises some 90 syllabic characters and 120 ideograms. The characters are first transcribed into alphabetic syllables in accordance with a generally but not wholly accepted scheme of phonetic values. The syllables are next combined in actual or possible Greek words, which are separated in the texts by interpuncts. The words are finally translated in contexts which are often indicated by ideograms and numerical notations. Results so far produced are therefore cautiously received by scholars who appreciate the hazards of phonetic and philological equations. No progress has yet been made in the interpretation of Script A. As current records and not archives the Linear B documents may be expected to belong to the latest years of the buildings in which they were found. But there were two destructions of the last palace at Knossos, at the beginning and the end of L.M. III respectively. Some of the tablets were associated there with the earlier occupation, but

others, particularly in the western magazines were recognized as having fallen from upper floors, and could not be dated stratigraphically. These may have belonged to the regular, if partial, reoccupation which is indicated by the shrine of the dove goddess and other late structural elements. The Minoan language has not been determined, but place names and certain groups of words in the later Greek vocabulary suggest connections with Asia Minor. Six inscriptions on stone in Greek letters and an unknown language, found at Praisos, and one from Dreros (near Neapolis), would seem to record the survival of the native speech in eastern Crete in the 5th and 4th centuries. *See* MINOAN LINEAR SCRIPTS.

15. Later Periods.—The two or three centuries which followed the destruction of Mycenaean culture in Greece are marked in Crete by evident loss of population and desertion of urban sites, particularly of coastal towns. Settlements and several shrines furnished with terra-cotta images have been found in Lasithi and other mountain districts, where re-used Mycenaean tombs contain the pottery with linear decoration which is known as Protogeometric, together with fibulae and iron weapons. The funeral rite was commonly cremation. In the period which is known from the character of its ceramic decoration as Geometric, the archaeology of Crete presents no distinctive features. But toward the end of that time the island took a prominent place in the renewal of contacts with Magna Graecia and Asia Minor. The population was replenished, probably by immigrants from Greece, and several large cities were founded in the west. This move explains the displacement of the cave of Dicte by that of Ida as the principal religious sanctuary. Among the offerings deposited there was a series of bronze shields and disks embossed and engraved with designs of oriental character but apparently of local technique. These are generally dated to the 8th century. Statuettes made of bronze plates hammered over a wooden core have been found in a Geometric temple at Dreros. A later temple at Prinias in central Crete was decorated with stone reliefs and figures in the round which belong to the 7th century, and statues of the same style found in mainland Greece were evidently derived from Crete.

III. HISTORY

1. Ancient History.—In historical times nothing remained of the Minoan civilization except a tradition that the first thalassocracy or sea power was that of a Cretan king Minos (*q.v.*). The island played no part in Greek history commensurate with its size. It was not involved in the Greco-Persian or Peloponnesian Wars.

It is mentioned in the *Odyssey* of Homer with respect as the island of a hundred cities, and with some curiosity in regard to its inhabitants, who are enumerated as Dorians, Achaeans, Pelasgians (*qq.v.*), Cydonians and Eteocretans. The general sense of these statements is clear and they were doubtless true in the poet's time (8th or 7th century B.C.). The dominant element in the population was then and later Dorian, but there is no archaeological or historical evidence for the time or manner of their arrival. Later Greek interest was attracted by the political and social constitution of the Cretans, who seemed to be more Spartan than the Spartans. As in Laconia, the people were distinguished as full citizens, unprivileged citizens, serfs and slaves. The full citizens were the Dorians, the unprivileged apparently the Achaeans and the serfs the Eteocretans or Minoans. The great inscription of Gortyna (*q.v.*) defines these classes. The system of communal life and military education were similar to those of Sparta.

Hellenic building styles appear in houses and temples in the 8th century, and revival of the coastal towns and maritime commerce was followed by the reception of Oriental influences which gave Crete for a time the foremost place in artistic progress. This was the time of the famous hundred cities, which were well equipped with temples, agoras and civil buildings. Elaborate polychrome pottery, embossed metalwork and monumental statutes of stone and hammered bronze were produced and exported abundantly. There were the works which formed the earliest archaic arts of Greece and were later attributed to the legendary master craftsman Daedalus (*q.v.*). But as in Minoan times, Crete having led the way was displaced by the greater resources of the mainland. It may be that the Dorian constitution which attracted Greek philosophers and historians did not encourage artistic and commercial progress. In historical times the strongly fortified cities were largely engaged in attacking one another, perhaps because of the confederacies which Cretans favoured and of which the most powerful states, Knossos, Lyttos or Gortyna, from time to time disputed the leadership. A consequence of these rivalries was that as Cretan men sought employment abroad as archers or other mercenary soldiers, the cities contracted short-lived alliances with dominant Hellenistic powers, and became notorious as providers of formidable corsairs. It was this proclivity which brought the island ultimately into disastrous collision with Rome. A final ill-advised alliance of the confederacy with Mithradates VI Eupator of Pontus was followed after his defeat by the invasion of Quintus Caecilius Metellus Creticus, and Crete was annexed by the Romans in 67 B.C. The Italian excavations at Gortyna, the administrative capital, revealed a model Roman city, with its conventional provision of temples and civic buildings, circus, amphitheatre and baths. As a favoured province securing the seaways to Syria, Egypt and Cyrene, Crete enjoyed a long period of unbroken peace and prosperity, until the beginning of Arab attacks on the southern borders of the Byzantine empire.

(E. J. F.)

2. Medieval Period.—In A.D. 826 Crete fell into the hands of Arabs exiled from Spain. Thereafter it became a formidable nest of pirates and a great slave mart; it defied all the efforts of the Byzantine sovereigns to recover it till 960, when it was reconquered by Nicephorus II Phocas. After the capture of Constantinople during the fourth crusade by the Latins in 1204, Crete was allotted to Boniface, marquis of Montferrat, but was sold by him to the Venetians, to whom it continued subject for more than four centuries.

Under the Venetian government Candia (Iraklion, *q.v.*), a fortress originally built by the Arabs, and called by them Khandax, became the seat of government and capital of the island, to which it gave its name. The Venetian administration secured the island external tranquillity, and did much to provide material prosperity and encourage commerce and industry; under it Crete was probably more prosperous than at any other time. But the system was arbitrary and oppressive, and gave rise to many insurrections. Comte Pierre Antoine Daru in his *Histoire de Venise* (1819) mentions 14 between the years 1207 and 1365, the most important being that of 1361–64, when the Venetian colonists rose against the republic. Disappointed in the hope of a Genoese occupation, the Cretans turned to the Turks.

3. Turkish Domination.—The Turks made no serious attempt to conquer the island until 1645; but in that year they landed an army of 50,000 men and soon reduced Canea. Rethimnon fell the following year, and in 1648 the Turks laid siege to Candia. After a siege of more than 20 years the city surrendered in Sept. 1669, and its fall was followed by the submission of the island. Venice was allowed to retain possession of Grabusa (Cape Vouxa), Suda (Soudha) and Spinalonga on the north, but in 1692 Grabusa, and in 1715 the other two strongholds fell to the Turks, and the island was finally lost to Venice.

Under Ottoman rule many of the Cretans embraced Islam, and thus secured the chief share in the administration of the island. But this did not benefit the population, and in 1837 Crete was considered the worst governed province of the Turkish empire. In 1770 an abortive attempt at revolt, the hero of which was "Master" John, a Sfakiot chief, was repressed with great cruelty. In 1813 the ruthless severity of the governor general, Haji Osman, who obtained the co-operation of the Christians, broke the power of the janizaries; but after Osman had fallen a victim to the suspicions of the sultan, Crete again came under their control. When in 1821 the revolution broke out in continental Greece, the Cretans headed by the Sfakiots, revolted and occupied all the open country, while the Turks and Muslims took refuge in the fortified cities. The island was reduced to submission in 1824 by Mohammed Ali pasha of Egypt, whose help the sultan had asked. The allied powers (France, Great Britain and Russia) decided that Crete

hould not be included among the islands annexed to the kingdom f Greece; but obtained from the Turkish sultan Mahmud II its ession to Egypt, which was confirmed by a firman of Dec. 20, 832. This change of masters brought some relief to the Cretans; he enlightened government (1832–52) of Mustafa Pasha, an Albanian like Mohammed Ali, who encouraged agriculture, im- roved the roads, introduced an Albanian police and put down rigandage, has been called the "golden age" of Crete.

In 1840 Crete was taken from Mohammed Ali and replaced nder the dominion of the Turks, but Mustafa retained his gov- rnorship until appointed grand vizier in 1852. In Feb. 1856 an nsurrection broke out as a result of the violation of the provisions f an imperial decree whereby liberty of conscience and equal ights and privileges with Muslims had been conferred upon Chris- ians. The promised concessions were confirmed in July 1858, but gain repudiated. A petition to the sultan in 1864 elicited only n injunction to obedience. A general insurrection which broke ut in 1866 was put down with great severity, but the organic tatute granted by the sultan in 1868 brought some reforms and kind of constitutional government.

Constitutional Experiments.—Under this instrument which was fterward proposed, under article xxiii of the treaty, at the Con- ress of Berlin (*q.v.*), as a basis for reforms in other parts of the)ttoman empire, various privileges already acquired by the Chris- ian population were confirmed; a representative general council vas brought into existence, composed of deputies from every dis- rict; mixed tribunals were introduced, together with a highly laborate administrative system, under which all the more impor- ant functionaries, Christian and Muslim, were provided with an ssessor of the opposite creed. The new constitution, however, roved costly and unworkable, and failed to satisfy either section f the population. In 1878 the Greek government, finding Hellenic spirations ignored by the treaty of San Stefano, gave the signal for gitation in the island. An insurrection followed, accompanied by arbarities on both sides. Eventually the Cretan chiefs invoked he mediation of Great Britain, which Turkey, exhausted by its truggle with Russia, accepted, and the pact of Halepa was drawn p in 1878 under the auspices of the British consul and Adossides asha, both of whom enjoyed the confidence of the Cretan popula- ion. The privileges conferred by the organic statute were con- rmed; the judicial and administrative systems maintained; the udges were declared independent of the executive, and an assem- ly composed of 49 Christians and 31 Muslim deputies took the lace of the former general council. The ensuing party govern- ent was a mere scramble for office and its rewards. In 1889 a risis occurred, when the "conservative" leaders, finding them- elves in a minority, took up arms and withdrew to the mountains. he latent fanaticism of both creeds was aroused, and the island gain became a scene of devastation. The Porte seized the oc- asion to proclaim martial law and abrogate many important provi- ions of the Halepa pact. The Christians boycotted the elections nder the new system, and for the next five years Crete was overned by a succession of Muslim valis; the deficit in the budget ncreased, the *gendarmerie*, which received no pay, became in- ubordinate, and crime multiplied. In 1894 the Porte, at the in- tance of the powers, nominated a Christian, Karatheodory Pasha, o the governorship, and the Christians agreed to take part in the ssembly which soon afterward was convoked; no steps, however, ere taken to remedy the financial situation. The refusal of the orte to refund considerable sums illegally diverted from the retan treasury, or even to sanction a loan to meet immediate equirements, caused great exasperation, which was increased by he recall of Karatheodory (March 1895). Before that event an *pitrope*, or "committee of reform," had appeared in the moun- ains. The *Epitrope* was at first nothing more than a handful of iscontented politicians, but its membership swelled rapidly, and n April 1896 it invested the garrison town of Vamos. Civil war egan. Serious disturbances broke out at Canea (Khania) on lay 24 and were only quelled by the arrival of foreign warships. espite the intervention of the foreign consuls, the sultan pro- eeded to crush the rising by force. The resulting devastation, nd the excitement it aroused in Greece, quickened the energies of the powers. Austria proposed an international blockade of the island, but Great Britain rejected this. At the representations of the powers, the sultan restored the pact of Halepa, the troops were withdrawn from the interior, financial aid was promised, a Christian governor general was appointed, the assembly was summoned and an imperial commissioner was dispatched to negotiate an arrangement. The Christian leaders proposed a moderate scheme of reforms, based on the Halepa pact, which, with a few exceptions, was approved by the powers and eventually sanctioned by the sultan.

Revolt of 1897.—On Sept. 4, 1896, the assembly formally accepted the new constitution and declared its gratitude to the powers. The Muslim leaders acquiesced in the arrangement, which the powers undertook to guarantee. It soon became evident, however, that the Porte was endeavouring to obstruct the execution of the reforms. The indignation of the Christians increased, a state of insecurity prevailed and the Muslim peasants refused to return to their homes. Hitherto the Greek government had loyally co-operated with the powers in their Cretan policy, but toward the close of the year a secret society known as the *Ethnike Etaireia* began to arrogate to itself the direction of Greek foreign policy. Its aim was war with Turkey with a view to the acquisition of Macedonia, and it found ready allies in the Cretan Christians. Emissaries of the society appeared in Crete, large consignments of arms were landed and at the beginning of 1897 the island was practically in a state of insurrection. On Jan. 21 the Greek fleet was mobilized. A series of conflicts took place at Canea on Feb. 4; the Turkish troops fired on the Christians, a conflagration broke out in the town and thousands of Christians took refuge on the foreign warships. The Greek government now dispatched an ironclad and a cruiser to Canea, which were followed a few days later by a torpedo flotilla commanded by Prince George. The prince soon retired to Melos, but on the night of Feb. 4 a Greek force landed at Kolimbari, near Canea, and its commander, Colonel Vassos, proclaimed the occupation of the island in the name of King George. This move caused immense excitement among the Christian population, who indulged in terrible massacres of the Muslim peasantry. The powers, however, occupied Canea, and afterward Iraklion and other towns, blockaded the coast and bombarded the insurgents' position. They then presented collective notes to the Turkish and Greek governments announcing their decision that: (1) Crete could in no case in present circumstances be annexed to Greece; (2) in view of the delays caused by Turkey in the application of the reforms Crete should be endowed with an effective autonomous administration under the suzerainty of the sultan. Cretan autonomy was proclaimed March 20, the Greek force left on May 9 and the insurgent assembly, under its president, Ioannis Sphakianakis, co-operated with the international commanders to maintain order. After Germany and Austria had withdrawn from the European concert (April 1898) the remaining powers divided the island into four departments, which they severally undertook to administer. The last Turkish soldiers left the island on Nov. 14, 1898.

4. Union With Greece.—On Nov. 26 the powers nominated Prince George of Greece as high commissioner for three years. He landed on Dec. 21. Order prevailed, but the Muslims, reduced to great distress by the prolonged insurrection, emigrated in large numbers. On April 27, 1899, a new autonomous constitution was voted by a constituent assembly, and in the following June, Cretan officials took over the local administration. Prince George's appointment was prolonged in 1901 and his extensive powers increased. The arbitrary methods of government awoke strong opposition, led by Eleutherios Venizelos, who had played an important part in the insurrection, but had been dismissed from his post of councillor in 1901. In March 1905 Venizelos, with the moral support of Sphakianakis, led a revolt at Theriso in the Levka Ori and proclaimed the union of the island with Greece, and this example was speedily followed by the assembly at Canea. The powers, however, reiterated their decision to maintain the *status quo*, and increased their military and naval forces; the Greek flag was hauled down at Canea and Iraklion, and some desultory engagements with the insurgents took place, the international troops

co-operating with the local *gendarmerie*. In the autumn Venizelos and his followers, having obtained an amnesty, laid down their arms. On July 25, 1906, the powers announced a series of reforms, including the reorganization of the *gendarmerie* and militia under Greek officers as a preliminary to the eventual withdrawal of the international troops, and the extension to Crete of the system of financial control established in Greece. On Sept. 25 Prince George left the island. His successor, Alexandros Zaïmis, a former and later prime minister of Greece, arrived in Crete on Oct. 1.

On Feb. 22, 1907, Zaïmis, as high commissioner, took the oath to the new constitution elaborated by the national assembly. His position was one of singular difficulty. Apart from the rivalry of the factions within the assembly, there was the question of the Muslim minority, reduced to 40,000 but still a force to be reckoned with. Zaïmis showed great skill and studied impartiality, and his administration was a marked success. Order was restored, and, Zaïmis having called the attention of the powers to the fact that the conditions they had laid down as preliminary to evacuation—(1) the organization of a local *gendarmerie;* (2) the maintenance of the tranquillity of the island; (3) the complete security of the Muslim population—had now been fulfilled, the powers informed him on May 11, 1908, of their intention to begin the evacuation at once and complete it within a year. The first withdrawal of the troops (July 27), hailed joyfully by the Cretan Christians, led to rioting by the Muslims, who believed themselves abandoned to their fate.

Meanwhile Zaïmis had made a further advance toward the annexation of the island to Greece by a visit to Athens, where he arranged for a loan with the Greek National bank and engaged Greek officers for the new *gendarmerie*. The issue was precipitated by news of the revolution in Turkey. On Oct. 12 the Cretan assembly once more voted the union with Greece, and, in the absence of Zaïmis, elected a committee of five to govern the island in the name of the king of Greece.

On July 26, 1909, the powers withdrew their remaining troops. The Cretans hoisted a Greek flag; the Turkish government adopted a minatory tone to Greece, and the powers cut down the offending flagstaff; war was postponed, but the humiliation was not forgotten. On Oct. 14, 1912, the eve of the First Balkan War, Venizelos, then Greek premier, admitted the Cretan deputies to the Greek chamber; Stefanos Dragoumis was sent to Crete as general administrator. Article 4 of the treaty of London (1913) ceded Crete to Greece. After that time its history was merged in that of Greece (*q.v.*).

The island still from time to time, however, played a separate part on the international stage. It was on Crete that in March 1935 Venizelos, then in voluntary exile from Athens, put himself at the head of the abortive revolution which sought in vain to frustrate the restoration of the Greek monarchy. It was to Crete that the Greek king George II and his government retired, with their British allies, after German forces had overrun mainland Greece in April 1941. With a view to establishing a legitimate government on Greek soil, the king then appointed a Cretan, Emmanuel Tsouderos, as prime minister as well as a Cretan minister of war; but barely a month later German air-borne troops captured Crete, and the king and government with most of the British forces retreated from Crete to Egypt. (*See* WORLD WAR II: *The Balkan Campaigns.*) Resistance to German occupation on the island never entirely lapsed between 1941 and 1945. But the resistance movement never reached the same scale or violence as on the mainland, partly because the Greek communists found less fertile soil in Crete for their revolutionary activities, and partly because a high proportion of Cretans of military age, who had formed the Cretan division in the mainland army, were unable to return to the island during the remaining years of the war. Liberation came to Crete only with the final surrender of Germany in May 1945, though most of the countryside had already long passed out of German control. (J. D. B.; W. M.; C. M. We.)

IV. POPULATION AND ADMINISTRATION

At the Turkish conquest (see *History* above) part of the population was converted to Islam, though the Cretan Muslims retained their Greek surnames and speech. During the Greek War of Independence (1821–28) Crete, which had risen together with the Greeks of the other islands and mainland, was occupied by Egyptian troops sent at the request of the sultan by his vassal Mohammed Ali. The population, which under Venetian rule was estimated at about 260,000, became greatly depleted during the years of war and was estimated in 1836 at about 130,000. In the following years it increased again and, according to a census taken by the Turkish authorities in 1881, reached the figure of 279,165, of whom 205,010 were Orthodox Greek Christians, 73,234 Muslims and 921 of other denominations. The Muslim element predominated in the principal towns, of which the population was: Candia (Iraklion *q.v.*) 21,368, Khania (Canea *q.v.*) 13,812, Rethimnon 9,274. In June 1900, after Crete had become autonomous, a fresh census registered the population at 301,273, the Christians having increased to 267,266 while the Muslims through wholesale emigration had fallen to 33,281. In 1923, after the Greco-Turkish War of 1919–22, the remaining Muslim population emigrated under the Lausanne convention for the exchange of populations between Greece and Turkey, which made emigration compulsory for all except the Orthodox Christian inhabitants of Constantinople and the Muslim inhabitants of Western Thrace. The place of the Cretan Muslims was taken by Greek refugees from Asia Minor, also exchanged under the convention.

Departments (Nomoi) *With Their Capitals and 1961 Populations*

Nomoi	Area (sq. mi.)	Pop.	Capital	Pop.
Iraklion	1,025	207,437	Iraklion (Candia)	64,492
Lasithion (Lasithi)	698	73,843	Ayios Nikolaos	3,167*
Rethymnon (Rethimni)	570	69,483	Rethymnon (Rethimnon)	11,057*
Canea (Khania)	925	130,898	Canea (Khania)	38,268

*1951.

At the census of 1928, the population of Crete was returned at 386,427 and at that of 1961 at 482,021.

The Cretan is hospitable, frank and full of engaging vitality, though he is given to violence. The vendetta survives in many parts of the island. In ancient times the people had a bad reputation as is shown by the poet's appraisal: "The Cretans are always liars, evil beasts, slow bellies," which St. Paul quoted to St. Titus (first bishop of Crete). Between King Minos and Premier Venizelos there have been few celebrated names in its history, but that of El Greco (Domenico Theatocopuli, 1541–1614), the great painter, should not be forgotten; and the author of the long epic poem *Erotokritos* (probably Vicenzo Kornaros or Cornaro, in the 17th century) deserves also to be recorded.

After the incorporation of Crete in the Greek kingdom, the island became a Greek province administered by a governor general. The old departmental divisions were retained. There are today four departments (*Nomoi*), Canea, Iraklion, Rethymnon and Lasithion, each governed by a prefect (*Nomarch*). The provinces are subdivided into 546 municipalities and communes for local government purposes, each with a mayor and municipal or communal council elected by universal suffrage. These councils, as in continental Greece, enjoy limited powers of taxation. In 1953 the post of governor general was suppressed, the administration remaining exclusively in the hands of the prefects who came directly under the minister of the interior in Athens. Crete sends 18 deputies to the Greek parliament. (A. A. Pa.)

V. THE ECONOMY

1. Agriculture.—Agriculture is the mainstay of the economy of Crete and provides five times as much employment as industry mining and transport combined.

Such is the rocky and barren nature of much of the island that only about 13% of its surface (not counting those parts given over to orchards and olive groves) is cultivated—an even lower proportion than in mainland Greece—and many of the fields are only small stoney terraces, laboriously reclaimed from the hill sides. Cereals form the staple of the Cretan diet and about half of the cultivated land is devoted to them. By contrast with mainland Greece, Crete grows more barley and oats than wheat, a dif

ference which is explained by the inferior quality of the soils on the island. The fertile plain of Mesara, which was one of the great granaries of the Roman empire, produces much of the island's wheat; but in addition considerable quantities have regularly to be imported.

Most of the arable land is worked in small holdings by independent proprietors who live in nearby villages. At progressively higher levels up the hill slopes are raised fruits, vines, olives, cereals and animals, and together these provide most of the necessities of life. Sheep and goats produce an important part of the standard diet, as well as wool and hair. The shepherds are semi-nomadic and each summer drive their flocks to the high mountain pastures. This system of farming is essentially for local subsistences and in it the cultivation of the cash crops of tobacco and cotton, which are important on the Greek mainland, plays virtually no part. There is, however, some commercial cultivation of olives, of grapes and of oranges. The olive, which is the only possible crop over many hilly tracts, is of great importance, and Crete accounts for more than a third of the total olive production of Greece. Cretan wines and sultanas are famous for their high quality and Crete alone in Greece produces raisins. There is a regular export of these commodities, as well as of olive oil, for the most part to the Greek mainland. The oranges and mandarins of Crete, also of high quality, come mainly from the district of Canea. The only other important agricultural export is the carob, of which Crete produces about nine-tenths of the Greek crop, mainly for sending to France.

2. Mining and Industry.—Although in past times Crete produced a range of minerals, its present output, except for limestone, gypsum and other quarry stones, is negligible. The deposits of copper, lignite, iron, chrome, lead and zinc are now small, of poor quality and remote.

The industries of Crete are on a small scale and mainly concerned with the processing of foodstuffs; for example, milling, olive crushing and the drying of grapes. Soap from the olive residue is made at Iraklion, Canea and Rethymnon, and some is exported. Iraklion and Canea have some small tanneries, textile mills and steel foundries for making farming tools. Cottage industries, notably weaving, embroidery and wood carving, are common, but not organized.

3. Communications.—Crete has no railways, except for some short mineral lines. There is one main metaled road, of indifferent quality, the length of the north coast and four branch roads, often impassable in winter, to the south coast at Palaiokhora, Khora Sfakion, Timbakion and Serapetra.

See also references under "Crete" in the Index volume.

(Wm. C. B.)

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CRETINISM is a condition resulting from the failure of the thyroid gland to secrete its hormone from the time of intrauterine life or very early infancy. The absence of thyroid hormone during this critical period leads to a characteristic failure of growth and development and a serious mental deficiency.

Cretinism can seldom be diagnosed before the age of three months. Its earliest manifestations—sluggishness, a heavy expression and piglike appearance of the eyes and a yellowish tint of the cheeks—are difficult to detect. As time passes, however, the fullblown syndrome, including many of the characteristic signs of adult myxedema (hypothyroidism), becomes clearly recognizable. The face is so typical that all cretins closely resemble each other. It is round and yellowish with a wide, flat, thick nose, thick lips and enlarged, often protruding tongue with associated drooling. The voice sounds deep and harsh. The skin is dry and thickened with sparse, dry, brittle hair. Growth is markedly retarded, the resulting dwarfism being characterized by disproportionately short extremities. The belly protrudes and umbilical hernias are not unusual. Dentition is retarded. Sexual maturation is held in abeyance. Hearing is impaired. Walking and talking are not undertaken at the usual age and mental growth is very slow. Imbecility is the rule in the untreated adult cretin. The general health of the untreated cretin is poor, and death has often occurred during early adult life from intercurrent ailments.

In areas in which endemic goitres prevail, endemic cretinism is also observed. It is the general opinion that these endemics are due to the lack of sufficient iodine in the drinking water and food. Iodine is an integral part of the thyroid hormone. When faced with chronic iodine deprivation and a resulting difficulty in synthesizing hormone in sufficient quantity, the gland enlarges; a goitre develops, and in some cases hypothyroidism ensues. Endemic cretinism only occurs when the parents have endemic goitres. The thyroid gland in endemic cretinism is incapable of secreting hormone; a goitre is usually present, but atrophic glands have also been observed. Sporadic cretinism occurs in non-goitrous regions in the children of normal parents. It is thus an unexpected but relatively rare disorder. The thyroid gland is usually atrophic or absent. The cause or causes are unknown.

The diagnosis of cretinism when it is fully developed is not particularly difficult. The problem of differentiating it from Mongolian idiocy has been frequently emphasized; although there may be some superficial similarities, any confusion in diagnosis should be resolved in relatively short order. The Mongolian idiot does not exhibit sluggishness, retarded growth and sexual development nor the classical signs of myxedema, such as thickened dry skin. Furthermore the basic defects of the Mongolian idiot are not corrected by treatment with thyroid extract.

It is imperative that the diagnosis of cretinism be made very early. The longer the organism as a whole is deprived of thyroid hormone the more irreversible become the defects of cretinism. If treatment is begun at three to six months of age, the child will probably develop in a normal fashion with no detectable residual. However, the longer the deficiency is untreated after this age the greater the likelihood of incomplete recovery. This is particularly true with respect to the nervous system. When treatment is not begun until late childhood some general improvement may be noted, but the imbecility persists. In some cretins the late introduction of therapy produces an unmanageable state of hyperirritability, and the patient is best managed by discontinuing this specific treatment. Treatment is with desiccated thyroid extract administered orally. The daily dosage varies with the age and size of the child, but in general the maximum nontoxic dose is given. It must be continued for the remainder of the patient's life. If it

is discontinued hypothyroidism develops. *See* also Endocrinology; Hormones, Vertebrate; Myxedema.

See S. C. Werner (ed.), *Thyroid; a Fundamental and Clinical Text* (1955). (R. L. L.)

CRETONNE, the name of a class of printed cotton fabrics used chiefly for furniture upholstery, hangings, window drapery, and other household purposes. The finer and lighter textures of cretonnes are also made into smocks and other garments for women and children. The name is said to be derived from Creton, a village in Normandy where linen was made.

CREUSE, a *département* of central France, comprising most of the ancient province of Marche (*q.v.*). Pop. (1962) 163,515. Area 2,165 sq.mi. Bounded north by Indre and Cher, east by Allier and Puy-de-Dôme, south by Corrèze and west by Haute-Vienne, it is situated in the northwestern part of the Massif Central and is comprised mostly of granite and other ancient crystalline rocks which form plateau country, inclined northward from the highest tracts in the south where the altitude exceeds 3,000 ft. Most of the *département* lies in the upper basin of the Creuse river, but portions of the westward drainage to the upper Vienne and the northeastward drainage to the upper Cher are included. The poor, acid and often badly drained soil and a chilly, wet climate limit farming. The arable area, as well as the moorland, has been reduced in favour of improved grasslands, and on the remaining arable land in the valleys poor grain crops have tended to be replaced by fodder crops. Farming has become increasingly pastoral and concerned with the rearing of livestock, especially cattle. There are a small coal field at Ahun and some scattered, unimportant ore workings. Some old established textile and leather industries survive; Aubusson is noted for its carpets, and Bourganeuf its porcelain industry. But the *département* is a rural backwater, off main railways and roads, and Guéret and Aubusson (*qq.v.*), the centres of the two *arrondissements* that constitute the *département,* are the only towns with more than 5,000 inhabitants. Guéret is the capital of the *département* which, with Haute-Vienne, forms the diocese of Limoges. The court of appeal is also at Limoges. Creuse forms part of the educational division (*académie*) of Clermont. (Ar. E. S.)

CREUSOT, LE: *see* Le Creusot.

CREUTZ, GUSTAV PHILIP, Count (1731–1785), Swedish poet, whose mastery of formal elegance reflected a sophisticated Epicureanism and greatly influenced Swedish poetic style, was born in May 1731, at Anjala, a family estate in Finland. In 1751 he went to Stockholm. Creutz and a young friend of his with literary ambitions, Count Gyllenborg, became closely associated with an already well-known poet, Hedvig Charlotta Nordenflycht; some of their works were published together. From 1756 Creutz held a post at court, and he was sent to Madrid as ambassador in 1763, and to Paris in 1766. Gustavus III recalled him in 1783 and heaped honours upon him. Creutz died at Stockholm on Oct. 30, 1785.

Creutz's literary output is slight; in 1763 he practically closed his career as a poet. His unusually musical diction and his striving for correctness in metre and style made him outstanding as an innovator in Swedish poetic diction. His masterpiece is *Atis och Camilla* (published 1762), a pastoral epic, for long the most admired poem in the Swedish language.

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CREVASSE, a fissure in a glacier, may be transverse or longitudinal, brought about by tension due to unequal rates of movement, the central part generally moving faster than the margins, and (or) movement over an uneven surface. Irregular pinnacles of ice between crevasses of great magnitude on steep slopes are known as *séracs* (*see* Glacier).

The word crevasse is also applied to wide cracks in the raised banks of rivers and canals.

CRÈVECOEUR, MICHEL GUILLAUME JEAN DE (1735–1813), French-American author known as St. John de Crèvecoeur and, especially in America, as J. Hector St. John and the "American Farmer." Born Jan. 31, 1735, at Caen, Normandy, after studying in Jesuit schools and spending four years as an officer and map maker with Montcalm in Canada, he chose in 1759 to remain in the new world. He wandered in the Ohio and Great Lakes region, took out citizenship papers in New York in 1765, became a farmer in Orange county, and married Mehitable Tippet in 1769, by whom he had three children.

When the American Revolution broke out Crèvecoeur, the peaceful, contented farmer, found himself in an untenable position because his wife was from a Loyalist family and he had friends and neighbours among the opposite faction. Persecuted by both sides, he left rebel country only to languish for months in an English army prison in New York city before sailing for Europe in 1780, accompanied by one son. In London, using his American name of J. Hector St. John, he arranged for the publication in 1782 of twelve essays called *Letters From an American Farmer.*

Within two years this book, charmingly written, optimistic and timely, went through eight editions in five countries and immediately made its author famous, gaining him influential patrons such as Buffon, Franklin and Mme D'Houdetot, a membership in the Academy of Sciences, and an appointment as consul to three of the new states in America. Before assuming his duties in 1784, Crèvecoeur translated and added to the original twelve essays, and in that year his two-volume *Lettres d'un Cultivateur Américain* was published in Paris.

In America again, Crèvecoeur found his home burned, his wife dead and his daughter and second son with strangers in Boston. Reunited with his children, he set about organizing a packet service between the United States and France, continued an interest in botany and published articles on agriculture and medicine. A two-year furlough in Europe resulted in a larger, second edition of the *French Letters,* in three volumes in 1787. Recalled from his consulship in 1790, Crèvecoeur wrote one other book on America, published in 1801 in three volumes as *Le Voyage dans la Haute Pensylvanie et dans l'État de New York.* He lived quietly in France and Germany until his death in 1813.

Because of his letters, Crèvecoeur was not only for a while the most widely read commentator on America, but also a great favourite with romanticists like Lamb and Campbell and with revolutionists like Brissot. His stature was further increased in the 1920s when a bundle of his unpublished English essays was discovered in an attic in France. These were brought out in 1925 as *Sketches of Eighteenth Century America, or More Letters From an American Farmer.* Crèvecoeur's books outline the steps through which new immigrants passed, analyze the religious problems of the new world, describe the life of the whalers of Nantucket, reveal much about the Indians and the horrors of the Revolution, and present the colonial farmer—his psychology and his daily existence—more completely than any contemporaneous writings were able to do it. The passage containing his "melting pot" theory and answering the question "What is an American?" is widely quoted, and historians of the frontier depend heavily on his documented account of the stages by which the log cabin became the opulent farmhouse. For the lover of literature Crèvecoeur provides natural history essays like those of Thoreau, descriptions of nature, Indian legends, poignant tales of the Revolution and melancholy, sentimental stories of slavery and the disappearance of the red men. His charming style, keen eye and simple philosophy are universally admired.

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CREWE, ROBERT OFFLEY ASHBURTON CREWE-MILNES, 1st Marquess of (1858–1945), British statesman, chiefly remembered for his part in securing the passage of the Parliament act of 1911, was born in London on Jan. 12, 1858, the only son of the 1st Baron Houghton (*q.v.*), and was educated at Harrow and at Trinity college, Cambridge. He was brought up in the best Liberal traditions, in the society of the

ost interesting people of the time. He soon developed a wide terest in European literatures, and like his father wrote occa- onal verses (publishing *Stray Verses* in 1891), which he regarded th a modesty never shown by his more flamboyant parent. ilnes was also unlike his father in his love for the English coun- yside and its traditional pursuits, especially the turf. While he is comparatively young, he had to face a series of domestic agedies: the deaths of both his parents, of his young wife in 1887 d of his only son in 1890.

Milnes became assistant private secretary to the foreign secre- ry, Lord Granville, in 1884. He entered the house of lords on s father's death in 1885. After a brief period as junior whip the house of lords, he was appointed lord lieutenant of Ireland Gladstone in 1892. The appointment was criticized on the ounds of his youth, but in Ireland he displayed his great quali- es of wisdom, tact and detachment. He left Ireland with few grets after the Liberal defeat in 1895, and was given an earldom, oosing the title Crewe because his uncle Lord Crewe had recently ed bequeathing him large family estates.

In 1899 Crewe married Lady Margaret Primrose, daughter of e former prime minister the earl of Rosebery. He held various ajor offices after the Liberal victory of 1905, notably that of lonial secretary, 1908–10, and secretary for India, 1910–15, ien he implemented the Morley-Minto Indian reforms and at- nded George V to the Delhi durbar (1911). He was also leader the house of lords from 1908. At one moment he became ill om overwork. H. H. Asquith called him "the most underrated an in England." He played a major part in the constitutional isis of 1909–11, directing Liberal strategy in the lords, and han- ing relations with the crown; together with Asquith he was the tt of the most virulent Tory abuse. Crewe, who had been made marquess in 1911, remained in the cabinet until 1916, when resigned with Asquith. He held office once more, in Ramsay acDonald's short coalition of 1931.

In 1922 Crewe wanted to retire, because of the tragic death his only son by his second marriage, but the foreign secretary ord Curzon persuaded him to become ambassador in Paris, and such he strengthened the entente at a period of acute strain Anglo-French relations. On his return to London in 1928, ewe gradually withdrew from public life, although he was still beral leader in the house of lords. He occupied his leisure in erary pursuits, and wrote his *Life of Rosebery* (1931). He died his home in Surrey on June 20, 1945.

Crewe inspired general respect by his keen intelligence, wide dture and singular absence of prejudice. In his lifetime he was en called "the last of the great English gentlemen," but more an this he was a striking example of a great landowner whose litical motives were invariably disinterested, and who calmly al consistently upheld political convictions regarded as danger- sly radical by his own class.

See James Pope-Hennessy, *Lord Crewe* (1955). (J. P.-H.)

CREWE, a municipal borough (incorporated 1877) of Cheshi, Eng., is 24 mi. E.S.E. of Chester. Pop. (1961) 53,394. The wn, built on the old Oak farm estate in the parish of Monks ppenhall, took its name from Crewe hall, seat of Lord Crewe. w one of the main railway junctions of England, it was created the 19th century by its situation on a nodal point for lines from ndon, Manchester, north Wales and Holyhead, north Stafford- re and Hereford. The site was selected by the former London al North-Western railway for its workshops and marshaling rd. The modern town, still mainly dependent on the railway dustry, is inhabited chiefly by railway employees.

CRIBBAGE, a game of cards in which the object is to form unting combinations that usually are scored by moving pegs a special cribbage board, the dealer scoring an extra hand, e crib, formed of discards. According to English antiquary hn Aubrey (*Brief Lives*), cribbage was invented by Sir John ckling (1609–42). It was probably an improvement of an older me, noddy, in which the game was 15 or 21 up, marked with unters or by means of a special scoring board. At cribbage, knave in the crib was formerly called "knave noddy," now cor- pted to "his nobs." Cribbage is essentially a game for two players, although it can be played by three or four. The full pack of 52 cards is used. The right to deal alternates; the loser of each game is usually first dealer in the next. Formerly each of the two players was dealt five cards, but in modern play the number is six. Nondealer cuts the balance of the pack, and dealer turns up the top card of the lower packet. This card, left face up, is the starter. If it is a knave, dealer pegs (scores) 2, called "2 for his heels."

Scoring is called pegging because it is done by moving pegs on a special scoring device, the cribbage board. This consists essentially of a tablet with 60 holes for each player, in two rows of 30. Two pegs are furnished to each player, and each increment to the score is marked by jumping the rearmost peg ahead of the other. Game is either 61 points (once around) or 121 points (twice around); it is a "lurch," and counts as two games for the winner, if his opponent has scored fewer than 31 or 61 points, respectively. Scores must be pegged in order, and the final point of a game is marked by pegging into an extra game hole at the head end of the board. By custom the pegs are moved away from the game hole on the outer rows and back on the inner rows.

The hands dealt, but before the starter is turned, each player lays away two cards, the four cards together forming the crib, which belongs to the dealer. Nondealer leads any card, and cards are played alternately except as noted below. They are not gathered in tricks; each player retains his own cards in a pile before himself. As each card is played, the owner announces the new total of pips on this card together with others previously played. The ace counts 1, while king, queen, knave and ten each count 10 (being therefore called tenth cards). The total of pips must never be carried beyond 31, and one object of play is to score a "go" by playing the last card in a series, to which the opponent cannot play without exceeding 31. Reaching exactly 31 allows the player to peg 2; winning a go on a lesser total pegs 1. When one player cannot play a card without carrying the total beyond 31, he calls "Go," and the other must add what cards he can and stay under 31. Thus it is possible for one hand to play two or three times in succession. If any cards remain in the hands after a go, the player who lost it must lead for a new series of plays.

The second object in play is to peg for certain combinations in cards played consecutively. These combinations score whether the cards were played in strict alternation, or one player showed several cards in succession following a go, but do not score if interrupted by the play of a foreign card. Pair, two cards of the same rank, pegs 2. Pair royal, three of a kind, scores 6. Double pair royal, four cards of a kind, pegs 12. Run, three or more cards in sequence (regardless of suits), pegs 1 for each card in the sequence. The cards rank: king, queen, knave, ten and so on down to the ace. The order of play within the sequence is immaterial; *e.g.*, the play of 9, 7, 8 in that order pegs 3 for run. Fifteen, bringing the total of cards played to 15, pegs 2. The score in every case is pegged by the player whose card completes the combination. Playing is followed by showing; *i.e.*, counting the value of the hands. The starter is construed to be a part of each hand and the crib, making five cards in each instance. Nondealer's hand shows first, then dealer's hand, then crib. Fifteens: each combination of two or more cards that sums to 15 counts 2. Combination is here used in the strict technical sense. Thus, a hand 8, 8, 7, 7, 7 contains $2 \times 3 = 6$ combinations that make 15, and pegs 12 therefor. Pairs: each combination of two cards that are a pair pegs 2, just as in the play. Runs: each combination of three or more cards in sequence of rank pegs 1 for each card in each sequence. Thus, K, Q, Q, J, 10 contains two runs of four cards each, plus a pair, pegging 10 therefor. Flush: four cards of the same suit in hand peg 4, or 5, if the starter also is of the same suit; four cards of crib and starter all of the same suit peg 5. His nobs: a knave in hand or crib of same suit as the starter pegs 1.

The highest possible score is made by three 5s and a knave, with the starter the fourth 5, of the same suit as the knave. It scores 16 for 15s, 12 for double pair royal and 1 for his nobs, a total of 29. No hand can make a score of 19, 25, 26 or 27.

Opportunity for skill arises in discarding and in play. Balking the adverse crib by laying away cards unlikely to make a

score is a constant necessity. Retaining cards that may be useful for pegging is also a consideration. Above all, the player must be able to calculate quickly the probabilities of improvement by the starter, when the hand suggests alternative discards. In play, the question often arises whether to play on or play off. Playing on means adding a card that may enable the opponent to score, in order to counter with a greater score; playing off is endeavouring to prevent opposing scores, even though one's own scoring be likewise hindered. The first one or two cards played by one's opponent sometimes gives a clue to those remaining in his hand.

Three-Hand Cribbage.—Each player receives five cards and lays away one, the fourth card of the crib being added from the top of the pack. The turn to play and to show moves in clockwise rotation, beginning with the player at dealer's left. A triangular cribbage board is sometimes used.

Four-Hand Cribbage.—Players cut for deal and partners, and take seats, as at whist. Each player receives five cards and lays one in the crib. Play and showing are in rotation as in the three-hand game. One partner for each side pegs its scores.

Five-Card Cribbage.—This variation, for two players, is obsolescent. In this game, nondealer scores 3 to offset the dealer's advantage. Each player has only three cards in hand, having laid away two for the crib; if these cards are of the same suit they score 3 for flush, or 4 if the starter is of the same suit. The play, and showing of the hand and crib, are otherwise as in the six-card game.

See Cavendish, *Pocket Guide to Cribbage* (1925). (G. Mh.)

CRICCIETH (Criccieth), a seaside resort town and urban district in the Caernarvon parliamentary division of Caernarvonshire, Wales, on Cardigan bay, 29 mi. S. of Caernarvon. Pop. (1961) 1,671. The castle, perched on a hill projecting into the sea, dates from about 1230 and was repaired in the time of Edward I, who granted the town a charter in 1284. In 1404 Owen Glendower (*q.v.*) captured the castle; by the 16th century it was a ruin, portions of two towers remaining. The view includes a wide sweep of Cardigan bay, backed by the Lleyn peninsula (west) and the Merionethshire hills with Harlech castle (east). Once a port for limestone and later for coal, there was also a big herring industry at Criccieth. Lloyd George, whose house, Brynawelon, is on a hill behind the town, is buried at Llanystumdwy, 2 mi. W., where there is now a Lloyd George museum.

CRICHTON, JAMES (1560?–1582), commonly called the "Admirable Crichton," was born, probably at Eliock in Dumfriesshire in 1560, the son of Robert Crichton, a lord of session (from 1560 till his death in 1582 lord advocate), and Elizabeth Stewart of the house of Beith, through whom he claimed royal descent. The traditional account of Crichton's many-sided perfections owes much to the exaggerated picture of him in Sir Thomas Urquhart's *Discovery of a Most Excellent Jewel* (1652), a book designed to show that before the Scottish nation had been loaded "with disrepute for covetousness and hypocrisy by the Presbyterians," it could produce gentlemen of the highest culture. The claims made by Urquhart are absurd; still, Crichton was a real person, and the achievements of his brief career are attested by good authority. He entered St. Andrews in 1570, became a B.A. in 1574 and went on to an M.A. in one year instead of the usual two. He may have been chosen as a companion for the young James VI; certainly, like other young Scottish scholars, he went to France to continue his education. He seems to have distinguished himself at the Collège de Navarre in Paris. A handbill printed in Venice in 1580 attributes to him excellence in every form of athletics, skill in arms and in horsemanship, a command of ten languages, an encyclopaedic knowledge of the Schoolmen and Fathers and a remarkable ability in debate on any subject proposed.

However, the first proof of Crichton's appearance on the continent is an oration which he delivered in July 1579 in the ducal palace of Genoa at an election of the senate. In Venice, where he arrived in 1580, he commended himself to Aldus Manutius (the grandson of the famous printer and himself a printer) to whom he dedicated a Latin ode. Manutius, probably the author of the handbill, brought the young Scotsman to the notice of well-known humanists, whom he greatly impressed. As was the custom, Crichton displayed his talents by holding public disputations in which, it seems, he worsted all his opponents save Giacomo Mazzoni. Two great disputations at Padua further enhanced his reputation in 1581. Manutius heard the debates; his edition of Cicero's *Paradoxa* (1581) carries a dedication to Crichton recording his success. Crichton returned to Venice and, in Feb. 1582, set out to enter the service of the duke of Mantua, to whose secretary he had been recommended by the secretary of the cardinal d'Este. He was not, as has been alleged, the tutor of the young prince Vincenzo Gonzaga, but he became a member of the duke's council and advised him on the fortification of his palace. In July 1582 he was slain in Mantua, at the instigation, and probably at the hand, of the young prince whose jealousy he had incited.

Published letters show that Crichton had his weaknesses; it seems he was constantly in debt, while certain complaints suggest that he was less robust than hitherto supposed. Yet his wide acquaintance with the philosophers, his astounding memory, knack for languages and skill in debate remain incontestable. He deserved the adjective "admirable," applied to him as early as 1603 in John Johnston's *Heroes Scotici.*

Bibliography.—P. Fraser Tytler, *The Life of Crichton,* 2nd ed. (1823); D. Crichton, *The Admirable Crichton* (1909). *See* also Sir Thomas Urquhart, *Works* (1834); J. H. Millar, *Scottish Prose in the 17th and 18th Centuries* (1912); D. Crichton, "James Crichton of Eliock," *Votiva Tabella* (1911). (Jn. D. M.)

CRICK, FRANCIS HARRY COMPTON (1916–) British biophysicist, co-winner, with M. H. F. Wilkins and J. D. Watson, of the 1962 Nobel prize for medicine for discoveries concerning the molecular structure of the nucleic acids (*q.v.*) and its significance in genetics. He was born at Northampton, Eng., on June 8, 1916, and was educated at University college, London. He gained his Ph.D. from Cambridge university in 1953 after doing scientific work with the admiralty in World War II. From 1949, except for spending 1953–54 at the Protein Structure project, Polytechnic Institute of Brooklyn, N.Y., Crick worked at the Medical Research council's unit for molecular biology, Cambridge, Eng. He became a fellow of the Royal society in 1959.

Crick's studies of the structure of deoxyribonucleic acid (DNA) began in 1952, when X-ray diffraction analysis techniques brought biophysicists into the field of biochemistry. Crick's and Watson's interpretation of Wilkins' X-ray crystallographic studies of DNA led to the elucidation of its structure as being of a double-stranded complementary, helical configuration. Crick and Watson advanced a theory of genetic continuity and mutation dependent on the pairing of specific bases, the type of genetic instructions carried by the DNA of the genes being determined by the order of arrangement of the bases. In 1961 Crick and his colleagues discovered that a triplet arrangement of the bases would provide 64 possible combinations for controlling the approximately 20 amino acids in protein. (J. G. Th.)

CRICKET, generally considered to be England's national summer sport, is a game of skill played with bat and ball in a large field. It has millions of devotees throughout the world, particularly in the British Isles and the commonwealth.

THE GAME

The Ground.—The size of a cricket ground varies from the great arenas of Lord's in London, Eng. (180 × 145 yd.), and of Melbourne, Austr., which is even a little larger, to village green, barrack squares, small meadows and unbroken stretches of common land. Well-rolled turf of fine texture is the ideal surface for cricket. The limits of the circular or oval playing area are usually marked by a boundary line or fence.

Equipment.—*The Bat.*—The blade of the originally paddle-shaped bat is made of willow and must not be broader than $4\frac{1}{4}$ in. The length of the bat including the handle must not exceed 38 in.

The ball has a core of cork built up with string and cased with polished red leather. Slightly smaller, harder and heavier than a baseball, it must weigh between $5\frac{1}{2}$ oz. and $5\frac{3}{4}$ oz. and be between $8\frac{13}{16}$ in. and 9 in. in circumference.

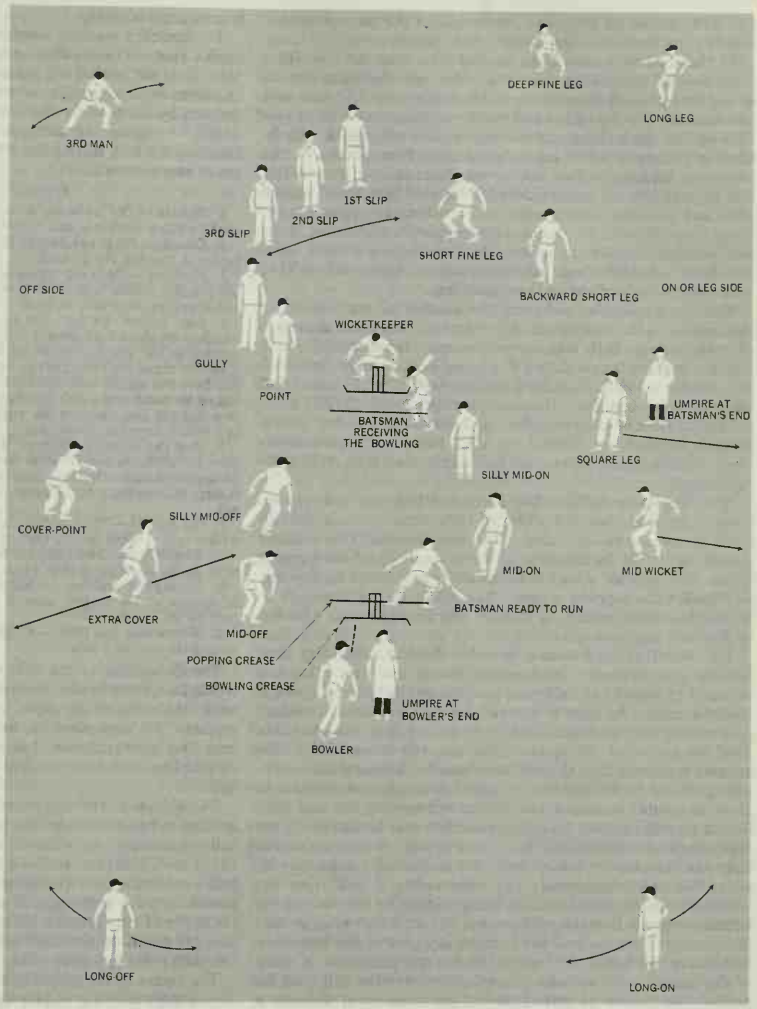
The wicket consists of three stumps or stakes each 28 in. high and of equal thickness (about $1\frac{1}{4}$ in. in diameter) stuck into the ground and so spaced that the ball cannot pass between them

wo pieces of wood called *bails* e in grooves on top of the stumps nd project not more than ½ in. bove them. The whole wicket is in. in width. These wickets, hich a batsman defends and a owler attacks, are pitched approximately in the centre of the round, facing one another at ach end of the *pitch*, which is ie area, 22 yd. long and 10 ft. ide, between the wickets.

Creases.—These are lines of hitewash marked on the ground t each wicket as follows: the *owling crease* is in line with the tumps, 8 ft. 8 in. in length with a ort arm marked at each end at ght angles behind the wicket—ie *return crease*—within which ie bowler's rear foot must be rounded in delivering the ball; ie *popping crease*, which demarks the batsman's ground, is arallel with the bowling crease ft. in front of it, that is, 62 . from the opposing bowling ease.

Dress.—Players usually wear hite flannel trousers and shirt, hite boots (shoes) of buck or anvas, a white woolen sweater, ften trimmed with club colours, nd club caps of kaleidoscopic vaety. The batsman wears white ads, or leg guards, a body protector and articulated batting gloves, sually of thick tubular rubber or f leather stuffed with hair. The icketkeeper also wears pads and einforced gauntlets (cricketers, nlike baseball players, do not ear gloves when fielding).

Language of Cricket.—ricket has evolved a colourful ocabulary of its own, as have any other sports. Many of the ore important terms are exained in other sections of this rticle (*see* also list, *Methods of ismissal*). Some of the variant multiple meanings of certain rms, and some additional terms d phrases, follow.



CRICKET PLAYING FIELD

Bowled for a duck.—Dismissed (put out) without scoring.

Capped.—Selected to play for England or other representative team (*see* below).

Century.—100 runs scored by one batsman in a single innings.

Clean bowled.—Bowled out.

Fixture.—A match, especially one of a series held annually or at some other regular interval.

Follow on.—Go in again to bat (out of turn) after scoring less than opponents by a specified number (75 runs in a one-day match; 100 in a two-day match; 150 in a match of three days or more).

Hit a six.—Hit a ball over the boundary (without first touching the ground) to score six runs.

Innings.—(1) A turn of a batsman to bat; (2) a turn of a team to bat; (3) in recording a result, when one team still has a turn to bat but has scored more runs than the opposition, which already has completed its two innings, the result is recorded as "an innings" (to go) and so many runs. (Hambledon beat "a representative England seven by an innings and 168 runs.")

Pitch.—(1) The area extending 5 ft. on either side of the centre line between the wickets; (2) the distance between wicket and wicket; (3) the impact of the bowled ball on the ground (pitch).

Point.—Position of fieldsman more or less in line with batsman or popping crease on the off side.

Representative team.—Team of players who have been selected, on the basis of ability, to represent a county, a country, etc. (as distinguished from a club team or a minor team).

Silly mid-off.—Fielding position about halfway between normal mid-off and batsman, about 10 or 15 yd. from batsman.

Slip.—Fielding position behind and to one side of wicket.

Square leg.—Behind the batsman as he faces the bowler.

Sticky wicket.—Pitch drying after rain and difficult for batsman.

Stonewaller.—Batsman who attempts only to protect wicket; excessively cautious batting.

Wicket.—(1) The goal, consisting of three stumps on top of which lie two sticks (bails), which the bowler attempts to hit and the batsman attempts to defend; (2) the area between two sets of stumps, synonymous with pitch; (3) a turn at bat, *i.e.*, the partnership between two batsmen for the 1st wicket, 2nd wicket, etc.; (4) in scoring, when a side is batting last the number of batsmen still to be dismissed when the opponent's score is passed.

Conduct of the Game.—A match is usually played between two sides of 11 players each, one of whom is captain. There are two umpires to control the game according to the laws, and two

scorers to record its progress. The object of the game is for one side to score more runs (*see* below) than the other.

At the start of a match the captain who wins the toss (of a coin) decides whether his own or the other side shall take first *innings; i.e.,* proceed successively as batsmen—the first two as a pair together—to the wicket and try to make as many runs as possible against the bowling and fielding of their opponents. An innings is completed when ten batsmen have been dismissed (the remaining batsman is "not out"), but the captain of the batting side may declare his innings closed if his side have made enough runs, and sufficient time remains to bowl out the opponents for fewer runs. Results are recorded by the margin of runs, or, if the side batting last passes the other side's total before all their batsmen have been dismissed, by the number of their wickets (*i.e.,* batsmen still to be dismissed) outstanding.

Matches are decided either by the number of runs scored in one innings each (usually one-day matches) or on the aggregate of runs made by each side in two innings. International (test) matches last five or six days (30 playing hours), other first-class matches from two to four days, and the bulk of club, school and village matches one day. Hours of play are usually 11:30 A.M. to 6:30 P.M. for first-class matches, and for many one-day games. Suitable intervals are allowed for lunch and tea and between innings. Minor teams often play half-day games (say, 2:30 P.M–7:00 P.M.).

How the Game Is Played.—The nonbatting side take up positions in the field (*see* fig.). One of their number bowls the ball from one wicket to the other. The first batsman (the striker) guards his wicket by standing with one foot behind the popping crease. His partner stands at the bowler's end within his ground; *i.e.,* behind the popping crease. The object of the bowler is to hit the batsman's wicket, or dismiss him in other ways (*see* list of *Methods of Dismissal*).

The object of the batsman is to hit the ball sufficiently hard for him to score a *run; i.e.,* to enable him to reach the other end of the pitch before any fieldsman can pick up the ball and throw it to the stumps. As soon as he runs, his partner (the nonstriker) runs toward him, and once they have crossed and each has made good his ground at the opposite end, one run is recorded to the striker; if there is time they will run back for a second run, crossing again: up to six runs can be scored from any one stroke. If an even number is scored, the striker will receive the next ball, but, if an odd number, then the nonstriker will be at the wicket opposite the bowler and will face the next ball. Only runs scored from the bat count to the batsman, but to the side's score may be added the following extras: (1) *byes* (when a ball from the bowler passes the wicket without being touched by the bat and the batsmen are able to make good a run); (2) *leg byes* (when in similar circumstances the ball has touched any part of the batsman's body except his hand); (3) *wides* (when a ball passes out of reach of the striker); (4) *no-balls* (for a fair delivery the ball must be bowled, not thrown or jerked, and at the moment of delivery a bowler must have some part of one foot behind the bowling crease and within the return crease; a breach of these conditions constitutes a no-ball, off which a batsman cannot be cut—except under *Methods of Dismissal* [5], [7], [8] and [9] [*see* list]—and which he may therefore try with impunity to smite, apprised in time by the umpire's cry of "no-ball").

When a ball, from a hit or any of the extras mentioned above, reaches the boundary, running ceases and four runs are added to the score. If the batsman hits the ball full-pitch over the boundary he scores six runs.

The ball is bowled from each wicket alternately in *overs* of six balls (eight in Australia and South Africa), not counting wides and no-balls. When the requisite number have been bowled, a new over is begun by a different bowler at the opposite end to the batsman at the former bowler's end, with a corresponding adjustment of the field. Subject to this alternation of overs, any member of the fielding side may bowl at either end as many overs as his captain decides, but the same bowler may not bowl two consecutive overs. If a bowler delivers a complete over without a run being scored from the bat, he has achieved a *maiden over,* a feat of some accuracy.

The ordinary ways in which a batsman or striker can be dismissed (put out) are indicated in the accompanying list. When a batsman is out bowled, leg before wicket or hit wicket the credit—and when he is out caught or stumped the main share of credit—is taken by the bowler, who is said to have "taken the batsman's wicket." Among the methods of dismissal hitting the wicket, handling the ball, hitting the ball twice and obstructing the field are of rare occurrence.

Methods of Dismissal

1. *Bowled.*—The batsman is out *bowled* if the bowler breaks the wicket; *i.e.,* dislodges a bail with the ball.

2. *Caught.*—He is out *caught* if a ball bit by the batsman is caught before it touches the ground.

3. *Stumped.*—He is out *stumped* if, in playing a stroke, he is outside the popping crease (out of his ground) and the wicket is broken by the wicketkeeper with ball in hand.

4. *Leg before wicket (l.b.w.).*—Essentially, illegal interference, whether accidental or intentional, with a ball that otherwise, in the opinion of the umpire, would hit the wicket: the batsman is out l.b.w. if he intercepts with any part of his person, except his hand, which is in line between wicket and wicket, a ball which has not first touched his bat or his hand and which has or would have pitched (hit the ground) in a straight line between the wickets or on the off side, provided the ball would have hit the wicket.

5. *Run out.*—Either batsman is out *run out* if, while the ball is in play, his wicket is broken while he is out of his ground. If the batsmen have passed each other, the one running for the wicket that is broken is out; if they have not crossed, the one running from that wicket is out.

6. *Hit wicket.*—The batsman is out *hit wicket* if he breaks his own wicket with his bat or any part of his person while playing at the ball.

7. *Handling the ball.*—Either batsman is out if he touches the ball with his hands while it is in play.

8. *Hitting the ball twice.*—Batsman is out if he hits the ball, except in defense of his wicket, after it has been struck or stopped by any part of his person.

9. *Obstructing the Field.*—Either batsman is out if he willfully obstructs the opposite side.

The disposition of the field will vary widely according to the technique of the bowler or of the batsman, the condition of the pitch, the state of the game, and the tactics determined by the captain. He may place his fieldsmen as he thinks best, and he may alter their positions, if he wishes, after each ball. There are no foul lines in cricket as there are in baseball so any hit is a fair ball.

The objects of the captain of the fielding side are: (1) to place his men in positions where the batsman may give a catch (in baseball terminology, hit a line drive or a fly ball to a fielder); and (2) to save runs; *i.e.,* to block the path of the ball from the batsman's scoring strokes (intercept or trap grounders). The tactical possibilities for a thoughtful and ingenious captain in directing the battle of wits between his bowlers and fieldsmen and the batsmen are manifold and constitute one of the charms of the game for player and spectator alike.

The names of the generally accepted positions are shown in fig. 3. As there are only 11 players in a team, two of whom must be the bowler and wicketkeeper, only nine other positions can be occupied at any one time. The field is spoken of as being divided lengthwise into "off" and "leg," or "on," sides in relation to the batsman's stance depending upon whether he bats right- or left-handed; the "off" side is the side facing the batsman and the "leg" or "on" side is the side behind him as he stands to receive the ball.

To sum up: the object of the bowler is primarily to get the batsman out, and only secondarily to prevent him from getting runs. The object of the batsman is to make runs, for only runs can win a match, but to make runs he must "stay in." The object of each fielder (and of the general distribution of the field) is first, to dismiss the batsman, and secondly, to prevent his making runs. The arts of batting, bowling and fielding are therefore a fusion of attack and defense, but ideally attack will always dominate.

Bowling can be right- or left-arm. For a fair delivery the ball must be propelled, usually overhand, without bending the elbow. The bowler may run any desired number of paces as a part of his delivery, as in bowling (with the restriction, of course, that he does not cross the bowling crease), but the ball is not rolled on the ground although it generally hits the ground (the pitch) before

aching the batsman. The first requisite of a good bowler is com-and of length; *i.e.*, the ability to pitch (bounce) the ball on a sired spot, usually at or slightly in front of the batsman's feet d varying with the pace of the bowler, the state of the pitch and e reach and technique of the batsman. The second requisite is mmand of direction. On this foundation a bowler may elaborate th variations of fingerspin, swerve, alteration of pace and flight, e path of the ball and the manner in which it is propelled that d deceptiveness and uncertainty as to exactly where and how will pitch. A *good-length ball* is one which causes the batsman doubt whether to come forward to play his stroke or to move ck. A *half volley* is a ball pitched so far up to the batsman that can drive it fractionally after it has hit the ground without hav-g to move forward. A *yorker* is a ball pitched on or inside the pping crease. A *full pitch* is a ball which the batsman can reach fore it hits the ground. A *long hop* is a ball short of good length "short of a length."

The primary purpose of the spin in bowling is to bring the ball from the pitch at an angle or in a direction that is difficult r the batsman to anticipate. The varieties of spin are: *off-eak*, the ball on pitching, that is, hitting the ground, turns from e off side of the wicket; *leg break*, the reverse of off-break; *p-spin*, the ball, on pitching, gathers pace but does not turn; *ogly*, a ball bowled by a right-arm bowler which deceives the tsman by turning from the off, though apparently bowled with leg-break action; *chinaman*, an off-break ball bowled by a left-m bowler. Occasionally, left-arm bowlers bowl a googly which, pitching, turns from the leg.

The two swerves are the *inswinger*, which moves in the air from to leg, and the *away-* or *outswinger*, which swerves from leg off.

Batting.—A batsman may play right-handed or left-handed. od batting is based on a straight (*i.e.*, vertical) bat with the ll face presented to the ball.

The chief strokes are: *forward stroke*, in which the batsman ad-nces his front leg to the pitch (direction) of the ball and plays in front of the wicket (if played with aggressive intent, this oke becomes the *drive*); *back stroke*, in which the batsman oves his rear leg back before playing the ball; *leg glance* (or *ide*) in which the ball, when pitched in a line with or outside e batsman's body, is deflected behind the wicket on the leg de; *cut*, in which the batsman hits a ball on the uprise (after hit-ng the ground on the off side) over and down behind the wicket through the slips with a vigorous whiplike action of the wrists.

Fielding.—The ideal fieldsman is a fast runner, with keen eye-ght, quick reactions and ability to throw straight and far. He ould be able to anticipate the batsman's strokes, move to cut the ball in its path, and pick it up and throw it to the stumps one movement. He must judge the flight of the ball in the air make a safe catch. By his alertness and skilful play he can save ns and contribute to a batsman's downfall.

The *wicketkeeper*, or catcher, is a specialist position requiring normally quick reactions, sharp eyesight and courage. He is the rdest-worked member of the team, and must concentrate on ery ball, whether standing 12 to 15 yd. behind the stumps for e fast bowlers, or crouching close to them for those of slow or dium pace.

CRICKET IN ENGLAND

Origin.—Samuel Johnson derives the name cricket from 'ryce," Old English, a stick. The word still survives in Cornwall d Devon in the sense of hedge sticks. The termination "et" itself a common diminutive, and the game would then take its me from its weapon of attack, a little staff, stick or bat.

For the practice of cricket as an elementary form of club ball re is pictorial evidence as early as the middle of the 13th cen-y. The first written reference to the game is possibly to be nd in an extract from the wardrobe accounts of 1300, in Ed-rd I's reign, which referring to certain sums disbursed on behalf the young Prince Edward alludes to a game called *creag*. cket was being played by boys of the free school of Guildford or about 1550. Oliver Cromwell is reported as having indulged in his youth in cricket and football, and in 1650 a scholar at Winchester is referred to as "attempting to wield a cricket bat." There appears to have been a cricket club at St. Albans as early as 1666. In 1668 the proprietor of the Ram inn, Smithfield, London, had been rated for a cricket ground, and in 1707 Chamberlayne's *State of England* included cricket among the people's recreations.

Early History.—Cricket has been played under recognized rules at least since the beginning of the 18th century. The first definite match of which there is record was played in Sussex in 1697, 11-a-side and for a stake of 50 guineas. In 1719 the "Londoners" met the "Kentish men" in what was virtually the first county match, London being synonymous with Middlesex.

The greatest enthusiasm and the most expert skill were concentrated in the southern counties near London. There, on the short turf of the open downs, cricket was discovered by Society and transplanted to London and to the home grounds of its noble patrons, for example at the Vine at Sevenoaks, and at Goodwood park. In London, matches were played on all the southern commons from Chelsea to Clapham. But by far the most famous cricket centre was the Artillery ground, Finsbury, Here was played on June 18, 1744, the famous match Kent *v.* All England, the first game to be recorded in A. Haygarth's *Scores and Biographies 1744–1878*.

A feature of the play in those days was the heavy stake money and side bets that more often than not depended on big matches. The crowds were often disorderly and violently partisan.

The next stage in the game's development was marked by the rise of the Hambledon club. On Broad-Halfpenny down (the historic site later acquired by Winchester college) this little Hampshire village for 30 years challenged and was a match for all comers. Indeed in June 1777, they beat a representative England eleven by an innings and 168 runs. This phenomenal ascendancy resulted in the main from the coincidence in the area of about a dozen men of extraordinary cricket genius who had a profound influence on the evolution of the game's technique. Fortunate, too, was the club in its historian, John Nyren. His *Cricketers of my Time*, together with *The Young Cricketer's Tutor*, edited by Cowden Clarke, both published in 1833, were the first prose classics in cricket's literature.

Hambledon played its last recorded match in 1793, appropriately enough at Lord's, London. This, the acknowledged Mecca of all cricketers, was first opened in Dorset square as a private ground for certain members of the White Conduit club by Thomas Lord, a Yorkshireman who was ground superintendent and bowler to the club. In 1809, to avoid a rise in rent, Lord removed to part of the St. John's Wood estate, and four years later he moved again to the present situation. In each case he relaid the original Dorset square turf, and he enclosed his newest ground with a high fence and built on it a pavilion and a tavern. The Marylebone Cricket club (M.C.C.), with its home at Lord's, was founded in 1787 and in its first year it revised the laws, thus proving that from its inception its authority was paramount. It is accepted throughout the world as the authoritative source of all cricket legislation.

For half a century at least, the M.C.C. was the great match-making agency in cricket, inviting subscriptions from its members to meet match expenses, and advertising in advance at the chief London social clubs. Most of the big matches were still played for money and were a field for heavy wagering by professional backers, games being constantly arranged at odds, whether of numbers or of given men.

In 1836 the first North *v.* South match was played, clear evidence of the spread of cricket. The missionary efforts of the M.C.C. began in 1846, seconded by the touring cricket of the All-England eleven, which played all over the country and was the focus of attraction wherever it went, winning to knowledge and appreciation of the game whole districts where hitherto it had been unappreciated or undeveloped. Its matches were great trials of budding talent, and many a young professional was discovered and launched on a successful career through its medium. Its success led in 1852 to the secession of some of the leading professionals and their formation into the United All-England eleven. These two teams monopolized the best cricket talent in the country, and

the annual match between them at Lord's on Whitmonday, first played in 1862, was for nearly 20 years the great event of the season. Eventually they both gave way before the rising tide of county cricket (*see* below).

Technical Developments.—Cricket was originally a game in which the country lads bowled at a tree stump, or at the hurdle gate into their sheeppens. This consisted of two uprights and a crossbar resting on their slotted tops, the latter called a "bail" and the whole gate a "wicket." The fact that the bail could be dislodged when the wicket was struck made this preferable to the stump, which name was later applied to the hurdle uprights.

Early manuscripts differ about the size of the wicket, but by 1706 the pitch was 22 yd. long.

The ball was probably much the same in the 17th century as it is today. Originally it weighed between five and six ounces. Its modern weight and size were laid down in 1774 and 1838, and its circumference was slightly reduced in 1927.

The primitive bat was no doubt a shaped branch of a tree, resembling a modern hockey stick, but considerably longer and very much heavier. The change to a straight bat was made to meet the cult of "length" bowling which had been evolved by the Hambledon cricketers. The bat was shortened in the handle and straightened and broadened in the blade, which led to forward play, driving and cutting. As few bowlers were able to combine length with break, swerve and flight, batting continued to dominate bowling in the 18th century. About the same time the first l.b.w. law was promulgated by which the umpire had the impossible task of deciding whether the obstruction had been deliberate. Early in the 19th century most bowlers favoured the high-tossed lob.

The next bowling development was "the round arm revolution" in which many bowlers deliberately threw. Controversy raged furiously, and in 1835 the M.C.C. rephrased the law to allow the hand to be raised as high as the shoulder. The new style led to a great increase in pace. Gradually bowlers raised the hand higher and higher in defiance of the law, until it became more honoured in the breach than in the observance. Matters were brought to a head when all nine professionals of an England eleven playing against Surrey left the field at the Oval in protest against one of their number's being no-balled for throwing, and as a result, in 1864, the bowler was officially accorded full liberty to bowl overhand. From time to time umpires have had trouble with bowlers who threw, and G. A. R. Lock of Surrey and C. N. McCarthy, the South African fast bowler, when playing for Cambridge university, were no-balled for throwing in 1952. Lock was afterward no-balled in the West Indies during the M.C.C. tour of 1954. In 1959 a storm arose in Australia over the suspect actions of some of the leading Australian bowlers, as a result of which a special meeting of the Imperial Cricket conference was held, though no drastic action was taken.

Most bowling continued to be fast throughout the middle of the 19th century, and though the standard of wicketkeeping was high, the role of long stop, positioning a fieldsman to back up the wicketkeeper, became most important. The batsmen now learned to protect themselves with additional armour. Pads and tubular batting gloves were invented, and the cane handle greatly increased the resilience of the bat. Thus fortified, batsmen developed their strokes. Hitting and pulling to the leg side became fashionable, forcing strokes on the leg side off the overpitched ball were developed, as were the classic principles of elegance and the straight bat. However, only the best professional batsman could cope with great speed because most pitches were bad. Until 1849, when permission was first given to sweep and roll the pitch at the beginning of each innings, it was unlawful to touch it from the beginning to end of a match.

Gradually the grounds improved, because of the advent of the heavy roller and of the perfection of the lawn mower, and in the 1870s fast bowling declined. The batsmen went over to the offensive and the bowlers fell back on accuracy of length. They also developed off theory, keeping the ball some distance wide of the off stump and concentrating the fieldsmen on the off side of the wicket. The batsmen countered by a policy of masterly inactivity, and the pace of some county cricket became so funereal that interest flagged and attendance fell off. From such a fate the game was saved by a transfusion of new and vigorous blood.

Profiting by the coaching of English professionals, Australians developed their cricket, especially their bowling, and when in 1882 they came to England and defeated its full strength, a further evolution in technique had taken place. Their great bowlers combined pace with spin and variety of flight. They bowled much straighter than the English, and were much more adaptable in their field placing. With the wicket taking off-spin, many catches were held in the then unprecedented place of silly mid-on.

A great wicketkeeper, J. McC. Blackham, stood up to the stumps to a fast bowler, even dispensing with a long stop, and by taking the ball cleanly, even on the leg side, set a new standard in wicketkeeping.

The opening years of the 20th century produced such an orgy of run-getting that a reform of the l.b.w. law was debated, and the M.C.C. denounced the over-preparation of pitches. But the heavy scores were due primarily to the arrival of a generation of batsmen who triumphed over much formidable and varied bowling by methods both versatile and individual. This was cricket's "Golden Age."

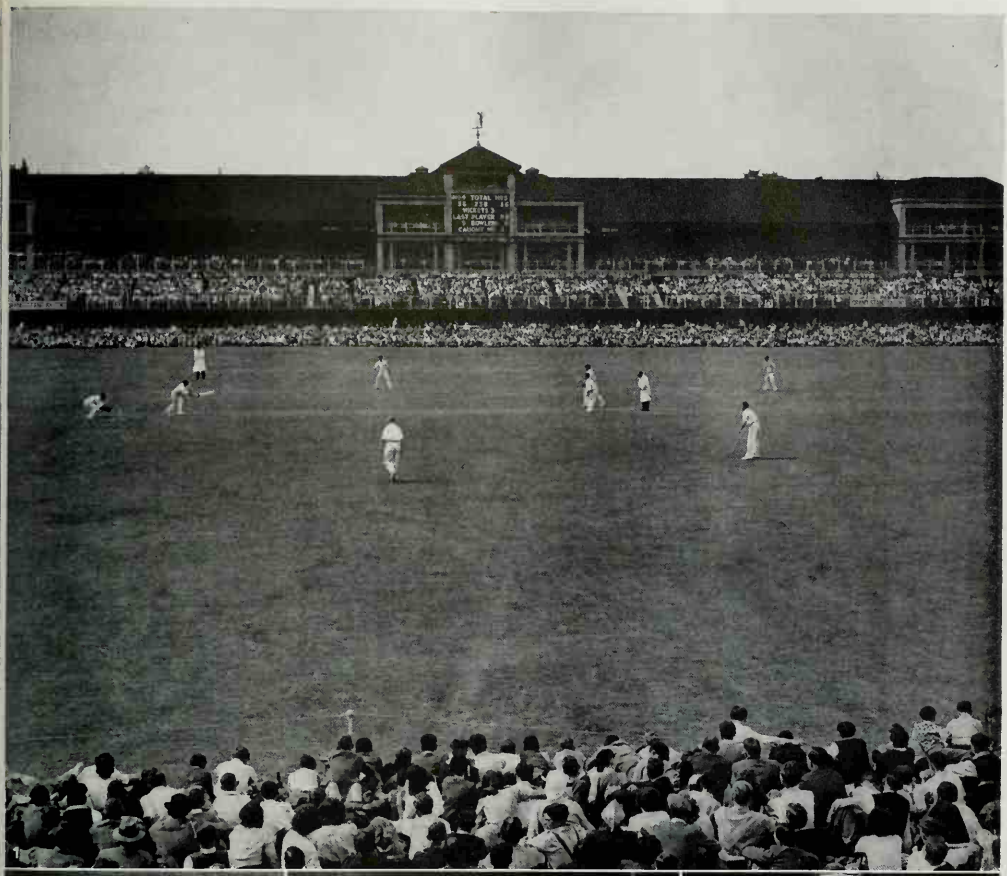
There now appeared in cricketing vocabulary the googly, a word coined in Australia when B. J. T. Bosanquet, on the 1903–04 M.C.C. tour, first exploited his ability to bowl an off-break with a leg-break action. This freak ball was brought to something like perfection in South Africa, where the matting used to form the surface of the pitch intensified its spin.

Contemporarily bowlers discovered a new weapon for the discomfiture of the batsmen—the swerve. Fast left-handers exploited inswerve, and right-handers learned to swing the ball either way, especially into a head wind or in a heavy atmosphere. A final development was the ball from the right-hander which swung into the batsman and dipped at the end of its flight. To supplement this inswinger, the field was largely reoriented, with the on side reinforced at the expense of the off.

To meet these new problems batsmen had to adjust their technique. K. S. Ranjitsinhji and C. B. Fry led the way by abandoning the long-striding forward stroke and making back play, together with a mastery of all on-side strikes, the foundation of their batting. But with the less gifted majority of batsmen, a two-shouldered and right-handed defense off the back foot began to predominate, and batting lost its aggression and charm. Such methods played into the hands of bowlers of real pace and of those who could flight as well as spin the ball, but the concentration on defense and the increasingly elaborate preparation of the pitch often thwarted all but the greatest bowlers. The most drastic and dramatic tactic was the so-called "body-line" attack in the 1930s (see *Test Matches* below).

The reaction of authority to the evolution of cricket in the 20th century was visible in a series of attempts to help the bowler and to quicken the tempo of the game. As early as 1902 the bowling crease had been extended in length; in 1907 the use of a new ball after every 200 runs had been legalized; during the M.C.C. tour of Australia in 1924–25 the eight-ball over was first used (this became standard practice in Australia and in South Africa); in 1927 a smaller ball was authorized; in 1931 the size of the wicket was increased; and in 1937 the l.b.w. law was extended to cover balls pitching outside the off stump.

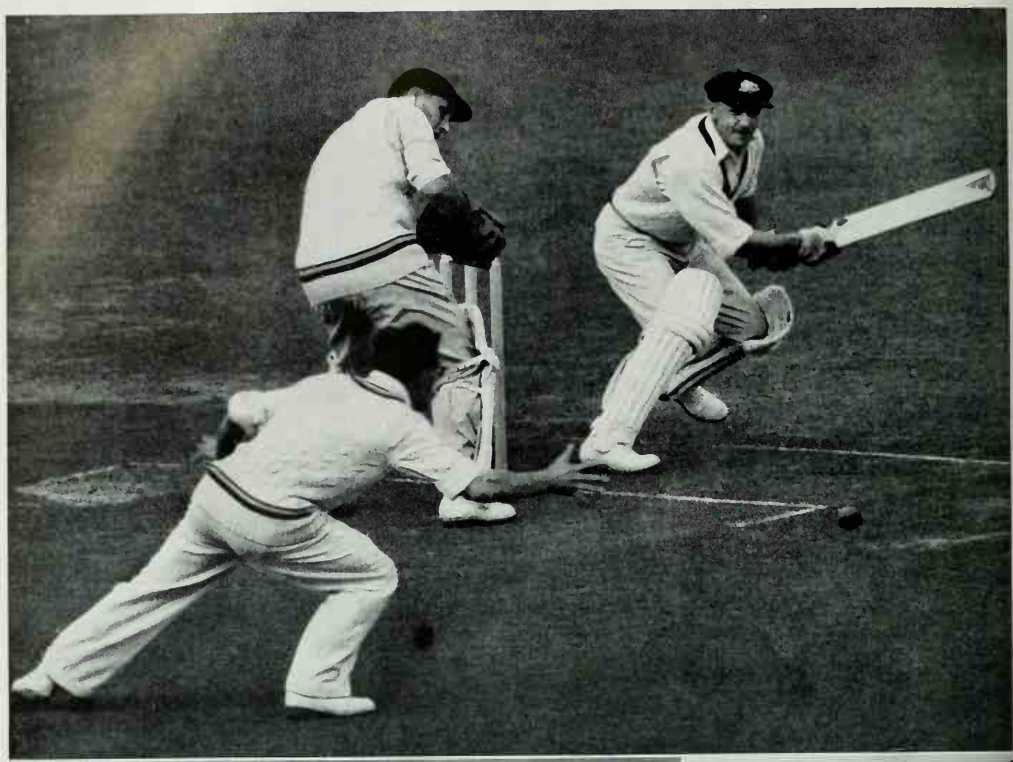
In 1947 the M.C.C. issued a revised code of laws, aimed at the clarification and better arrangement of the previous laws. The extension of the l.b.w. law encouraged the inswinging bowler and the off-spinner, thus further restricting the batsmen's more attractive off-side strokes. The rate of run-getting deteriorated as too many bowlers bowled short of a length, with a majority of the fieldsmen on the leg side, and the M.C.C. and other governing bodies were much concerned about slow play. There were widespread appeals for brighter cricket, and for groundsmen to prepare pitches in which the balance was not too heavily tilted in favour of the batsmen. Finally in 1957 the M.C.C. introduced for English county cricket, for an experimental period, a law limiting the number of fieldsmen on the on side to five, of whom not more than two were to field behind the popping crease. It was also agreed



PHOTOGRAPHS, (1, 2) THE SPORT & GENERAL PRESS AGENCY, LTD., (4) THE "TOPICAL" PRESS AGENCY LTD.

1. General view of Lord's cricket ground, London
2. F. E. Woolley at the finish of a "hook," showing perfect balance and follow through (Woolley is a left-handed batsman)
3. W. G. Grace (left) and C. B. Fry opening the innings for England at Nottingham in 1899; Grace's last test match, Fry's first
4. V. Trumper, one of the most natural and brilliant of Australian batsmen

CRICKET



PHOTOGRAPHS, (TOP, BOTTOM LEFT) THE SPORT AND GENERAL PRESS AGENCY, LTD., (BOTTOM RIGHT) THE CENTRAL PRESS PHOTOS, LTD.

Top: D. G. Bradman at the finish of a cut; S. C. Griffith keeping wicket; W. J. Edrich at slip

Bottom left: F. Trueman bowling for England in a test match against Australia; A. K. Davidson of Australia watches the delivery

Bottom right: The perfect stance of J. B. Hobbs, "the old Master"

at boundaries should be limited to a maximum of 75 yd. from the ntre of the pitch.

County Cricket.—The greater part of first-class cricket, aside om the Oxford *v.* Cambridge, the Gentlemen *v.* Players and test atches, is played in the county championship between sides rep- senting counties. The origin of county cricket may be found in cal antagonisms of the "home counties." Successive county premacies were enjoyed by Kent (about 1750); Hampshire 780–90); Surrey (1790–1810); Sussex (about 1825); and the eat Kent eleven of the 1830s and 1840s. Yorkshire first took e field in 1833 (club formed in 1863) and Nottinghamshire in 35 (club formed in 1859). Surrey, first organized as a county ub in 1845, enjoyed a renewed ascendancy in the late 1850s and rly 1860s. Between 1867 and 1870 Yorkshire, with a wholly ofessional eleven, were champions thrice.

The modern county championship is generally reckoned to date om 1873, when the M.C.C. first laid down rules governing quali- ation. In the next five years, Gloucestershire, owing almost erything to the Grace brothers, E. M., W. G. and G. F., were ampions three times, but it was another ten years before the nour came south again. The 1880s were a great decade for ottinghamshire, but toward the end Surrey came again and were the head of the championship table eight times between 1887 d 1895. Yorkshire now enjoyed a great revival. Unlike the eat majority of its rivals, its eleven consisted almost entirely of tive-born men, and its success was proportionately more popular the county.

In the last 12 years before World War I the championship was n by six different counties, a variety of fortune that was excel- nt for the game's welfare. No victory was more popular than at of Warwickshire in 1911, when it became the first county tside the Big Six (Yorkshire, Lancashire, Nottinghamshire, ent, Surrey and Middlesex) to win the honour in 34 years. Kent s the most consistent in this period, winning four times, while rrey carried off the honours in the curtailed 1914 season.

The early years of the 20th century produced in J. B. Hobbs ter Sir Jack) of Surrey and F. E. Woolley of Kent two of the eatest artists the game has known. Hobbs, who was the com- ete batsman, graced first-class cricket for 30 years during which amassed records for Surrey and England (61,237 runs, 197 cen- ries) which by the 1960s had not been beaten. Woolley, whose gregate was second only to that of Hobbs, was cricket's most aceful left-hand batsman.

After World War I, Middlesex had a brief period of triumph, but tween 1922 and 1939 the championship was monopolized by the rthern counties of which Yorkshire won 11 times, Lancashire 5, d Nottinghamshire and Derbyshire 1 each. The reason for this endancy was not difficult to find. Lancashire and Yorkshire ded largely professional teams which remained virtually un- nged throughout the season. They exhibited a toughness of re, an economical competence of technique and a concentra- n on the game compared with which most of their rivals tended appear, as in fact some of them continued to be, relatively un- lled. Above all they excelled in the accuracy and hostility of ir bowling, supported by aggressive fielding and handled by otains who knew their jobs.

The leading personalities of the Yorkshire team during this era re W. Rhodes, greatest of all slow left-arm bowlers and also ood batsman, P. Holmes and H. Sutcliffe, a famous pair of open- ig batsmen, who in 1932 made the record partnership of 555 for t first wicket, M. Leyland, a phlegmatic and stout-hearted left- nder, and the bowlers W. E. Bowes, fast-medium, and H. Verity, w left-arm. L. Hutton (later Sir Leonard) appeared as the ical successor to Sutcliffe in 1936.

Lancashire won the title five times between 1926 and 1934, nks primarily to the hostile fast bowling of the Australian E. A. cDonald, supported by the lively spin and enterprise of C. rkin and the accurate slow bowling of R. Tyldesley, and to a putation for solid batting inspired by H. Makepeace, C. Hallows d F. Watson, supplemented by attractive stroke play by E. ldesley.

In 1929 a battery of fast bowlers in H. Larwood, W. Voce and F. Barratt, coupled with the defensive patience of W. Whysall and the wayward genius of G. Gunn, won the championship for Not- tinghamshire. Derbyshire's success in 1936 was the first outside the Big Six since Warwickshire's in 1911.

Had all its talented amateurs been available more regularly, Middlesex might have challenged the northern supremacy. Too much, however, depended on the all-round ability of J. W. Hearne and the batting of E. Hendren, who was one of the world's great batsmen. Quick on his feet, full of strokes, only Hobbs and Woolley scored more runs, and only Hobbs more centuries. G. O. Allen was the greatest of the amateurs. A fast bowler with a beautiful rhythmic action, he was also a correct and skilful bats- man.

Despite a wealth of batting headed by Hobbs and A. Sandham, and a number of distinguished captains, such as P. G. H. Fender, D. R. Jardine and E. R. T. Holmes, Surrey never won the cham- pionship between World Wars I and II. Surrey's cricket ground, the Oval, Kennington, London, was a batsman's paradise, and bowlers of the requisite class were not forthcoming.

The feature of Kent cricket was the number of amateur batsmen and brilliant fieldsmen, of whom A. P. F. Chapman was outstand- ing. But the team was based on three great professionals; Wool- ley, A. P. Freeman and L. Ames. Whereas Kent had a number of fine batsmen to support Woolley, its bowling depended virtually on Freeman. Highly accurate, and with pronounced leg-spin to which was added a well-disguised googly, in eight seasons he took 2,090 wickets, with 304 in 1928 as an all-time record. Ames was the finest batsman-wicketkeeper of his generation. He regularly scored more than 2,000 runs a season and kept wicket more than 40 times for England.

Sussex was a particularly attractive team in the 1920s under the captaincy of A. E. R. Gilligan. For a few years Gilligan and M. W. Tate were the best pair of opening bowlers in the country, while Tate was the greatest fast-medium bowler of his time. K. S. Duleepsinjhi and the South African A. Melville supplied grace and culture to the batting. Sussex always batted with enterprise and fielded superbly.

Gloucestershire was runner-up in 1929 and 1930, due primarily to the left-arm bowling of C. Parker, who was good on all wickets and the best in England on sticky wickets, and to the majestic batting of W. R. Hammond.

The nucleus of the Yorkshire side which had won the champion- ship in the last three seasons before World War II was sufficiently strong to retain it in 1946, but thereafter it was gradually a waning force before the onslaught of Middlesex and Surrey.

Middlesex had a wonderful season in 1947 under the eager lead- ership of R. W. V. Robins and inspired by the record-breaking achievements of D. C. S. Compton and W. J. Edrich. Compton, profiting by a hot summer, made the highest aggregate (3,816 runs) and the most number of centuries (18) ever achieved in a season. A genius in his quickness of reaction, speed of foot, ver- satility and unorthodox style, Compton ranked with the greatest batsmen of all time. Edrich too had a bigger aggregate (3,539 runs) than anyone before him.

Glamorgan, the youngest of the counties, provided the surprise of the century by winning the championship for the first time in 1948. W. Wooller was an enthusiastic captain and invaluable all- rounder, but his side's was a triumph for team spirit and brilliant catching and fielding.

Another of the less fancied counties, Warwickshire, headed the table in 1951, 40 years after its only other success. Amateurs good enough to be worth their place in first-class cricket and able to spare the time to play regularly were becoming increasingly dif- ficult to find. Warwickshire in 1949 took the bold step of appoint- ing one of its senior professionals, H. E. Dollery, as full-time captain. Two years later he led his team to the top of the table, thus proving that a professional could make a successful captain. Within a few years, five other counties had followed suit.

The 1950s belonged to Surrey. By 1958 it had been champion county for seven consecutive years, and was incomparably the best side in England. The first success coincided with the appointment of W. S. Surridge as captain, and under his enterprising leadership

Surrey became famed for brilliant fielding and catching, top-class bowling, and belligerent team spirit. G. A. R. Lock headed a squad of suicidally close fieldsmen on the leg side, Lock and J. C. Laker were the best pair of spin bowlers in England, A. V. Bedser the greatest fast-medium bowler of his generation and P. J. Loader a fast bowler of England class. The batting revolved round P. B. H. May, the best batsman in England, who succeeded Surridge in 1957, and who built up a tradition of quick scoring without which many victories would not have been won.

The Gentlemen *v.* Players Match.—This, the leading representative domestic fixture, has been played regularly at Lord's since 1819. For many years, the Gentlemen were no match for the Players, but the personal prowess of W. G. Grace (*q.v.*) gave the amateurs a period of success in the 1860s and 1870s. From then on supremacy varied with the heyday of great players, amateur and professional. Invariably the appearance of 22 of the leading cricketers in the same game produced high-class cricket with none of the tensions of intercounty competition and championship points. Ability is the hallmark of selection, and all the great cricketers at one time or another have taken part. Whether amateurs, whose numbers were rapidly dwindling in the second half of the 20th century, would be able to keep up the fight would depend more and more on the right material coming from the universities of Oxford and Cambridge.

The Oxford *v.* Cambridge Match.—This has been played at Lord's since 1827. These two universities rank with the counties as first class and are the chief nurseries of amateur cricket. Until the outbreak of World War II, the match was one of the social occasions of the summer season in London, but with the raising of academic standards and the increased cost of a university education, many of the best schoolboy cricketers no longer went to the university, and competition for places in the eleven was accordingly less keen. Nevertheless the universities continued to supply players for the England eleven.

Women's Cricket.—Women first played in England in the 18th century and spasmodic references appear during the 19th century. In 1887 the first club, "White Heather," was formed and in 1888 two professional teams known as "The Original English Lady Cricketers" were in action. About the same time, women's cricket was first played in Australia and New Zealand.

In 1926 the Women's Cricket association was founded after a successful cricket week at Malvern, Eng., and these weeks became an annual fixture. Representative fixtures soon followed and in 1933–34 the first team toured Australia and New Zealand. Australia paid a return visit in 1937. By the second half of the 20th century the Women's Cricket association was a flourishing organization, responsible for the administration of the game in England and for organizing test matches home and away. The latter take place at regular intervals against Australia and New Zealand, and new ground was broken in 1960–61 with a first tour of South Africa, where the women's game began only in 1951.

INTERNATIONAL CRICKET

The English introduced their national game wherever a pitch could be found and two teams collected. Cricket flourishes especially in east and west Africa, Hong Kong, Singapore, Canada and, outside the commonwealth, in Ceylon, Brazil and Argentina. But the firmest roots are in those countries which, with England, are members of the Imperial Cricket conference, founded in 1909, and including Australia, the West Indies, New Zealand, India and Pakistan, and South Africa until the latter's withdrawal from the commonwealth in 1961.

Australia.—Cricket began in Australia in the early 19th century and was competitive between clubs from the start. The first interstate match took place in 1856 between Victoria and New South Wales. By the end of the century South Australia was playing with them in a triangular competition for the Sheffield shield. Queensland was the next to join, and Western Australia was accepted to membership after World War II. Despite the huge distances, all five states play one another home and away each season, but New South Wales and Victoria are the dominant teams.

The real foundation of Australian excellence is club cricket. Each state has an association of affiliated clubs which controls players and grounds. Clubs are graded and competitions are arranged for each grade. First-grade teams in which novices play with great cricketers are the recruiting ground for the state team. Perfect light, hard, true pitches, long hours of sunshine and the fewness of first-class matches are some of the reasons why Australians are such good cricketers.

South Africa.—Cricket was brought to South Africa in the middle of the 19th century by British troops and was played in military and police centres of the Cape and Natal till 1889. Despite a delightful climate, interstate fixtures were made difficult owing to wide distances and sparse population.

In 1889 Sir Donald Currie offered a cup to the team which put up the best performance against the first English touring team. Kimberley won, and next year Transvaal challenged and beat them. Thus began the Currie cup competition which is South Africa's provincial championship. Before the turn of the century Cape colony (as it then was) had entered two teams (Western province and Eastern province) and Natal had also joined. After World War I, a board of control became the ruling body for South African cricket. The three most powerful provinces are Transvaal, Western province and Natal.

West Indies.—The characteristics of West Indies cricketers are great keenness and genuine enthusiasm for the game, a natural ability to bowl, and a desire to hit hard and score fast.

The game has probably been played since mid-19th century, but the first intercolonial match took place in 1865 between Demerara (British Guiana) and Barbados. By the end of the century a triangular tournament between Demerara, Barbados and Trinidad was being held. In 1926 a board of control, with representatives from all the islands, was set up to control the interisland competitions, and to organize foreign tours. One of its problems has been to agree upon a national captain, so intense is the rivalry between the islands.

Since World War II air travel has enabled Jamaica to play the other islands, and in 1956 Barbados, British Guiana, Trinidad and Jamaica played a knockout tournament at Georgetown, which British Guiana won. Apart from this, interisland matches remain on a friendly basis.

New Zealand.—The game was first played in 1841, and the first representative game was between Auckland and Wellington in 1860. In South Island the discovery of gold in Otago brought many Australians, who helped to spread the game, and the first of the annual fixtures between Otago and Canterbury took place in 1864. Canterbury and Wellington met for the first time in 1885. New Zealanders are rightly proud of their cricket grounds, which are the reward of enterprise in surmounting natural geographical drawbacks. The New Zealand Cricket council was formed in 1894, thus fulfilling a long-felt want for management in such a scattered country. Each province has its own association, made up of delegates from affiliated clubs, and representatives of these serve on the council. The Plunket shield (named after a former governor general) is played for annually between Auckland, Wellington, Canterbury, Otago, Northern Districts and Central Districts. The first English team visited the country in 1864, and others have gone at frequent intervals, but New Zealanders have fewer opportunities than others of seeing great players, and the expense of sending teams abroad is great, so the standard of play has not materially advanced.

India.—English settlers introduced the game and the army helped to popularize it. The first all-Indian club was the Oriental Cricket club, for Parsees, formed in 1848. English professional improved the standard of play, and there was a gradual sinking of jealousies of the various races and creeds in the cause of cricket. In 1877 the first match between the Parsees and the Europeans in Bombay was played, and the Parsees showed such improvement that Parsee teams went to England in 1886 and 1888.

In 1906 the Hindus competed with the Parsees and the presidency (the Europeans) in a triangular tournament, and by 1912 this had become quadrangular with the advent of the Muslims. Pitches were uneven, grounds often agricultural and gear crude, but enthusiasm was tremendous.

In 1926 the M.C.C. sent their first team to India, and the princes egan to pick their own sides—a sign that cricket was spreading. ince 1934 India has staged a national championship for the Ranji ophy, with "The Rest" joining the quadrangular in 1937.

Pakistan.—Since partition in 1947, cricketers have had a difficult isk of organization. An embryo test team was soon formed and uring the first years of its existence it has had a good record. In n attempt to build up a cricket tradition and find reserves for ie national eleven, the country has been divided into four groups or a championship for the Quaid-i-Azam trophy.

TEST MATCHES

History.—The first international or test match between sides f players chosen to represent the best cricket each country had offer was played in Melbourne in 1877, when Australia beat ngland by 45 runs. Australia's success was repeated in 1882 at ie Oval, London, in the game celebrated in the *Sporting Times* y the obituary notice announcing cricket would be cremated and ie ashes sent to Australia, giving birth to the legend of the Ashes," which became the popular objective in games between ngland and Australia. The ashes, kept in an urn at Lord's, were ade from a stump burned on the England tour of Australia in 883. For the rest of the century, the two countries met almost early, and with W. G. Grace in his heyday, England was generally o strong, though Australia had the greatest bowler of his era in . R. Spofforth, and the first of the great wicketkeepers in J. McC. lackham. Australia had a period of ascendancy at the turn of the entury, the 1902 series producing thrilling cricket, with Australia inning by three runs at Manchester to which England replied with one-wicket victory at the Oval.

In 1903 the M.C.C., determined to restore the prestige of Eng- sh cricket, for the first time organized a team to visit Australia recover the Ashes. This was a highly successful operation, but ie pendulum swung to and fro till the outbreak of World War I.

In the meantime new and worthy opponents for England were athering strength. In 1894 the South Africans first went to Eng- nd and their cricketers gained invaluable experience during two sub- equent tours in South Africa, one by England and one by Australia. 1905 the first M.C.C. team to South Africa lost the rubber rimarily because of googly bowling, which mastered English bats- ien on the fast matting wickets. Such a triumph won for South frica the right to test matches in England, and in 1907 they roved their ability to play England's best.

After World War I, England, Australia and South Africa con- nued to play one another at regular intervals, and in 1928 the Vest Indies for the first time entered the test match arena. In 931 New Zealand joined them, and in 1932 India followed. The sult was a serious crowding of the fixture lists. England, with s reliance on county cricket for six days a week, was hardest hit, id life for the top players became a round of cricket and travel. nterest in test matches was stimulated in the 1930s by the intro- uction of radio commentary and by the advent of the corre- pondent whose object was news stories and off-the-field activities the expense of straightforward cricket reporting. In 1930 test atches between England and Australia were increased to four ays' duration.

England was slow to recover from World War I, and Australia ominated the test match scene for the first six years, because of ie fast bowling of J. M. Gregory and E. A. MacDonald, the goo- ies of A. A. Mailey, and overwhelmingly strong batting and su- erb fielding. In 1926 England recovered the Ashes and held them r four years, during which their leading cricketers were opening atsmen J. B. Hobbs and H. Sutcliffe, fast bowlers H. Larwood and . W. Tate, and all-rounder W. R. Hammond.

In 1930 English crowds for the first time saw the new young ustralian phenomenon D. G. (later Sir Donald) Bradman. Be- veen 1928 and 1948 he scored 19 centuries against England and s average in all tests was 99.94 runs. On his first English tour e made 254, 334 and 232 in the tests, and these, with the slow owling of C. V. Grimmett, were sufficient to win the rubber.

D. R. Jardine, captain of the next M.C.C. team to Australia 1932–33), evolved the plan known as "body-line," with H. Lar- wood as chief protagonist. Bowling very fast and accurately at the leg stump, with a majority of fieldsmen on the leg side, he effectively curbed Bradman and his colleagues, and was largely instrumental in winning the rubber for England by four games to one (a "rubber" is any series of test matches—3, 4 or 5—between any two countries that are full members of the Imperial Cricket conference). The new technique, however, savoured so much of direct attack on the batsman that it caused a storm of protest and was subsequently outlawed by the M.C.C. as being contrary to the spirit of the game.

The remaining Anglo-Australian rubbers until World War II were dominated on the Australian side by Bradman and another prolific run maker W. H. Ponsford as batsmen, and by the per- sistence and hostility of the slow bowling of Grimmett and W. J. O'Reilly. Australia won in 1934 in England and in 1936–37 in Australia. In 1938 a new English batting star L. Hutton made his- tory with an innings of 364 at the Oval, which ensured a record victory by an innings and 579 runs.

Meanwhile England had had to strike its flag at home to South Africa, who won at Lord's in 1935 by 157 runs, for the first time. When the next M.C.C. team toured South Africa in 1938, turf wickets were in common use, and the result was an unprecedented orgy of run-getting, culminating in an infamous final test match at Durban which was abandoned on the 10th day with the ground flooded by a thunderstorm, and England, with victory in its grasp, having to catch the ship home.

Between these tests against ancient rivals, England now sand- wiched matches against the West Indies in 1928, 1933 and 1939, against India in 1932 and 1936, and against New Zealand in 1931 and 1937. In none of these was the home country really extended, though New Zealand forced a draw at Lord's in 1931. Return vis- its were paid to New Zealand after each of the Australian tours and to India in 1933. In 1934 an M.C.C. team toured the West Indies, which had been for the first time to Australia in 1930–31.

In 1931–32 the South Africans toured Australia and came home via New Zealand for the first time, and in 1935–36 they received Australia. Hence the pattern of continuous cricket was already being evolved when war broke out in 1939.

After World War II.—Test cricket began again in 1946, and in every succeeding summer a touring side has engaged in test matches against England. Australia comes twice in every eight years, South Africa every five years, and the other countries take turns at longer intervals. Pakistan was admitted to the Imperial Cricket conference in 1952 and first toured England in 1954. The M.C.C. has continued to travel to Australia every four years, and visits to other countries are a feature in two out of every three winters. The other members of the Imperial Cricket conference have gradually extended their fixtures, with the result that there is never more than a few months in any one year when a rubber of test matches is not being played somewhere in the commonwealth.

Matches between Australia and England last 30 hr., five days in England and six in Australia. The duration of tests between other countries is by mutual arrangement, but the position was simplified in 1955 when the English board of control accepted a suggestion that a rubber should consist of five tests of five days, and recommended that other countries should follow suit. Most have done so, except by local agreement.

Australia.—As in the 1920s, the first few years after World War II were dominated by Australia. Bradman was still a tremendous force, and the team he led to England in 1948 was as strong as any in history, with K. R. Miller and R. R. Lindwall as one of the great fast-bowling combinations of all time. This team held its own in world cricket till 1953, winning three rubbers against Eng- land 3–0, 4–0 and 4–1, one against India 4–0, one against South Africa 4–0, and one against the West Indies 4–1.

The first signs of a waning of power occurred when South Africa toured Australia in 1952–53 and drew the rubber 2–2. In 1953, at the Oval, Australia at last relinquished the Ashes held since 1934. In 1954–55 an M.C.C. team in Australia won a resounding victory 3–1, largely because of the devastating speed of F. H. Tyson and the accuracy of J. B. Statham.

Australia took some time to recover from this defeat. The 1956

team in England won a good victory at Lord's but was twice caught on bad wickets at Leeds and Manchester, and lost the series. An abnormally wet summer provided a feast of wickets for off-spinner J. C. Laker, who at Old Trafford, Manchester, achieved the unprecedented feat of taking 9 for 37 (9 wickets for 37 runs) and then 10 for 53.

The Australian recovery began with a successful tour of South Africa in 1957–58, and they had their revenge by beating the 1958–59 M.C.C. team in Australia 4–0. English batsmen had difficulty in playing the fast left-arm bowling of A. K. Davidson and I. Meckiff, and the widespread belief that Meckiff, as well as another fast bowler G. Rorke, "threw" or "jerked" the ball unsettled them.

England.—Aided by a wet summer in 1946, England easily won the only match finished in a short rubber against India. South Africa came in 1947, a summer memorable for hot sunshine and astonishing batting feats on both sides. The visitors lost the rubber 3–0, but achieved moral victories in the two drawn games.

Defeat followed in the West Indies in 1947–48, and in England in 1948 at the hands of Bradman's Australians. The rot was temporarily stopped in South Africa in 1948–49 when England won the rubber 2–0, the series opening in thrilling style at Durban when the winning run was scored off the last ball. There followed in 1949 stalemate at home against New Zealand, the visitors, with a strong batting side, achieved a draw in each of four three-day tests. In 1950 the West Indies, after losing the first of four five-day tests, recorded at Lord's its first win in England, and went on to win the rubber 3–1.

But in Australia in 1950–51 the corner was turned. After losing the first four tests, England won the fifth by eight wickets, thus inflicting on Australia her first defeat since 1938. From this beginning, England slowly built the fine side which dominated the test scene till 1958.

In 1951 South Africa was beaten in England 3–1, India was swept aside 3–0 the following year and then came the triumph when the Ashes were recovered in 1953. England under Hutton, its first professional captain, and later under the young amateur P. B. H. May, lost individual matches in the next five years, but never a rubber.

The new English spirit was seen at its best in the West Indies in 1953–54, when Hutton's men lost the first two tests but rallied to draw the series. Pakistan on the first English tour in 1954 exceeded all expectations by winning at the Oval, thus ensuring a drawn rubber. In 1954–55 Hutton achieved his crowning triumph by retaining the Ashes in Australia, and then made way for May, whose first venture as captain against South Africa in 1955 was crowned with success, due largely to his own superb batting. Australia was beaten in 1956, and though in 1956–57 South Africa, on its own wickets, recovered, after losing the first two games, to draw the series, England at home continued on its winning way against the West Indies. After putting up a good fight in the first test, the visitors gradually faded and lost the three finished matches each by an innings. In 1958 New Zealand had not the resources to give England a good game, and lost four matches by overwhelming margins.

South Africa.—Between 1947 and 1960 South Africa contested six rubbers against England, three against Australia and one against New Zealand. England won five, by margins of 3–0, 3–1, 3–2 and 3–0 in England, and 2–0 in South Africa, but the home side succeeded in drawing the series in 1956–57, 2–2. These figures argue progress in the course of which victories were won, in each case for the first time, at Nottingham, Leeds and Manchester. South Africa's ability to fight back from a losing position was exemplified in 1955 in England and in 1956–57 at home, after the habit had first been formed in Australia in 1952–53.

The Australians had not been beaten in South Africa, but in the 1952–53 series in Australia, South Africa won both tests at Melbourne. The series against New Zealand (1952–53, 1953–54) were won easily, one at home and one away.

West Indies.—West Indies cricket reached world class between 1946 and 1956. It owed its success primarily to three great men—C. L. Walcott, wicketkeeper-batsman, E. D. Weekes, batsman, and F. M. Worrell, all-rounder, all of whom reached their prime together. On the 1950 English tour two young spin bowlers, S. Ramadhin and A. L. Valentine, perplexed and spun out England's best batsmen. In a high-scoring series in 1948–49 in India, the West Indies won the only finished match, batting dominating bowling on the improved Indian wickets. The successful trip to England followed, and this was probably their high-water mark. They found the Australians at home in 1951–52 too much of a handful and lost the series 4–1, while on their own wickets a year later they could only win one game against India, the other four being drawn. Australia paid a first visit in 1954–55, and confirmed its superiority by winning the rubber 3–0. Another visitor to the West Indies for the first time was Pakistan in 1957–58, whose tour was remarkable for two mammoth innings, one of 337 in 16 hr. 13 min. by Hanif Mohammed for Pakistan and the other by G. Sobers, the West Indian left-hander, who set up a new world record by scoring 365 not out. In 1959–60 England won the rubber, 1–0, in the West Indies for the first time.

New Zealand.—New Zealand had made tours to South Africa, India and Pakistan without recording a victory, but in 1956 it entertained a West Indies team and won its first test victory at Auckland. In addition to its British tours, New Zealand receives M.C.C. teams every four years.

India.—Partition in 1947 created problems of reorganization both for India and for Pakistan. Between 1947 and 1959, in addition to three tours of England, India lost three series with the West Indies, two at home and one away. In 1954–55 India engaged in a series of five drawn matches against Pakistan, and was not strong enough for the Australians on their way home from England in 1956–57.

Pakistan.—Pakistan made an auspicious entry into world cricket. Its draw in the rubber against England in 1954 was followed by a win over Australia in a match in 1956 at Karachi. Pakistan has held its own with neighbouring India, and though afflicted by injuries, fought nobly on its first tour of West Indies in 1957–58.

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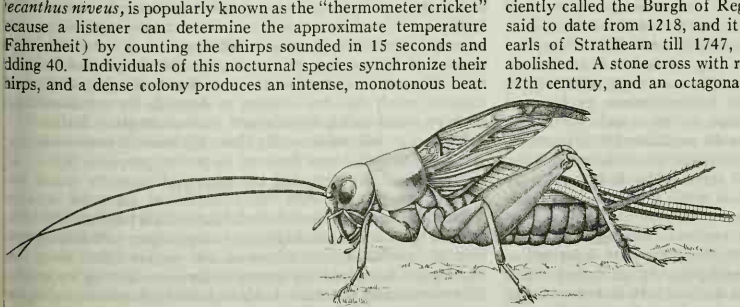
CRICKET, an orthopteran insect of the family Gryllidae (*see* ORTHOPTERA), universally known because of the musical hirping of the males. There are about 1,500 species, varying in ength from one-eighth inch to over two inches; all have thread- ke antennae, jumping hind legs, three-jointed tarsi and two ender abdominal cerci. The forewings are stiff and leathery, earing a stridulatory apparatus in the males of most species; the ind wings are flying organs, long and membranous when devel- ped.

Most distinctive among the 16 subfamilies of Gryllidae are: the ee crickets (Oecanthinae), delicate, greenish insects with trans- arent wings; the field and ground crickets (Gryllinae and Nemo- iinae), stout-bodied, black and brownish species, which often xcavate shallow burrows; the ant-loving crickets (Myrmecophili- ae), minute, wingless, hump-backed insects living in ant nests; nd the mole crickets (Gryllotalpinae), subterranean insects with reatly modified shoveling forelegs, cylindrical bodies, pointed eads and velvety coats of hairlike setae.

Crickets chirp by rubbing an upturned scraper on one fore- ing along a row of 50–250 teeth on the underside of the other orewing. The dominant frequency in the sound depends upon he number of teeth struck per second, and varies from around ,500 cycles per second (c.p.s) in the largest species to nearly 0,000 c.p.s. in the smallest. The sounds are produced as series f pulses, up to about 150 per second, each pulse corresponding o a wingstroke; behavioural significance lies in variations in pulse ate and rhythm. Most commonly heard is the calling song, which ttracts the female; the courtship or mating song induces the emale to copulate and the fighting chirps repel other males. Both exes possess highly sensitive and directional auditory organs, ocated within oval slits on the forelegs. Cricket sounds are af- ected by temperature; the North American snowy tree cricket, *Oecanthus niveus,* is popularly known as the "thermometer cricket" ecause a listener can determine the approximate temperature Fahrenheit) by counting the chirps sounded in 15 seconds and dding 40. Individuals of this nocturnal species synchronize their hirps, and a dense colony produces an intense, monotonous beat.



COURTESY OF RICHARD D. ALEXANDER

MALE FIELD CRICKET (GRYLLUS ASSIMILIS) WITH FOREWINGS LIFTED IN STRIDULATION

Most female crickets inject their eggs into the soil or into plant stems through long, slender ovipositors; the oviposition slashes of tree crickets often seriously damage berry canes and small twigs. Subterranean crickets lack long ovipositors, but place their eggs in underground chambers, sometimes along with plant materials upon which the newly hatched nymphs later feed. In northern latitudes most crickets mature in fall. They overwinter as eggs, which hatch into nymphs the following spring. A few burrowers overwinter as nymphs and mature in early summer. There are 6–12 nymphal molts, and the adults usually live 6–8 weeks.

Crickets vary in feeding habits, and many are omnivorous. Several species frequent human dwellings and refuse heaps, most notably the straw-coloured house cricket, *Acheta* (formerly *Gryllulus*) *domesticus,* and the decorated cricket, *Gryllodes sigillatus.* Subterranean species subsist largely upon roots and are quite injurious when abundant in crops, gardens and newly reforested areas.

House and field crickets are reared and sold by the millions as fish bait in the United States; they are also important laboratory animals in many parts of the world. In the Orient, the males are caged for their songs, and cricket fighting has been a favourite sport in China for over a thousand years.

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CRICKLADE, a market town in Wiltshire, Eng., is 8 mi. N.W. of Swindon by road. Pop. (1951) 1,881. Its situation at a crossing of the upper Thames, where it first becomes navigable, gave it an early importance; the Roman Ermine street from Silchester to Cirencester passes through the parish. In A.D. 69 the emperor Vespasian established a centre of reconnaissance there and coins of Vespasian, Flavius Honorius and Galerius Valerius Maximinus have been found. Alfred the Great made Cricklade a burgh in 871. Early in the 10th century it possessed a mint and examples of its coins date from Aethelred II to William II (Rufus). During the 12th century Matilda (*q.v.*), in flight from Stephen, was befriended by the townsfolk to whom her son, Henry II, granted a charter in 1155.

St. Sampson's church, on the site of a 9th-century Saxon building, is cruciform and mainly Perpendicular. The small church of St. Mary has an Early English tower, Perpendicular aisles and a Norman chancel arch.

There is a creamery and canning factory outside the town, which also has a glove factory and rural hand potteries. It is the only parish council in the United Kingdom to bear arms. With Wootton Bassett it now forms a district council. (CL. A. H.)

CRIEFF, a small burgh in Perthshire, Scot., and the capital of Strathearn, 18 mi. W.S.W. of Perth by road. Pop. (1961) 5,773. It occupies the southern slopes of a hill on the left bank of the Earn and is a tourist centre for the Perthshire highlands. Anciently called the Burgh of Regality of Drummond, its charter is said to date from 1218, and it was the seat of the courts of the earls of Strathearn till 1747, when heritable jurisdictions were abolished. A stone cross with runic carvings, believed to be of the 12th century, and an octagonal 17th-century market cross stand in High street, but the great cattle fair, for which Crieff was once famous, was removed to Falkirk in 1770. It was probably in connection with this market that the "kind gallows of Crieff" acquired their notoriety, for they were mostly used for the execution of Highland cattle stealers; the timber is now in the tolbooth (1665), the present town hall. Among the principal buildings are Morrison's academy (1860), a school

for boys and girls, and Strathearn house, a hydropathic establishment on a hill sheltered by the Knock of Crieff (911 ft.). Tourism and agriculture, with milling, are the main industries. Drummond castle, about 3 mi. S.S.W., is celebrated for its ten-acre gardens planned by the 2nd earl of Perth (d. 1662) and laid out in terraces illustrating Italian, Dutch and French styles. The keep dates from 1491, but the present structure was erected after the Jacobite rebellion.

CRILE, GEORGE WASHINGTON (1864–1943), U.S. surgeon, the most notable of whose many contributions to surgery were his experimental and clinical investigations of surgical shock, was born in Chili, O., on Nov. 11, 1864. He graduated from Ohio Northern university and Wooster university medical school and studied in London, Vienna and Paris. He was distinguished as a surgeon of the respiratory system, developed the nerve-block anesthesia and was one of the early users of the technique of blood transfusion, for which he devised a method of direct linkage of the donor's artery with the recipient's vein. During World War I Crile was professional director and consultant of a U.S. base hospital in France and was awarded the distinguished service medal. He was also founder of the Cleveland Clinic foundation. He died in Cleveland, O., Jan. 7, 1943.

Among Crile's many published works were *Surgical Shock* (1897); *Surgery of Respiratory System* (1899); *On the Blood Pressure in Surgery* (1903); *Hemorrhage and Transfusion* (1909); *Nature of the Emotions* (1915); *Notes on Military Surgery* (1924); *A Bipolar Interpretation of Living Processes* (1925); *Diseases Peculiar to Civilized Man* (1934); and *The Phenomena of Life* (1936).

CRILLON, LOUIS DES BALBES DE BERTON DE (1541–1615), French soldier whose knightly courage caused him to be regarded as the Bayard of his times and to be saluted as *le brave des braves* by Henry IV, was born at Murs, in Provence, on March 5, 1541. He began military service under François, duc de Guise, and distinguished himself in the taking of Calais from the English (1558) and in the wars against the Huguenots from 1562 to 1569. A knight of Malta from 1566, he fought against the Turks at Lepanto (1571) and was chosen to bring the news of the victory to the pope. Disgusted by the massacre of St. Bartholomew's day (1572), he nevertheless served against the Huguenots at La Rochelle (1573). He accompanied the duc d'Anjou to Poland and remained loyal to him when he returned to France as Henry III and had to contend with the League. Invited by Henry to kill Henry de Guise, he offered to fight a duel but refused to act as an assassin. Supporting Henry IV likewise against the League, he fought at Ivry (1590) and served in the siege of Paris. After the Savoy campaign of 1600, he retired to private life, with little reward save compliments from his king. In his devout old age he is said to have cried out indignantly in church when the story of Christ's Passion was being read, "Where were you, Crillon?" He died in Avignon on Dec. 2, 1615.

CRIME. In modern civilized societies only violations of rules promulgated and enforced by agencies of the government technically are crimes. Although crime is sometimes viewed in a very broad way as the violation of any important group standard or as the equivalent of antisocial, immoral and sinful behaviour, much immoral behaviour is not covered by the criminal law, and violations of some laws included in the criminal code are not regarded as immoral or even antisocial, or are so regarded only by a small portion of the population. Labour unions, professional organizations and many other groups within a society establish rules for their members and provide penalties for infractions, but such rules are not part of the criminal law. No matter how immoral, disgusting or harmful an act may be, it is not legally a crime unless it is covered by a law which prohibits it and prescribes punishment for it.

The concept of crime therefore involves the idea of a public as opposed to a private wrong, with the consequent intervention between the criminal and the injured party by an agency representing the community or public as a whole. In this view, crime is the intentional commission of an act deemed socially harmful or dangerous and usually specifically defined, prohibited and punishable under the criminal law. Difficulties arise from this definition because of the practical problems often involved in determining whether or to what degree an act is intentional, because some offenses known as "strict liability offenses" (*see* CRIMINAL LAW) are punished as crimes even though they may be unintentional, and because there are wide differences of opinion concerning what is socially harmful and dangerous. Legislatures are sometimes influenced by powerful vocal minorities to enact legislation which benefits only a certain group or which reflects only its views of what is right and wrong. Such laws may be contrary to the general good and opposed to the moral convictions of the general public. In short, laws themselves may be immoral. For example, violations of anti-Semitic laws in Nazi Germany or of anti-Negro laws in the United States constitute crimes, in that they are violations of laws prohibiting such acts and prescribing punishment for them; but the morality of such laws is a different matter.

Varying Attitudes and Practices.—Conceptions of crime vary so widely from culture to culture and change with time to such an extent that it is extremely difficult to name any specific act universally regarded as criminal. Treason or disloyalty to the group, especially in time of conflict or war, is perhaps one of the most universal and among the first acts to have been recognized as a public wrong. Other types which emerge very early in human history are sacrilege or the violations of supernatural taboos and incest which, although almost universally condemned in primitive and modern societies, is differently defined in different cultures. Adultery, fornication, prostitution, homosexuality and other disapproved forms of sexual expression are handled in many ways in contemporary societies and are sometimes covered by the criminal code and sometimes not. (*See* SEXUAL BEHAVIOUR: *Legal Aspects.*) Murder is a recognized crime in all civilized societies, but primitive peoples and folk communities within civilized societies may treat the killing of a human being as a relatively private matter to be dealt with by the kinship groups involved. The blood feud (*q.v.*) is an example of this. The deliberate killing customary in some primitive societies, such as infanticide, head hunting, cannibalism and the killing of very old persons, would be classified as murder in civilized societies.

If crime is viewed only as violation of criminal codes promulgated and enforced by the state and its agencies, however, it can hardly be said to exist in primitive societies in which political and legal institutions are undeveloped. In such societies conduct is largely controlled by customs and standards shared by virtually all members and serious violations are relatively rare. When they do occur they may be handled as private rather than public wrongs by the persons, families or kinship groups directly involved. In more complex preliterate societies the conception of a public offense (crime) emerges more clearly and offenders may be summoned before the headman or a council of elders, who hear the case and fix the punishment in accordance with the traditions of the group. In general it may be said that primitive peoples more often than civilized peoples, handle infractions of social norms as torts (private wrongs) rather than as crimes; that they pay less attention to the state of mind or intention of the offender and that responsibility is more often collectively assessed than is the case in modern criminal law where criminal guilt is generally regarded as strictly personal. While practices vary widely, the manner of determining guilt among preliterate peoples is usually very different from that of the contemporary criminal trial and involves much that has nothing to do with the actual evidence, such as ritual oaths, ordeals and various magical devices.

In modern industrial society there has been an enormous proliferation of criminal laws designed to protect property rights. The conception of property and the nature of property crimes have changed enormously with the evolution of capitalist economic institutions such as those of credit, large-scale business and industry and the modern publicly owned corporation. With this expansion of criminal law in economic and certain other areas there has been a compensating tendency for laws relating to religious observances and to certain kinds of sexual behaviour to disappear or not to be enforced. Crime in contemporary civilization is thus a far different matter from crime in even the more advanced

rimitive societies. The criminal codes of modern nations are normously complicated, growing bodies of written rules and doc-rines, most of which are unknown to the average citizen. Offend-rs are detected, brought to court, tried, convicted and punished y professionals especially trained for their particular functions, nd in the meantime other professionals, the criminologists, nvestigate the causes of crime and examine the ways in which orrection and prevention are handled. Academic students of rime, judges, prosecutors, defense lawyers, the police, prison offi-ials, sociologists, social workers, psychiatrists and psychologists, ll have different perspectives of the problem and different sug-estions to offer.

The dominant conflict of views in the field of penology is be-ween those who put their faith in severe punishment in the belief hat this will prevent the criminal from repeating his crimes and lso serve as a deterrent to others and, at the other extreme, the chool of thought which emphasizes the futility of punishment nd the evil effects of prison life. The advocates of this latter osition often conceive of the criminal as a victim of social and sychological forces outside his control. They contend the crimi-al should be regarded as though he were mentally ill and instead f being made to suffer for his crimes should be treated for his lness. Punishment is said to be an expression of vengeance based pon a discredited psychological doctrine of free will and should herefore be eliminated.

A compromise position located between the two extremes seems o be the one toward which most of the nations of the world are noving. This position rejects the idea that punishment should be olished and insists that moderate and just punishment itself as rehabilitative value. Instead of severity it stresses swiftness nd certainty of punishment, which it regards as having more eterrent effect and as increasing the opportunity to reform the riminal. Treatment without punishment is regarded as applica-le only to the mentally ill and the very young. The evils of rison life are admitted but it is proposed to mitigate them by nposing shorter sentences, by using probation, fines and other ubstitutes for imprisonment, by improving conditions within risons and by experimenting with new kinds of prisons and re-abilitative techniques. It is also commonly recognized that some riminals must be incarcerated for long periods of time, not so uch for the sake of severity as for the protection of society.

During the last several centuries use of the death penalty has eclined and it is under attack in many of the jurisdictions that ill retain it, as do Great Britain and most of the states of the nited States. Corporal punishment, torture, banishment and ther more brutal forms of punishment have largely been aban-oned in favour of imprisonment for almost all serious crimes nd fines for the lesser ones.

Public opinion in regard to the punishment of criminals is di-ded and vacillating. Rising crime rates invariably create a emand for greater severity of punishment, restoration of corporal unishment or more frequent infliction of the death penalty. hen legislatures respond to these pressures, however, public op-osition often develops and may prevent the actual imposition the increased penalties. Low crime rates tend to be associated ith lenient and liberal treatment of criminals, but it is difficult o say whether the lenient treatment of offenders reduces crime whether a favourable situation in regard to the amount of ime reduces public hostility toward offenders and causes them o be handled more gently.

See also CRIMINOLOGY and articles on various specific crimes ARSON; ASSAULT AND BATTERY; BURGLARY; etc.

(A. R. L.)

UNITED STATES

Identification of Criminal Acts.—In the United States statu-ry prohibitions vary from one political jurisdiction to another nd from time to time within a given jurisdiction; adultery, domy and gambling are a few examples of acts that are prohib-ed in some places and tolerated in others. Similarly, traffic gulations are notoriously inconsistent in different states and unicipalities. Nevertheless, statutes in the various U.S. states exhibit considerable uniformity in outlawing specific acts ranging from such minor offenses as disorderly conduct and vice to such relatively severe offenses as larceny, assault, robbery, homicide and treason.

While statutes define crime, it remains for police and courts to take appropriate judicial measures against persons accused of violating these statutes. Conviction of a crime in a criminal court means that, officially at least, the offender has committed a designated criminal act, that he has been assigned the legal status of a criminal, and that in most cases he has been deprived of some of the prerogatives of citizenship, such as the right to vote or to hold public office. (These rights, however, are sometimes restored after punishment or other corrective action has been consummated.)

Thus specific instances of criminality are identified by the judicial process. If this process is not applied uniformly and efficiently, violations of statutes may infrequently result in criminal convictions. For example, it has been estimated that only 35 persons are committed to penal institutions for every 1,000 offenses known to the police. Other cases, of course, are placed on probation, given fines, or sentenced to short jail terms. But the disparity between the number of known offenses and the number of court convictions is one of the most difficult crime problems in the United States.

Law violators may avoid punishment or other official controls for several reasons. Many offenses escape detection. It is sometimes hard to tell whether objects have been lost or stolen, for example, and even violent offenses such as assault or homicide may be difficult to identify. When death is surrounded by unusual circumstances, investigation may fail to determine if it is due to suicide, homicide or "natural causes." Detection of crime is especially troublesome when the victim is feeble-minded, psychotic, intoxicated or otherwise irresponsible.

Methods of criminal investigation and identification have shown much improvement in modern times but law-enforcement agencies often fail to obtain the public support and co-operation that is essential for effective use of the judicial process. Many known offenses are not reported to the police. When the reputation of the victim is likely to be endangered, as in certain sex offenses, attempts at concealment commonly occur. Or the victim may be reluctant to report certain offenses because he, too, is involved in law violations, as is frequently the case among victims of "confidence games" and "shady deals." Again, the victim may refuse to co-operate with the police if the offender is willing to make restitution for any damages resulting from the offense.

Offenses that are reported may not be solved by the police. Although more than three-fourths of reported rapes, assaults and murders are "cleared" by arrest, this is true for only about one-fourth of larcenies and burglaries. Even after arrest a number of offenders avoid court convictions; about three-fourths of the persons arrested for burglary and larceny are found guilty, while approximately half of those charged with rape, assault or murder are convicted. Finally, some persons—children and the insane, for example—do not ordinarily come under the purview of criminal courts regardless of the severity of their offenses, because they are not considered to be legally responsible for their actions.

Trends and Frequencies.—The main source of information on nationwide crime is the *Uniform Crime Reports,* issued semi-annually by the Federal Bureau of Investigation (*q.v.*). These reports are compiled from data contributed voluntarily to the bureau by numerous law-enforcement agencies. They provide statistical information on offenses known, arrests made and guilty verdicts obtained. The reliability and comprehensiveness of the data are impaired, however, by local and regional variations in definitions of terms, lack of efficient records systems in some agencies, and the fact that reports of local agencies to the bureau are not compulsory or subject to other legal controls.

Estimates indicate that 2,500,000 offenses occur annually in the United States. Approximately 200,000 prisoners are confined in state and federal correctional institutions. Another 100,000 are held in various jails and about 40,000 in juvenile institutions. The number of prisoners is increasing by about 4,500 annually,

and the cost of construction for housing them is perhaps $45,000,000 per year. The use of probation and parole is increasing even more rapidly, but probably at less cost. Over-all estimates of crime costs vary from $10,000,000,000 to $20,000,000,000 per year.

Moreover, crime rates appear to be increasing considerably more rapidly than the rate of population increase. This is especially true of most property offenses. Homicide rates appear to be fairly stable. Aside from traffic violations, drunkenness is the single offense with the highest frequency of arrest. Among the categories of major crime larceny seems to occur most frequently followed by burglary, auto theft, assault, robbery, rape and homicide, in that order.

Variables Associated with Criminality.—Numerous studies show that crime varies according to the social and cultural characteristics of a community. Consistent regional differences in criminality can be noted, for example. The New England states have relatively low rates for nearly all types of crime; the southern states have the highest rates for assault and homicide; the Pacific coast states have the highest rates for robbery, burglary and larceny. Generally, large cities have higher crime rates than small cities and urban areas have higher rates than rural areas, although crimes such as rape and homicide do not appear to follow this pattern.

Similarly, crime rates vary within a given area or community according to the social and cultural characteristics of the constituent neighbourhoods. The highest rates are frequently found in deteriorated areas near the centre of large cities where there is extreme poverty and unemployment, where change of residence is frequent and inhabitants have few ties with the community, where diverse cultural and ethnic groups are temporarily intermingled, and where parents are often either negligent or unreasonable in relations with their children. Gang violence and juvenile delinquency are also concentrated in such areas. These are the neighbourhoods in which legitimate avenues to success and achievement are greatly restricted and contacts with traditions of criminality are prevalent.

In addition, crime rates vary according to the social and psychological traits of individuals. Thus, males have higher rates than females, unskilled labourers have higher rates than skilled workers or professionals, Negroes have higher rates than whites, members of the lower socioeconomic classes have higher rates than members of the middle or upper classes, psychopaths and severely maladjusted persons have higher rates than those who are emotionally healthy and so on. These traits, of course, are not major causes of crime, but they are often closely related to more fundamental social and cultural factors.

Youthful offenders are most likely to commit serious crimes such as auto theft, robbery, burglary, and larceny; rates for these offenses among persons 16 to 25 years of age are considerably higher than they are among other age categories. These offenses comprise 95% of major crimes and are characterized by frequent repetition on the part of a single offender.

Organized Crime and Racketeering.—After World War I there was in the United States a spectacular growth of organized crime which assumed control over such tremendously profitable activities as gambling, bootlegging, bookmaking, the numbers racket, slot machines, narcotics traffic, prostitution and a variety of "protection" devices. Since segments of the American public have been willing to support organized crime by patronizing a variety of these illegal businesses and recreational activities, which are frequently highly organized, gangsters have attempted, often successfully, to exert political influence on all levels of government to prevent interference by the police and the courts.

(*See* also CRIMINOLOGY: *Causation.*)

White-Collar Crime.—Although crime is commonly regarded as primarily an underworld activity, certain kinds of criminal behaviour occur with striking frequency among groups and persons who are viewed as respectable members of the community. White-collar crime refers to law violations committed by persons of respected occupational, economic or social status in the pursuit of their occupational activities; the offenses generally involve swindles, frauds and duplicity in financial dealings. White-collar criminals may lead outwardly conventional lives, except for their illegal activities, and may be widely trusted and respected. Despite their relatively high social positions, however, they may cost the public far more than is involved in the combined losses resulting from such crimes as robbery, burglary and theft. (*See* also EMBEZZLEMENT; FRAUD.)

Crime Control.—Attempts to curb the rising crime trend involve both suppressive and preventive measures. Crime suppression has been marked by a continuous increase in the range and number of activities that come under the scope of criminal law and by a related increase in the number of crimes defined by statute. No doubt some of the increase in the crime rate is a result of these changes. In addition, there has been a proliferation of police organizations on local, city, county, state and national levels of government (*see* POLICE), and efforts at co-ordinating and consolidating law-enforcement services are receiving widespread attention.

Prevention devices include a variety of guidance services, clinics, clubs, camps and other institutions. Several states have established prevention bureaus to work with local communities on a consultant basis. The children's bureau in the federal department of health, education, and welfare has initiated preventive services and co-ordinated efforts on a nationwide basis. (*See* also CRIMINOLOGY: *Prevention;* JUVENILE DELINQUENCY.)

In the final analysis, however, the public gets the kind of crime control it demands and is willing to support. If laws are regarded as outmoded, if citizens desire that laws be enforced only at certain times and places, if they demand preferential treatment, and if they place supreme value on wealth and power regardless of the way in which acquired, then, of course, they cannot expect the agencies of crime control to enforce laws or to supervise activities with any degree of efficiency, uniformity or impartiality. This is the major crime problem.

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(C. C. Sc.)

GREAT BRITAIN

Changing Concepts of Crime.—Christianity had a profound influence on the attitude toward crime in medieval Europe, including England. It was thought necessary for criminals to be brought to repentance before being executed and the practice of torture arose from a legal prohibition to execute one who had not confessed, though its subsequent use tended to form an integral part of punishment in Norman times. Another important factor was the need to build up a strong central government. Acts against the church and the person and power of the king and his officers became crimes. Treason against the king's person was first made punishable by death under Alfred the Great. As the king became more powerful, legislation against private crime increased and after the Norman conquest a distinct body of criminal law evolved for the first time. Thieves were to be hanged and many new crimes were designated.

The maintenance of law and order from the reign of William I to about 1500 varied with the stability of the political system. During the civil war between Stephen and Matilda (1135–54) individual barons and their retainers plundered and pillaged the countryside. As part of his policy of strengthening the central government, Henry II (1154–89) established the system of itinerant justiciars, forerunners of the judges of the assize, as an alternative to the manorial courts. Not until the reign of Henry VI however, did a strong central government emerge and with it a relative degree of social stability.

During the Tudor period Britain emerged as a modern state. The rapid economic expansion and the religious upheavals of the time are reflected by the great increase in the types of crime against which legislation was passed. The establishment of a state church under Henry VIII both intensified the drive against heresy and limited severely the jurisdiction of the ecclesiastical courts,

rtain crimes (notably sodomy) then falling within the province the civil courts. The reign of Elizabeth I was characterized repressive legislation against Puritans and Roman Catholics d an elaborate counter-espionage system, not unlike that in a odern totalitarian state, was developed by Sir Francis Walsing- m.

Meanwhile the economic revolution, accompanied by inflation, ricultural unemployment and the enclosure system, swelled the nks of "sturdy beggars" who roamed the countryside in search subsistence. In the last half of the 16th century the penalties r vagabondage became increasingly brutal, but legislation failed distinguish between criminality and genuine destitution or to re- ce the incidence of either (*see* Poor Law).

Under the Stuarts, the need to raise money for the crown led new crimes being defined and the increased use of fines as nishment. Old laws were invoked and those who evaded the yment of obsolete taxes were fined heavily. Also, such extraor- nary courts as the Star Chamber (*q.v.*) dealt with crimes of rruption, breach of trust, attempted felony and crimes of polit- al misdemeanour (*e.g.*, libel and conspiracy) and were used even ore intensively than they had been under the Tudors. Religious imes were common—it was not until 1677 that capital punish- ent for heresy was abolished. During the Commonwealth 649–1660) an attempt was made to reduce drunkenness, swear- g and sexual immorality by making them crimes. Another mpaign was that against the "black arts" in which the fanatical atthew Hopkins and other "witch-finders" sent dozens of women be burned alive.

The 18th century is commonly thought of as a time of great wlessness and corruption. This is partly explained by the growth population, the inadequate police system and increasing pros- rity which invited crimes against property. The death penalty as enforced for petty theft and also became customary for seri- us crimes against the person. Piracy was first seriously regarded a crime toward the end of the 18th century. The growth of e banking system at the turn of the 18th century led to an exten- on of the legislation against forgery; the growth of trade, to legis- tion against new crimes such as adulteration.

Gradually there was an awakening from the excessive brutality the 18th century. Humanitarian feeling militated against the tensive use of the death sentence, resulted in reform of the isons (*see* Prison) and led to concern for the reformation of e criminal. The first scientific studies of crime in England ere sociological in character and modeled closely on the work A. M. Guérry in France. Between 1830 and 1862 R. W. Raw- n, J. Fletcher, J. Glyde and others made regional and national rveys while H. Mayhew made an exhaustive study of crime in etropolitan London, reported in his *London Labour and the ondon Poor* (1851).

The social and economic changes of the 19th century resulted legislation such as labour laws, education acts and public health gulations, which related to acts bearing little resemblance to the aditional forms of crime; many of them were challenged initially the grounds of interference with individual freedom. These d the inception of a modern police force resulted in an increased olume of recorded crime while the emphasis of criminal jurisdic- on shifted from the high courts to the magistrates' courts (*see* ourt).

20th-Century Developments.—By 1900 the dominant type of ime was urban property crime committed by young men chiefly om the lower social classes. Sociological studies were largely lipsed by the work of C. Lombroso and his pupils (*see* Criminology: *Causation*), the only important work in Britain being refutation of his major thesis by C. Goring in *The English Convict* (1913). The disorganization of the social structure resulting om World War I was accompanied by an appreciable increase crime, especially juvenile crime, together with new crimes asso- ated with food rationing and price racketeering.

Between 1920 and 1940 penal techniques were developed and panded, notably the Borstal system (*q.v.*) and probation. Re- arch into crime was comparatively limited, Cyril Burt's *The oung Delinquent* (1925) being the most outstanding. The Institute for the Scientific Treatment of Delinquency was founded in London in 1931 and provided for the first time a centre for the psychiatric treatment of offenders. In 1935 the first experiments in psychotherapy were begun by J. V. Mackwood in Wormwood Scrubs prison, and in 1938 W. N. East and W. H. de B. Hubert wrote their famous memorandum on the treatment of mentally abnormal criminals, *Report on the Psychological Treatment of Crime*, which was published the following year.

From 1931 to 1939 indictable crimes known to the police rose from about 190,000 to just more than 300,000 a year, an increase partly due to improvement in police techniques and changed methods of crime registration. Property crimes predominated but unemployment among young men led to outbreaks of gang warfare notably in Liverpool and Glasgow. Anti-Semitic activities organized by the British fascist movement, together with left-wing counter demonstrations, occasioned the Public Order act of 1936 which gave the home secretary wide powers to limit political demonstrations leading to public violence. As in other countries, the motor car offered increased opportunities to certain types of criminals, *e.g.*, the "smash-and-grab" raider who smashes a display window, scoops up jewelry or other loot and flees in a waiting motor car, while the police became increasingly involved with the enforcement of traffic laws.

World War II produced a greater dislocation of the civilian population than had occured during World War I. Evacuation in 1939, followed by the drift back to the cities, dislocated the school system and this, combined with life in air raid shelters and the absence of fathers on war service, is generally regarded as a major cause of the rise in juvenile delinquency in 1940–41. The blackout increased the opportunities for many types of crime, including assaults and sex crimes, and the "blitz" period was accompanied by outbreaks of looting. Price racketeering was more effectively controlled than in World War I, though rationing coupons were frequently bought and sold and otherwise respectable citizens bribed shop assistants or dealt in black market goods.

Although juvenile delinquency rose sharply the total increase in indictable offenses during most of the war years was smaller than might have been expected. Among adults, the proportion of first offenders to recidivists increased and criminality among girls and young women showed a serious rise. The rapid increase in 1945 was variously attributed to the black market, deserters from the forces, a general lapse into lawlessness and a shortage of police. During the postwar years the effects of abnormal wartime conditions were most acutely felt. The volume of indictable offenses rose to 524,500 in 1951 and, after having declined for three years, began to rise again in 1955 and continued to rise (743,713 in 1960).

Not all crimes increased at the same rate after 1938. Larceny and other nonviolent offenses against property rose by about 150%, but breaking and entering and similar offenses by 250%. Most serious was a rise of over 400% in crimes of violence against the person. The distribution of types of crime in the total of indictable offenses remained remarkably stable with property offenses (about 85%) predominating. Police efficiency, as measured by the percentage of offenses "cleared up," dropped from 50.1% in 1938 to 44.7% after World War II. The number of offenses recorded in the criminal statistics was almost certainly an underestimate.

Analysis of the age and sex of persons prosecuted indicated the biggest group of offenders were boys in their last year of school (age 14+), as compared with age 13+ in 1938. The rate in criminality among persons between 14 and 30, especially in the 17–21 age group, was considerable. The ratio of those under 30 to those over 30 found guilty of violence against the person altered from 50%–50% in 1938 to 73%–27% by 1960. This youthful violence was associated with a distinctive new urban youth culture —characterized by the "Teddy boy" and "rock 'n' roll" music— similar to that which emerged in other European countries, notably Sweden and western Germany. Much of this violence was apparently motiveless and was directed against property as well as persons; in Britain a number of people campaigned for the reintroduction of corporal punishment to curb it.

Traffic offenses also rose continuously in the postwar period and traffic offenders tried summarily (automatically excluding those causing death by dangerous driving) constituted 60% of all persons before the criminal courts.

Treatment and Crime Prevention.—The Criminal Justice act, 1948, introduced major changes into the prison system, abolishing penal servitude and introducing special sentences of corrective training and a new form of preventive detention. All corporal punishment was abolished except for violence against prison personnel. Two new forms of treatment were introduced for juveniles, the attendance centre and the detention centre, and imprisonment under the age of 21 was severely limited. Capital punishment was suspended for a brief period but was reintroduced, following public pressure, in the Homicide act of 1957, a political compromise which satisfied neither abolitionists nor retentionists. The probation system was developed and the number of officers increased but the percentage of offenders placed on probation declined. Instead, the courts appear to have employed short-term imprisonment and fines, both methods out of keeping with the modern emphasis on reformation. Subsequent legislation attempted to reduce the prison population by limiting the imprisonment of first offenders, and attaching the wages of husbands who failed to maintain their wives. Solicitation by prostitutes, which had become widespread in London by the mid-1950s, was reduced dramatically by the Street Offences act, 1959, which provided for much heavier fines and prison sentences than 19th-century legislation had done. New proposals for changes in the penal system appeared in a white paper, *Penal Practice in a Changing Society,* relating particularly to the treatment of young offenders.

Between 1950 and 1960 criminological research in Britain expanded rapidly, much of it subsidized and commissioned by the home office and the prison commission. Investigations were largely concerned with evaluation of penal techniques and studies of offenders, rather than long-term analysis of the causes of crime. In 1960 an Institute of Criminology was established at Cambridge university.

While the volume of criminal legislation passed between 1948 and 1960 was impressive, there were few attempts at direct crime prevention other than those of individual social workers working with juveniles. Experiments such as the Barge club in London were followed up elsewhere with varying degrees of success, but the total impact of these projects was small. There were several preventive schemes in Liverpool, notably the Dolphin club, and a police juvenile liaison scheme which was viewed with some disfavour by professional social workers.

Paradoxically the growth of crime in postwar Britain and the development of social security took place simultaneously, suggesting that classical theories relating crime to poverty were no longer valid.

See CRIMINAL LAW; CRIMINOLOGY; JUVENILE DELINQUENCY; PRISON; PROBATION; *see* also references under "Crime" in the Index volume.

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(J. C. SR.; T. P. M.)

CRIMEA (KRYM or KRIM), a large peninsula, known anciently as the Tauric Chersonese, lies between the Black sea and the Sea of Azov, which are separated by the narrow strait of Kerch (Kerchenski Proliv) at the eastern end of the Crimea. The peninsula (Krymski Poluostrov) is coterminous with the Crimean (Krymskaya) *oblast* of the Ukrainian Soviet Socialist Republic. Pop. (1959) 1,201,517. Area 9,884 sq.mi.

Physical Geography.—The peninsula is connected to the mainland by the 5–14-mi.-wide Perekop isthmus, the scene of many battles for the control of the Crimea and crossed since ancient times by a ditch and earth bank. Between the Crimea and the mainland lies the Sivash, or Putrid sea, with a very high saline content (up to 2–3%). The Sivash is shallow and is separated from the Sea of Azov by the remarkable 70-mi.-long sandspit known as the Arabatskaya Strelka, along the eastern shore of the Crimea.

The Crimea itself falls into three regions. The north and central parts comprise a level plain (about 75% of the peninsula), sloping down gently from south to north. This is dry steppe on black earth and chestnut soils, with very little surface water. The intermittent rivers, the longest of which is the Salgir, mostly dry out in summer. The second region is the Kerch peninsula (Kerchenski Poluostrov) in the east, consisting of low hills, rich in iron ore and with many mud "volcanoes." There too there is steppe vegetation. The third region is made up of the Alpine fold mountains of the south, which form three chains, parallel to the south coast. These chains, known as the Crimean mountains (Krymskiye Gory), are successively higher to the south, all with steep faced southern slopes and more gentle northern slopes. The highest, southern range consists of flat-topped limestone blocks known as *yaily,* which rise to 5,069 ft. in Roman-Kosh. This range drops steeply to the sea, where there is a narrow coastal plain, broken by cliffs and headlands. The mountains have a luxuriant and varied forest vegetation of oak, beech, hornbeam, maple and other species. Many exotics have been introduced such as cypress, oleander, almond and myrtle, together with palms and other subtropical plants.

The climate of the northern part is dry, with 12–14 in. of rain annually, and continental, although modified by the surrounding seas. January average temperatures are just below freezing and warm spells are common. The southern coast, sheltered by the mountains from cold northern air, has a mild, Mediterranean type of climate, with January average temperatures about 42° F. The rainfall there and on the mountains is higher, 20–25 in. a year. Hours of sunshine on the Crimean coast are the highest in the Soviet Union.

History.—The Crimea has a long and varied history. The first settled occupation was perhaps by the Cimmerians (*q.v.*) about 1000 B.C. In the 7th century B.C. the Scythae conquered the steppe area, but the kingdom of the Cimmerian Bosporus (*q.v.*) survived in the Kerch peninsula, where it came under strong Greek influence. From the 5th and 4th centuries B.C. onward the Greeks established colonies along the Crimean coasts, the most important being at Chersonesus Heracleotica, near the modern Sevastopol, and Panticapaeum, where Kerch now stands. These colonies, which came under Rome in 15 B.C., survived the series of invasions by eastern nomadic hordes who in turn occupied the steppe. In the 10th century A.D. these cities fell to Prince Vladimir of Kiev, but Kiev was unable to retain the Crimea, which came under the Polovtsy (Kumans) of the steppe and later under the Tatars. In the 13th century the Genoese established "factories" along the coast, which remained until the conquest of the area by the Turks in 1475. Inland a remnant of the Tatar Golden Horde, owing nominal suzerainty to the Sultan, had their capital at Bakhchisarai (*q.v.*). These Tatars made frequent raids on the Muscovite state.

In 1774, by the Treaty of Kuchuk Kainarji, Catherine the Great forced Turkey to recognize the Crimea as independent, and in 1783 she annexed the peninsula. There in the Crimean War (*q.v.*) of 1853–55 the Anglo-French armies fought the battle of the Alma, Inkerman and Balaklava (*qq.v.*) and laid siege to Sevastopol. Sevastopol was once more to make a prolonged and desperate defense against besiegers in the German invasion of 1941. In 1945 the heads of the Allied powers, Churchill, Stalin and Roosevelt, met at Livadiya near Yalta.

Population.—Many of the Tatars of the Crimea were forcibly dispersed to other parts of Russia after the Crimean War, but enough remained for an autonomous republic to be set up for them in the Crimea in 1921, after the Revolution. However, after World War II the remaining Tatars were also dispersed, for collaboration with the Germans, and the Crimea was downgraded to an *oblast* of the Russian Soviet Federated Socialist Republic. It was transferred to the Ukraine in 1954. Nearly all the population are Russians and Ukrainians. Scarcely any of the Karaite Jews, who once lived there, survive.

In 1959, 784,688 (65%) of the population were urban. The largest of the 13 towns are the administrative centre of Simferopol (pop. 189,000), the port and naval base of Sevastopol (148,000), Kerch (99,000), Yevpatoriya (57,000) (*qq.v.*), Yalta and Feodosiya.

Economy.—The Crimea is of great agricultural importance. The northern steppes are mostly under the plow, growing winter wheat, maize (corn) and sunflowers. The dry climate there is marginal for agriculture and after 1961 a canal was constructed to bring irrigation water to the area from the Dnieper at Kakhovka. In the mountain valleys and on the southern coast there are extensive and steadily expanding vineyards. There, too, much good-quality tobacco is grown, as well as flowers for scent: roses, lavender and sage. The number of livestock, chiefly cattle and sheep, is well above the average for Ukrainian *oblasts*.

Iron ore is mined on a large scale in the Kerch peninsula. Although the ores have a low iron content (about 40%) by U.S.S.R. standards, they are conveniently close to the great industrial area of the Donets basin. Heavy industry is largely concentrated in Kerch, with iron and steel, coke-chemical and engineering works. Some chemical industries are based on brine from the Sivash. Other towns have light engineering, clothing, leather and footwear industries, while the processing of agricultural products is widespread (canning, wine, tobacco and scent-making). There are many quarries of building stone, such as Balaklava limestone and Crimean diorite, which is used as a decorative stone throughout the U.S.S.R. All round the coasts fishing is important.

Along the south coast the tourist industry is well developed, the main centres being Yalta, Gurzuf, Alushta and Alupka. A fast motor road links the resorts to Moscow. There are numerous sanatoria and rest homes. The frequently clear skies led to the establishment at Simeiz of one of the largest observatories of the Soviet Union.

See also references under "Crimea" in the Index volume.

(R. A. F.)

CRIMEAN WAR, the war of 1854–56, fought mainly in the Crimean peninsula, between Russia on the one hand and Great Britain, France and Turkey, with support from Jan. 1855 by Sardinia (Piedmont), on the other. The war arose from a series of misunderstandings and diplomatic errors in the conflict of interests of the great powers in the near east. The Straits convention of 1841 had implied that no single power was to seek exclusive influence in Ottoman affairs, but the chaotic Turkish administration caused constant concern and the spread of nationalism everywhere was likely to threaten European Turkey with the same disorders that had produced the revolutions of 1848–49 in Europe (*see* EASTERN QUESTION).

The Seymour Conversations (1853).—Disturbances in Montenegro in Dec. 1852 alarmed Nicholas I of Russia. His foreign minister, Count K. V. Nesselrode, therefore began sounding Sir Hamilton Seymour, the British ambassador in St. Petersburg, on the British attitude to the Turkish question. At the same time the Earl of Aberdeen formed his government in Great Britain (Dec. 28, 1852). In his conversations with Seymour (Jan. 9 and 14, 1853), Nicholas painted a gloomy picture of the Ottoman situation and said that Turkey was "very sick." However, he merely desired some prior arrangement with Great Britain to meet a possible crisis and to provide for a peaceful partition, should the Ottoman empire disintegrate. In his despatch to Seymour of Feb. 9 the British foreign secretary, Lord John Russell, declared that he thought the possibility of a Turkish collapse remote and that in any case a two-power agreement might itself cause war, but he added his assurance that the British government would in all circumstances consult Russia. Nicholas I was well satisfied by the British attitude.

The Holy Places.—Subsequent friction between Russia and Great Britain thus had other sources. Ostensibly the dispute arose over the question of the Holy Places in Palestine. Nicholas I, convinced that France was too much occupied with internal affairs to adopt a forward foreign policy, felt that Great Britain alone need be consulted. In France, however, the new emperor, Napoleon III, and the Bonapartist faction were in fact inclined to a policy that would at once satisfy nationalist pride, serve the interests of French commerce in the Levant and please the clergy by the assertion of the Roman Catholic Church's priority in the Holy Places, but Nicholas thought that they would never secure the necessary British backing to pursue it.

The Holy Places consisted of the churches of the Holy Sepulchre and of the Virgin in Jerusalem, the church of the Nativity in Bethlehem and the place of Golgotha. The priests of the Latin rite had been associated in the administration of the Holy Sepulchre up to 1808, when the sultan had handed it over to the Greeks, who remained in possession despite the *firman* of 1812 restoring the Latins. The French, however, having already obtained that the keys of the church at Bethlehem and the grotto of the Holy Manger should be handed over to the Latins (Feb. 1852), extracted further concessions in Dec. 1852. Nicholas, therefore, seeing this pressure on the sultan as a threat to Russian influence in Ottoman affairs contrary to the spirit of the Straits convention, decided to make the Holy Places a test issue and sent Prince A. S. Menshikov to Turkey to clarify Russia's position and to assert Russian rights under the treaties of Kuchuk-Kainardji (1774) and Adrianople (1829). He wrongly assumed that he could assert Russian rights against France without arousing the misgivings of Great Britain. As early as March 20, 1853, Lord John Russell, then minister without portfolio (he had surrendered the foreign office to Lord Clarendon in February), said that a near eastern crisis was imminent. The news that a Russian observation corps in Bessarabia had been mobilized and the Black Sea fleet put on a war footing at Sevastopol seemed to confirm this, since both measures would intimidate the Turks. British suspicion was shown by the renewed appointment of Viscount Stratford de Redcliffe (*q.v.*) as British ambassador to Turkey. Stratford, who took up his duties in April, was well-known as a leading opponent of Russia at the Straits. His appointment led the Turks to believe that they might enjoy British support.

The Menshikov Mission and the Outbreak of War.—On May 5, 1853, Menshikov presented the Russian demands that Russia's treaty rights should be recognized. He even offered a secret alliance to uphold the sultan's authority. Stratford advised the Turks to be cautious, but the Porte (the Turkish government), though ready to give assurances about the Holy Places, was not disposed to flout Turkish opinion by submitting to Russia on the major questions of the treaties of Kainardji and Adrianople. On May 21 Menshikov withdrew his mission, having failed to obtain a satisfactory reply. Aberdeen and the British cabinet thought that the Russian demands were unreasonable, aiming at establishing a Russian protectorate over Turkey. On June 2 the British fleet was ordered to Besika bay, just outside the Dardanelles, where it arrived on June 13, to be joined by a French squadron next day. Nicholas I, determined to uphold Russia's position, on June 27 ordered the occupation of the principalities of Moldavia and Walachia, and the Russian forces crossed the Pruth on July 4.

To prevent hostilities, British, French, Austrian and Prussian representatives conferred in Vienna during July, and on Aug. 1 recommended in their "Vienna note" that the sultan should "remain faithful to the letter and spirit of the treaties of Kainardji and Adrianople relative to the protection of the Christian religion," not altering them without French and Russian consent. The Russian attitude was that the Vienna note was merely a confirmation of existing treaty rights, but the Porte, in spite of Stratford's recommendation of Aug. 12 to accept the note, declared on Aug. 19 that the Turkish government itself would undertake the protection of the Christian religion. The Turkish declaration

meant the exclusion of all foreign intervention, whereas Russia was claiming the right to intervene.

The deadlock produced a sense of panic in London, especially when the French ambassador informed Clarendon that there was a danger of rioting in Constantinople and on Aug. 23 Aberdeen and Clarendon, without cabinet authority, issued the order for the British fleet to move up to Constantinople. At a meeting with the Austrian emperor Francis Joseph on Sept. 24 Nicholas I expressed willingness to accept the face-saving formula that recognition should be given to the rights of Russia under the treaties of Kainardji and Adrianople and to the sultan's duty to protect the Christian religion, but this was unacceptable to the British government. The Turks had by now sensed that they could provoke a crisis and in the long run obtain British and French support. On Oct. 4 Turkey declared war on Russia, though Stratford refused to put into operation the cabinet order which he received that day to call up the fleet to Constantinople, for fear of encouraging Turkish intransigence. The British order to the fleet was nevertheless repeated on Oct. 8. On Oct. 20 Austria, Prussia, Great Britain and France made representations to the Porte to avoid hostilities, but on Oct. 23 Omer Pasha opened the attack upon Russian troops in the principalities and on Nov. 1 Russia declared war on Turkey. The British and French fleets were then called into the Bosporus. The Russians could not be expected to remain idle while the Turks attacked them. Accordingly on Nov. 30 the Russian Black Sea fleet under Admiral P. S. Nakhimov destroyed a Turkish squadron off Sinope, to prevent its giving aid to the Ottoman forces on the Caucasian front. This Russian naval victory excited great indignation, especially in Great Britain.

Aberdeen wavered in the face of public demand for resolute action. On Dec. 22 he agreed to co-operate with France to the extent of sending the two fleets into the Black sea to contain the Russian fleet at its base at Sevastopol. The entry of the fleets into the Black sea on Jan. 3, 1854, was a direct challenge which Nicholas I could not ignore; he therefore withdrew his ambassadors from London and Paris in February. Great Britain and France could now obtain satisfaction from Russia only by delivering an ultimatum: on Feb. 27 they demanded that Russia should evacuate the principalities of Moldavia and Walachia—a demand which seemed to show desire to associate Austria with their action, for Austria was vitally interested in that area. On March 12, 1854, Great Britain and France concluded a military alliance with Turkey. As Russia made no reply, they declared war on March 27.

The War to the Battle of Inkerman.—The allies first sought to isolate Russia diplomatically. On April 9, 1854, Austria, Prussia, Great Britain and France signed an agreement to maintain the *status quo* in Turkey and the principalities. On April 20 Austria and Prussia signed a treaty of armed neutrality, by which Prussia undertook to assist Austria in case of a Russian attack—an unlikely event, because Nicholas I would wish to avoid trouble. On April 29 British and French troops disembarked at Varna to protect Constantinople from attack by the Russian army. The way was therefore clear for Austrian action, and on June 3 Austria demanded that Russia should evacuate the principalities. Threatened with an Austrian attack, Russia on Aug. 5 ordered its army to withdraw from Moldavia and Walachia, permitting the Austrians, by agreement with Turkey as the suzerain power, to enter them and thus seal off the Balkan theatre of war. The Russian move was astute because it also satisfied the terms of the Franco-British ultimatum of Feb. 27. Austria was therefore less inclined to support British and French action, while the allies were left with no obvious reason for fighting. They nevertheless needed to achieve some solid success to satisfy public opinion. Unable to attack in the principalities, they decided to send an expedition to the Crimea to destroy the naval base at Sevastopol.

On June 29, 1854, the British cabinet ordered its forces to invade the Crimea and plans were drawn up by the allied commanders, Lord Raglan and Gen. A. J. Leroy de Saint-Arnaud, at a war conference at Varna on July 18. On Sept. 14 an allied force of 57,000 men was landed at the small Crimean port of Evpatoria, but neither Raglan nor Saint-Arnaud were vigorous commanders; both were in fact to die during the course of the war, Saint-Arnaud in Sept. 1854 (to be succeeded by Gen. F. C. Canrobert), and Raglan in June 1855 (to be succeeded by Gen. Sir James Simpson). Both allied armies had on the whole elderly officers and used outdated methods. Raglan himself was 65 years of age, a veteran of the Napoleonic Wars. The Russian forces under Menshikov showed equal lack of tactical skill: 80,000 in number (including 50,000 regulars), they let the allies land unopposed. The allies advanced south against Sevastopol, but in the confused and costly battle of the Alma (*q.v.*) on Sept. 20 they failed to exploit their advantage and could not take the north and weaker side of the fortress. They therefore decided to march to the southern side of the city, where they could be more easily supplied by sea. The bombardment of Sevastopol was begun on Oct. 17, but the French magazine blew up and the final assault had to be postponed. Delays gave the Russian engineer, Col. Count E. I. von Todleben, a chance to prepare the city's defenses. The ensuing engagements were marked by scant military skill. A Russian counterattack at Balaklava on Oct. 25 was repulsed with considerable losses on both sides. (*See* BALAKLAVA, BATTLE OF.) A second Russian attack on Nov. 5 at Inkerman (*see* INKERMAN, BATTLE OF) was so costly to the allies that they could no longer envisage an assault on Sevastopol and would be obliged to winter in the Crimea. On Nov. 14 the British supply ships were destroyed in a violent storm. This left the British army in a lamentable state when winter set in.

The British public, for the first time kept in touch with the details of military operations by telegraphic reports printed in the newspapers, bitterly criticized Aberdeen's government for mismanaging the campaign. The mission of Florence Nightingale (*q.v.*) with a party of female nurses to tend the sick and wounded at Scutari (Üsküdar on the Bosporus) gave additional publicity to the British army's sufferings. Some glorious success was now most urgently required if the government was not to be defeated in parliament. Napoleon III and his advisers felt similar anxieties. The British and French governments therefore redoubled their efforts to bring Austria into their alliance in order to insure military victory.

Diplomatic Efforts to End the War.—When Austria demanded that Russia evacuate the principalities on June 3, 1854, the Austrian foreign minister, Count K. F. von Buol-Schauenstein, foresaw the dangers of war and therefore asked the allies to declare their war aims. Discussions then led to the notes of Aug. 8, 1854, which stipulated these four points: (1) a European instead of a Russian guarantee for the principalities; (2) the improvement of Danubian navigation; (3) the revision of the Straits convention of 1841 "in the interests of the balance of power"; and (4) the substitution of a European protection for the Christian subjects of the Ottoman empire in place of Russian protection.

The Austrian government was in doubt whether or not to make an alliance with Great Britain and France, but false rumours that Sevastopol had fallen (which would have allowed the allies to withdraw honourably from war) prompted Buol to submit a draft treaty. On Dec. 2 a formal treaty of defensive alliance was signed between Austria, France and Great Britain but with the provision that, if Russia rejected the four points, the powers should concert measures to make their alliance effective, which meant that Austria would declare war on Russia. Buol, however, had received news on Nov. 20 that Nicholas I would accept the four points, so that war between Austria and Russia seemed in part unlikely.

The key to the situation was the third of the four points, the revision of the Straits convention. For internal political reasons, Great Britain and France interpreted this to mean the destruction of the naval base at Sevastopol and the removal of the Russian fleet from the Black sea. This would have justified the war costs and the heavy loss of life, but was a demand so far reaching that Austria was unlikely to force it on Russia. Great Britain and France therefore resorted to a subterfuge in their exchange of notes with Austria of Dec. 17–19. In their notes to Austria they defined point 3 as meaning to end "the preponderance of Russia upon the Black sea," which was vague; but between themselves they agreed that "England and France . . . must insist upon the demolition of Sevastopol." On Dec. 28 the British and French ambassadors (the earl of Westmorland and Baron F. A. de Bour

ueney) in Vienna and Buol agreed to meet Prince A. M. Gorchaov, the Russian ambassador, and asked him if he would negotiate n the four points as defined in the British and French notes to .ustria. Gorchakov inquired whether this meant the destruction f Russian fortresses, to which the ambassadors replied that they ould not discuss the four points, but asked merely whether negoations were possible. When Gorchakov stated that he would onsult his government and asked for 15 days' grace, the ambasadors thought that he was merely seeking to postpone a rupture ith Austria and that Russia would eventually refuse to negotiate ith the result that Austria would enter into the war on their side. orchakov, however, outmaneuvred them. He wrote to Buol sking that the powers should seek to impose "no condition which ight detract from the tsar's sovereign rights," which Francis oseph agreed was a good basis for negotiation. The French amassador objected strongly to this formula, but Buol neither anted war, nor wished to oppose his emperor's opinion. Gorchaov saw his chance to exploit a fundamental difference between .ustrian and allied policies. On Jan. 2, 1855, he secured an interiew with Francis Joseph who assured him he had no intention of ffending the tsar's dignity. Gorchakov thus found that Russia ould negotiate on more equal terms with the allies, and secured is government's approval to open discussions. This was agreed y the ambassadors in Vienna on Jan. 7. The allies had trapped hemselves into negotiating on terms other than the destruction f Sevastopol.

A ministerial crisis in London further complicated the situaon. On Jan. 23, 1855, J. A. Roebuck tabled his famous motion or an enquiry into the condition of the British army before evastopol. Lord John Russell resigned on the grounds that the otion was unanswerable. After defeat in the house of commons, berdeen's government itself resigned on Jan. 29. Lord Palmerston formed an administration in February on the understanding hat steps would be taken to end the war but, when the pacific eelite members of his cabinet resigned because he would not re st an inquiry into the management of the war, he reverted to a ore warlike policy. Meanwhile Lord John Russell had been sent o Vienna to act as British plenipotentiary, under the impression hat the British government's intent was pacific. Peace was in the ir, for on March 2, 1855, Nicholas I had died; with the accession f Alexander II the emperor's personal prestige no longer seemed o be involved.

When discussions opened in Vienna on March 15 the interpretaon of point 3 still gave trouble. Buol and Lord John Russell egan to move a compromise solution limiting the number of Rusan ships on the Black sea, but on March 30 the French foreign inister, Edouard Drouyn de Lhuys, visited London, where he hd Palmerston formulated schemes of limitation and neutralizaon which they considered would be unacceptable to Russia and herefore force Austria into the war. Drouyn arrived in Vienna n April 6, but Buol would have nothing to do with the London lans and began to put forward a plan of his own for limitation or "counterpoise," by which he meant a British and French guarntee to Austria. Drouyn had consistently worked for a permanent rench alliance with Austria, which he considered would force a ore conservative policy on the unreliable Napoleon III. He herefore returned to Paris to press Buol's plan on Napoleon. In iew of the disarray of the allies, Gorchakov announced on April 7 that he could not accept the principle of limitation, and the onference was adjourned *sine die* on April 21.

At first Napoleon III was inclined to accept the Austrian plan ut Lord Cowley, the British ambassador, was against it and Iarshal J. B. P. Vaillant, the minister of war, declared that the rench army's honour now required a military victory. Napoleon herefore rejected Drouyn's advice. Drouyn resigned and was eplaced by Alexandre Walewski. Lord John Russell, at first inlined to offensive action, had at Vienna come to favour peace. hen this reversal became publicly known, he was attacked in the ommons and compelled to resign from the government on July 13, ever again able to challenge Palmerston's leadership for the iberal party.

The Continuation of the War.—The war dragged on into the spring and summer of 1855. The allied forces, joined by 15,000 Sardinians on Jan. 26, began a series of costly bombardments and assaults on Sevastopol. Marshal J. J. Pélissier, who succeeded Canrobert on May 16, carried out a successful raid on Kerch on May 24, and allied ships ravaged the shores of the Sea of Azov. In the Baltic an allied squadron subjected Sveaborg (Suomenlinna) to a 45-hour bombardment. On Aug. 16 a Russian counterattack under the new Russian commander-in-chief, Gen. Mikhail Dmitrievich Gorchakov, cousin of the ambassador, was repulsed on the Chernaya. On Sept. 8, after the sixth of the sustained bombardments carried out by the allies, Gorchakov gave the order for the evacuation of Sevastopol, but the British and French forces were too weak to advance against the retiring Russian troops.

GERNSHEIM COLLECTION

ENCAMPMENT OF HORSE ARTILLERY IN THE CRIMEA, 1855

With Sevastopol captured, Napoleon III was satisfied and willing to negotiate, but Russia was not easily persuaded. The allies thus sought to exert further pressure, even proposing to raise the Polish question, but the year was too far gone for new operations. The only further allied action was to bombard and destroy the Russian base at Kinburn. Buol, however, thought that Austria had now so much offended Russia as to have forfeited the diplomatic support in central Europe which Russia had given Austria in Metternich's time and Austrian policy must rest henceforth instead on an alliance with Great Britain and France. On Nov. 14, therefore, he agreed with Bourqueney on the presentation of an Austrian ultimatum to Russia, which would include the demand for the neutralization of the Black sea. This proposal was finally agreed on Dec. 5, and on Dec. 16 Valentin Esterhazy was sent to St. Petersburg with an ultimatum, which he delivered on Dec. 28. Meanwhile Russia learned of a Franco-British defensive alliance with Sweden, which might spread war to the Baltic. The Russian ministerial council on Jan. 1, 1856, considered a plan for submitting counterproposals to Austria, but both Esterhazy and Buol warned Russia that this would be construed as a refusal of the ultimatum. On Jan. 15 the council advised Alexander II that Russia must submit, and accordingly the Austrian ultimatum was accepted. Russian statesmen saw that prolonged resistance, though possible, would lead only to further reverses whereas Russia would not be without advantages at the peace conference. The allies had not gone far into Russia, while in Asia Minor the Russians had captured Kars on Nov. 27, 1855, which gave Russia some bargaining power. Moreover, there were signs that Napoleon III was contemplating links of friendship with Russia and would not always support British and Austrian demands. The policy of Russia was therefore to submit when the three powers were united and to exploit their differences when they disagreed.

The Crimean War had important consequences. Russian statesmen and, above all, Alexander II realized that the defeat was due to the empire's backwardness and that social conditions must therefore be attuned to those prevailing elsewhere in Europe. They saw also that during the long period of modernization Russia would be unable to exert so much influence abroad as between 1815 and 1848. This new passivity of Russia in Europe greatly altered the pattern of European diplomacy. Austria, by submitting the ultimatum of Dec. 1855, had sacrificed Russian diplomatic support,

but did not secure the territorial guarantee from Great Britain and France that Buol had expected. The Crimean War above all isolated Austria diplomatically after 1856 and thus began the events which brought about the defeats in 1859 and 1866, which in their turn led to the unification of Italy and Germany.

For the treaty of Paris (1856) and its repercussions *see* EASTERN QUESTION. *See* also references under "Crimean War" in the Index volume.

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CRIMINAL APPEAL, COURT OF. The English court of criminal appeal was created by statute in 1907. Its membership includes the lord chief justice and all of the judges of the queen's bench division of the high court of justice. Its primary function is the review of judgments rendered in criminal cases at the assizes or at quarter sessions sitting as a trial court (*see* COURT: *England*).

Prior to the Criminal Appeal act, 1907, there had been no right of appeal in important criminal cases in England and Wales. A practice had developed much earlier of reserving questions of law arising at criminal trials for resolution by all of the trial judges. The procedure was formalized by statute in 1848 with the creation of the court for crown cases reserved. But review by this method was entirely at the discretion of the trial judge or the chairman of the quarter sessions. Beginning in 1844, efforts were made in parliament for legislation which would mirror that adopted by most western countries, *i.e.,* the right of appeal in criminal cases. But not until 1907 was this effort brought to fruition. Much of the agitation which forced the bill through the house of commons was the result of the conviction of Adolph Beck in 1904 on what was ultimately shown to be a case of mistaken identity. Ironically, the error in the Beck case is not one subject to correction by the appellate process, since the function of determining the credibility of witnesses, except in extraordinary circumstances, is one which is still, and of necessity, allocated to the trier of the facts.

Unlike the court of appeal (*q.v.*), which hears appeals in civil cases in England and Wales and which is staffed largely by judges hearing nothing but appellate cases, the court of criminal appeal ordinarily consists of two trial judges and the lord chief justice as presiding officer. The statute as amended, however, authorizes any odd number of judges of the queen's bench division to act as the court of criminal appeal, and a bench of five has occasionally been invoked where special circumstances have warranted this unusual procedure. Indeed, on one occasion the court was made up of 13 judges.

The court's powers are broad. An appeal of right may be taken on any question of law. With leave of the trial judge or the court of criminal appeal, issues of fact may also be reviewed. Also, with leave of the court of criminal appeal, it may entertain an appeal from sentence. The court may dismiss the appeal, quash the conviction or modify the sentence, either by increasing or decreasing it. But there are two major limitations on its power. As in almost all Anglo-American systems, there can be no appeal taken from a judgment of acquittal. Unlike the rule in most of these other jurisdictions, however, the court of criminal appeal has no power to order a new trial. The question of extending the court's power in this latter regard is a constantly recurring one. An amendment to accomplish this result was rejected by parliamentary committee in 1948, but it continues to be a subject of controversy.

The court of criminal appeal is an extremely busy tribunal, dealing with approximately 1,500 cases each year. All applications for leave to appeal are sent to a single judge for consideration. If he denies leave, the defendant has the right to seek further review of the application by a full court. If any one of the members of the full court thinks leave should be granted, the appeal is heard. When the full court sits, it hears appeals first and then passes on applications for leave to appeal. Decisions of the court are given by the judges in rotation, but all of the judges read all the papers presented to the full court for consideration. Leave to appeal is granted in about 5% of the cases involving alleged error in conviction and in about 6½% of the cases where the sentence is the subject of contest. Appeals are heard on the basis of transcripts of the trial proceedings, or relevant portions of such transcripts, and oral argument by counsel. The court does, however, have the power to take additional evidence where it thinks it necessary to do so.

The judgments of the court of criminal appeal may be reviewed in the house of lords, but only when one of the law officers has certified that such an appeal involves a point of law of exceptional public importance. Since such certificates are not given on the average of more than once a year, for all practical purposes the court of criminal appeal is a court of last resort in criminal matters. *See* also APPEAL: *Great Britain and the Commonwealth.*

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CRIMINAL LAW may be broadly conceived as that body of law which defines criminal offenses, establishes procedures for the apprehension, charging, and trial of suspected offenders and which fixes penalties and modes of treatment applicable to convicted offenders. All organized societies display, even if in rudimentary form, a body of rules, norms or customs tending to protect the security of individual interests and the survival of the group as a whole. The distinction between the criminal law and other forms of social control, however, is ordinarily not sharply drawn in primitive societies. Even in modern Anglo-American law the distinction between criminal law and tort law defies wholly satisfactory definition. For most practical purposes, however, it is sufficient to say that a tort is a private injury and that the purpose of a tort suit is primarily to obtain compensation from the wrongdoer for injuries sustained by the victim. A crime, on the other hand, even though it may (and ordinarily does) involve injury to some individual, is conceived as an offense against the state and is punishable as such. Thus the same conduct may render the actor liable in tort to make compensation to the victim for injuries inflicted and, at the same time, answerable to the state in a criminal proceeding. Tort law and criminal law may also be distinguished by the procedures employed and the sanctions imposed in the two types of actions. (*See* also TORT.)

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I. SOURCES OF THE CRIMINAL LAW

1. England.—The modern criminal law of England and of the United States derives from the English common law of crimes. This body of law had its origins in judicial decisions which, by the middle of the 13th century, were applied throughout the realm and were thus "common" to it. Even in the medieval period, however, legislation played an important role in the development of the English law of crimes. In some instances legislation was confined to matters of procedure or the stipulation of penalties, leaving definition of the elements of the offenses to judicial precedents. Thus, as late as the 1960s there was no statutory definition of murder in English law. Even the Homicide act, 1957, confined itself to such matters as eliminating certain types of conduct from earlier judicial definitions of murder and specifying the types of murder punishable by death. In other instances, however, parliament has created offenses wholly unknown to the common law. Examples include the embezzlement acts of the 18th century and the spate of statutory offenses enacted in increasing numbers since the first quarter of the 19th century to achieve objectives of economic regulation or public welfare. England has consistently rejected all efforts toward comprehensive legislative codification of its criminal law, even though the movement for codification has been supported by the prestige of such names as Jeremy Bentham and Sir James F. Stephen. (*See* also ENGLISH LAW.)

2. United States.—Although the criminal law of the United States clearly reveals its derivation from the English common law, the adoption of the common law was neither complete nor uniform in the American colonies. The early criminal legislation of Massachusetts, for example, was little influenced by English precedents, being derived in major part from Old Testament sources. In New York the influence of English precedents was earlier and more strongly felt. The famous "Quaker code" brought by William Penn to Pennsylvania and Delaware in the closing years of the 17th century was remarkable for its leniency in that only one capital offense, murder, was recognized. Although Penn's code was operative for only a short period, it is important as anticipating by over a century the humanitarian impulses later reflected in the Anglo-American law. Throughout the 18th century an increasing number of lawyers trained in the English law practised in the colonies, and their influence strongly supported recognition of common-law principles by colonial courts and legislatures. By the time Sir William Blackstone's *Commentaries* were published (1765–69), the common law of crimes was generally adopted. After the American Revolution, the states incorporated into their law the English common law as it existed prior to a specified date (either 1607, when the settlement at Jamestown was founded, or 1776, the date of the Declaration of Independence). The adoption of the common law was made subject to the constitution of the United States and of the particular state and only insofar as compatible with the conditions of the new nation. These limitations encouraged the rejection of certain archaic features of the common law of crimes, particularly those relating to outmoded and degrading forms of punishment.

In about one-third of the states of the U.S. the common law of crimes has been expressly repealed by legislation. The effect of such enactments is primarily that no person may be tried for any offense not specified in the statutory law of the state. Common-law principles retain great influence in such jurisdictions, however, for the criminal statutes often are simply codifications of the common law, and their terms and provisions are ordinarily interpreted by reference to the common law. No federal offenses other than those provided for by statute are recognized, but, again, federal criminal statutes are interpreted in the light of the common law. In the remaining states, prosecutions for common-law offenses not specified in the statutes are possible and sometimes occur. Among the most numerous of these prosecutions are those for conspiracy, criminal solicitation and breach of peace.

Criminal legislation has proliferated in the United States, as in England, since the first quarter of the 19th century. It has been estimated that the number of offenses defined by U.S. legislatures doubled in the first half of the 20th century. This frequent resort to penal legislation, however, has ordinarily not been accompanied by sober and systematic consideration of the issues of penal regulation by U.S. lawmakers. In many states the so-called penal or criminal codes are simply collections of individual provisions enacted at different times in response to particular problems then current, with little effort to relate the parts to the whole or to define or implement any general theory of social control by penal measures. As a result, U.S. criminal legislation characteristically is poorly drafted, inconsistent and ill-considered. Nor have the courts succeeded conspicuously in rationalizing the U.S. criminal law through the processes of judicial interpretation. Early in the 19th century, U.S. disciples of Jeremy Bentham, such as Edward Livingston, advocated comprehensive and systematic codification of criminal legislation. While these efforts were not wholly devoid of results, they did little to affect the character of U.S. criminal law as a whole. In the 20th century three states adopted comprehensive criminal codes: Louisiana in 1942, Wisconsin in 1956 and Illinois in 1961. Since World War II greater and more serious interest in the criminal law has been manifested in several U.S. jurisdictions. At the beginning of the 1960s a number of states, including New York, Minnesota and Missouri, were considering fundamental revisions of their criminal statutes. Such interest has been significantly stimulated by the American Law institute, a private organization of lawyers and judges, which in 1952 began the drafting of a model penal code. The model code represents the co-operative efforts of judges, lawyers, legal scholars and behavioural scientists. In 1930 the American Law institute published a model code of criminal procedure. The adoption of the Federal Rules of Criminal Procedure in 1946 also provided a stimulus for procedural reform in other U.S. jurisdictions.

3. Continental Countries.—The nations of western Europe entered the modern period with a corpus of criminal jurisprudence reflecting the varying influences of Roman law, canon law and local custom. The law that so evolved was notable for its harshness and its arbitrary qualities, and few protections to accused persons were provided. Reform of the criminal law thus became an important objective of liberal reform. As early as 1532 Charles V promulgated the Constitutio Criminalis Carolina for the whole of the Holy Roman empire. Austria produced two famous codes in the 18th century: the Constitutio Criminalis Theresiana of 1769 and the emperor Joseph II's code of 1787.

By far the most important enactments in the history of modern European criminal law were the two Napoleonic codes, the code of criminal procedure of 1808 (Code d'Instruction Criminelle) and the Code Pénal of 1810. The first was finally replaced in 1958 by the Code de Procédure Criminelle, but the latter, although substantially revised in 1832 and in 1863 and frequently amended at other times, has never been repealed. The Code Pénal constituted the leading model for European criminal legislation throughout the first half of the 19th century. Thereafter its influence waned, although it continued to play an important role in the legislation of certain Latin American and middle eastern countries. The German codes of 1871 (penal code) and 1879 (procedure) provided the models for many central European countries. The German influence has also been significant in Japan and South Korea. The Italian codes of 1930 represent one of the most interesting legislative efforts in the modern period. Since World War II notable undertakings include the code of procedure of 1950 and the penal code of 1957 adopted by the German Federal Republic and the Yugoslav criminal code of 1951. (*See* also FRENCH LAW; GERMAN LAW.)

II. SUBSTANTIVE CRIMINAL LAW

The substantive criminal law is concerned with defining the kinds of conduct that are to be considered criminal, thereby render-

ing the perpetrators eligible for penal sanctions. "Conduct," as the word is used in this context, should be understood as encompassing not only specified acts or omissions but the accompanying mental states as well. The substantive law consists of more than provisions of statutes or judicial decisions articulating the ingredients of particular offenses. Attention must also be given to certain doctrines, some of them of constitutional origin, which exclude various kinds of conduct from the definition of criminal behaviour, and to certain principles which apply to all or large parts of the substantive law and which qualify the provisions of criminal legislation even though not expressed in the particular statute defining the offense.

A. Limitations on the Definition of Criminal Conduct

1. Constitutional Limitations.—The criminal law, having at its disposal some of the most rigorous sanctions within the power of the state, inevitably poses fundamental problems regarding the relations of the individual and the political group. It is not surprising, therefore, that the regulation of the criminal process is one of the primary objectives of U.S. constitutional law. Most of the constitutional limitations apply to matters of criminal procedure, but others directly limit the power of legislatures and courts to denounce certain types of behaviour as criminal.

At the outset, no political entity may denounce and punish behaviour that falls outside its jurisdiction. Thus the federal government, being a government of delegated powers, may declare criminal only behaviour that falls within the scope of its granted authority. The validity of a federal criminal statute must be predicated on such bases of authority as the power of congress to regulate foreign and interstate commerce, the revenue powers, the war powers, powers relating to the currency, and the like. The individual states are also presumably limited to punishment of behaviour occurring within their geographical boundaries or, if it occurred elsewhere, to conduct affecting the interests of the state in some substantial way.

The constitutional grant of freedom of speech or religion has as its natural consequence the immunization of conduct falling within these provisions from criminal punishment by federal or state authority. Thus, in *Cantwell* v. *Connecticut,* 310 U.S. 296 (1940), the U.S. supreme court overturned a state conviction for the common-law crime of breach of peace upon a finding that the conduct of the defendant was within the exercise of his freedom of religion protected by the 14th amendment of the U.S. constitution. In the U.S. political system the states enjoy broad powers of regulation, including regulation by criminal sanctions, in the interests of public health, safety and morals. Occasionally, however, attempts at such "police power" regulation have been held to exceed the limits of constitutional tolerance. Thus a New York statute that imposed criminal sanctions on junk dealers having stolen goods in their possession, even when the dealer did not know and could not reasonably have discovered the goods were stolen, was held to be unconstitutionally arbitrary and a violation of due process of law (*People* v. *Estreich,* 272 App. Div. 698 [1947]). State criminal legislation may be voided when the state has attempted to enter a field validly regulated by the federal government and the state statute is deemed incompatible with the proper exertion of federal power. The equal-protection clause of the 14th amendment forbids the enactment of criminal legislation which discriminates on grounds of race or colour or which erects other unreasonable classifications. Various other constitutional provisions may limit legislative powers in the definition of criminal offenses. (*See* also Constitution and Constitutional Law; *United States.*)

2. Legality.—The first article of the U.S. constitution (sec. 9, cl. 3 and sec. 10, cl. 1) and the constitutions of most of the states contain provisions prohibiting the enactment of ex post facto legislation. These provisions represent an expression in constitutional form of one aspect of the broad principle of legality or the rule of law in the criminal process, recognized as fundamental in most civilized legal systems.

The principle of legality has been employed in four senses. The most common usage is that there can be no crime without a criminal law. Conduct may be immoral or antisocial, but it is not criminal without a law which forbids it. This application of the principle parallels the maxim of the European criminal law, *nullum crimen sine lege* ("no crime without law"), which was abandoned in 1926 when the Soviet code penalized any "socially dangerous" behaviour and by Germany in 1935 when conduct was made punishable even though not forbidden by statute if it violated "the sound feelings of the people."

Second, the principle directs that only legally prescribed punishment can be imposed upon a convicted person. This is reflected in the maxim of the European law, *nulla poena sine lege* ("no punishment without law"). In the United States it has been held that the principle is not violated by statutes providing indeterminate sentences so long as the maximum limits are specified.

Third, the principle of legality forbids retroactive penal legislation. In order that a person may be convicted, a law must have been in effect at the time of the conduct, forbidding it and rendering it punishable. It is to this aspect of the principle that the ex post facto provisions of the U.S. constitution directly relate. (*See* also Ex Post Facto Law.)

Fourth, the principle of legality requires that criminal statutes be interpreted strictly; *i.e.,* ambiguities and vagueness must be resolved in favour of the accused. In the United States most of the litigation involving the principle concerns this application of it. If a criminal statute is vague, it is unconstitutional as violative of due process (*Lanzetta* v. *New Jersey,* 306 U.S. 451 [1939], declaring invalid a statute which penalized membership in a "gang"). If a criminal statute is ambiguous it is not invalid, but it is given a narrow interpretation favourable to the accused. Thus in *McBoyle* v. *U.S.,* 283 U.S. 25 (1931), it was held that an airplane is not included in a federal statute which penalized stealing any "motor vehicle . . . or any other self-propelled vehicle for running on rails." The rule of strict construction is not properly employed, however, to defeat the clear purposes of the legislature. Occasionally U.S. state legislatures, in reaction to the rule, have enacted provisions similar to that of New York: "The rule that a penal statute is to be strictly construed does not apply . . . , but all such provisions must be construed according to the fair import of their terms, to promote justice and effect the objects of the law" (N.Y. Penal law, sec. 21).

All the applications of the principle of legality are intended to assure that no person will be punished as a criminal except on the basis of definite law existing at the time the act in question was committed. The major attack on the principle has been made by some criminologists and psychiatrists who contend that the fixing of maximum sentences handicaps rehabilitation of the criminal and defense of social interests. By the early 1960s this position had not found acceptance in the legislation of any state; everywhere maximum limits were prescribed by statute. Since World War II it has become widely and increasingly accepted that, although considerable discretion should be allowed for individualization of treatment of offenders, that power in a democratic community must be subjected to reasonable restraints.

3. Entrapment.—In the United States the scope of criminal liability is limited by the doctrine of entrapment. When acts otherwise criminal are committed by the accused as a result of the direct instigation of law-enforcement officers or undercover agents, criminal liability does not attach. Entrapment should be distinguished from situations in which the officer does not instigate the offense but merely provides the opportunity or occasion for its commission. The distinction in many cases is a difficult one to draw. The doctrine of entrapment has received its most frequent application in cases of offenses like liquor violations, gambling and narcotic offenses. Its application to cases of homicide and those involving serious bodily injury is far from clear. Dispute has also arisen regarding the precise theoretical basis for the doctrine. By far the majority of courts take the view that an accused led into conduct otherwise criminal by the instigation of law-enforcement agents has committed no offense. Some authorities have urged that under such circumstances an offense has been committed but that the state should withhold penal sanctions from the offender. However articulated, the doctrine reflects

thical repugnance to such law-enforcement measures.

B. The General Part

The substantive criminal law expresses a large number of general doctrines and principles which form an important part of the definition of criminal behaviour, even though they customarily are not expressed in statutes defining particular offenses. In a fully articulated penal code these matters are dealt with in the "general part" of the code. Of all the problems of the criminal law, those of the general part are among the most important and difficult.

1. Criminal Act or Omission.—It is generally agreed that an essential ingredient of any crime is a voluntary act or omission. The act may be understood as a willed muscular contraction. Its voluntary character is requisite. "The reason for requiring an act," wrote the late Justice Oliver Wendell Holmes, "is, that an act implies a choice, and that it is felt to be impolitic and unjust to make a man answerable for harm unless he might have chosen otherwise." Thus movements made in an epileptic seizure are not acts. So also, movements made by a somnabulist before awakening, even those resulting in the death of another, are not acts and do not render the sleepwalker criminally liable. The line between such cases and those involving the doctrines of insanity is sometimes difficult to draw. In general it can be said that movements performed in a state of "open-eyed consciousness" are acts, even though the acts are the product of mental disorder. In such cases exculpation must come, if at all, by virtue of the insanity defense.

Criminal liability may also be predicated on a failure to act when the accused was under a legal duty to act and was reasonably capable of acting. The legal duty to act may be imposed directly by statute, such as the requirement that those earning income must file a tax return. It may arise out of the relationship of the parties. Thus duties of care attach to the relationship of parent and child, husband and wife, guardian and ward. In the English case *Rex* v. *Gibbons and Proctor*, 13 Cr. App. R. 134 (1918), two persons having a child under their care were convicted of murder when the child died from the failure of the defendants to supply her with food sufficient to sustain life. Nevertheless, the duty to act is defined rather narrowly in the Anglo-American law. There is thus no general obligation to protect others from harm. These restrictions on the principle have often been protested. The proposed code for Louisiana, drafted by Edward Livingston in 1833, would have imposed liability for criminal homicide on persons failing to save the life of another when this could be achieved "without personal danger, or pecuniary loss." Proposals for the drastic enlargement of the legal duty to act are attended by genuine difficulties of articulation and administration and have generally been rejected.

2. Mens Rea or Mental Element.—In general, the definition of an offense includes not only an act or omission and its consequences but also the accompanying mental state of the actor. Appraisal of the moral character or social dangerousness of the offender requires that it be known whether his conduct was purposeful, reckless, negligent or accidental. Frequently, in the modern era, the Anglo-American criminal law has imposed liability without requiring the showing of a *mens rea* or guilty mind. Nevertheless, the tradition of the common law strongly supports the proposition that the stigma of serious criminality ought not, on grounds of justice and utility, to be imposed on one who produced harm inadvertently or accidentally. "Even a dog," wrote the late Justice Holmes, "distinguishes between being stumbled over and being kicked."

Despite the evident importance of proper definition of the mental element, the performance of courts and legislatures in this area has often been far from satisfactory. Criminal statutes are frequently silent on what sort of *mens rea*, if any, must be shown. In other instances, as many as two dozen different terms intended to signify various mental states are employed without clear indication of how such terms are to be interpreted and applied. In still other instances the same term is used in several statutes, although entirely different meanings are intended to be conveyed. Thus in the U.S. cases almost every possible meaning has been attributed to the term "willfully," and almost as wide a range of meanings has been given to the word "intentionally." The tentative draft of the American Law institute's model penal code would reduce the *mens rea* terms to four: "purposely," meaning an actual, consciously formed intent to achieve the criminal consequence; "knowingly," conscious awareness that the actor's conduct will produce the consequence; "recklessly," conscious disregard that the actor's conduct is creating an unreasonable peril; and "negligently," inadvertence to peril that would have been apparent to a reasonable man. These terms, singly or in combination, appear adequate to deal with most of the common *mens rea* problems. Their general adoption would greatly clarify and rationalize the substantive law of crimes.

3. Absolute Liability.—Although Sir William Blackstone, writing in the 18th century, asserted that the *mens rea* is an indispensable element of a crime, developments that have occurred largely since that time have created a considerable body of penal offenses in which no intent or other mental state need be shown. Absence of the *mens rea* requirement characterizes a few offenses like statutory rape, in which knowledge that the girl is below the age of consent is not necessary to liability, and bigamy, which in most jurisdictions may be committed even though the parties believe in complete good faith that they are free to marry. For the most part, however, absolute liability has been created by statutes defining offenses to which only slight or moderate penalties are attached. These offenses, sometimes called "public-welfare offenses," are most frequently concerned with economic regulation or with protection of the public health and safety.

The justification for elimination of the *mens rea* requirement is ordinarily made on grounds of expediency. It is asserted, for example, that to require the prosecution to establish the defendant's intent, or even recklessness, would render such regulatory legislation largely ineffective and unenforceable. Nevertheless, commentators both in England and the United States have frequently condemned the creation of absolute liability. To expose the citizen to the social moral condemnation of a criminal conviction without a showing of moral culpability raises issues of justice; and it may be doubted whether recognition of criminal guilt without moral fault serves the larger interests of the criminal law. In many instances, moreover, the regulatory objectives of such legislation can more effectively be achieved by civil sanctions such as suits for damages, injunctions and the revocation of licences. Even when criminal sanctions must be employed, it is often feasible to permit the defendant to answer the charge by showing that his conduct did not involve a negligent failure to exercise due care. Negligence, involving merely inadvertence rather than consious wrongdoing, hardly satisfies the full requirements of the *mens rea* principle. Negligence, however, has been recognized as the basis of liability in certain statutory offenses and, in any event, is preferable to the rigours of absolute liability. By mid-20th century, courts in England and the U.S. were displaying increasing hostility to absolute criminal liability and were frequently refusing to construe statutes as creating it when a fair question of interpretation was posed. Thus, the U.S. supreme court held that a federal theft statute required proof of an intent to steal even in the absence of words of *mens rea* in the statutory language (*Morissette* v. *U.S.*, 342 U.S. 246 [1952]). A number of U.S. state cases held that statutes creating absolute criminal liability denied due process of law when serious penalties were attached. The U.S. supreme court invalidated a California ordinance that punished the failure of an ex-convict to register with the police department even when the accused was unaware of the registration requirement (*Lambert* v. *California*, 355 U.S. 225 [1957]). (*See* also Negligence.)

4. Ignorance and Mistake.—The maxim *ignorantia facti excusat* ("ignorance of fact excuses") represents one aspect of the *mens rea* doctrine. It expresses the obvious deduction that when the accused is operating under an assumption of fact which, although mistaken, is inconsistent with the *mens rea* required to be shown, no crime is committed. Thus one who takes and carries away goods of another, believing them to be his own, does not

commit larceny, for he lacks the requisite intent to steal. So also, if the offense is one of absolute liability, a mistake of fact about a material element of the offense does not relieve the actor of liability since his mental state is irrelevant to the definition of the crime.

On the other hand, the Anglo-American law recognizes the maxim *ignorantia legis neminem excusat* ("ignorance of the law excuses no one"). Thus, in general, it is no defense that the actor was unaware that his conduct was criminal. Two principal grounds for differentiating mistake of law from that of fact have been advanced: First, it is the sole responsibility of courts and legislatures to declare authoritatively what the law is. This function could not be discharged effectively, it is asserted, if the accused's guilt is made to depend on his judgment or that of his attorney as to the meaning of the law. Second, the infliction of injury in ignorance of the relevant law does not mean that the doer was unaware of the immorality of his conduct. The doctrine that mistakes of law do not excuse seems reasonably supportable when the offense involves conduct which would be recognized as dangerous and immoral by any responsible adult. The matter is much less clear, however, when the case is one of a statutory offense prohibiting conduct that is not obviously dangerous or immoral. A substantial body of opinion would permit mistakes of law to be asserted in defense of criminal charges in such cases, particularly when the defendant has in good faith made reasonable efforts to discover what the law is. In Germany and some other continental countries an even wider scope to the defense of mistake of law appears to be recognized. (*See* also IGNORANCE.)

5. Responsibility.—It is universally recognized that, in appropriate cases, persons suffering from serious mental disorders should be relieved of the criminal consequences of their conduct. This principle has been part of the English common law for at least seven centuries. There is little controversy regarding the justice and utility of the basic proposition. Sharp and persistent differences of opinion have been expressed, however, regarding the proper statement of the legal tests of responsibility. (*See* INSANITY.)

In Anglo-American jurisdictions the law of responsibility rests primarily on the famous case of *McNaghten* (10 Cl. and Fin. 200 [1843]). In that case the judges of England, in response to questions propounded by the house of lords, announced that ". . . to establish a defence of insanity, it must be clearly proved that, at the time of committing the act, the party accused was labouring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing; or, if he did know it, that he did not know it was wrong." The federal courts and those of about one-quarter of the states have supplemented the McNaghten rules by the so-called irresistible impulse test, which also relieves the accused of criminal responsibility if he could not control his behaviour because of mental disorder.

The McNaghten rules have been the object of sharp controversy since the date of their formulation. Critics have charged, for example, that they express an overintellectualized concept of mental disorder, reflecting outmoded notions of human behaviour. Since the rules are not based on modern concepts of medical science, the psychiatrist finds it difficult to translate his learning into the legal formula, thereby depriving the court of the full benefit of his knowledge and insight. Many other criticisms of varying degrees of cogency have been advanced. The McNaghten rules have had staunch defenders, however, even among members of the medical profession; and the courts have almost unanimously resisted arguments to abandon them. An important development occurred with the 1954 decision of *Durham* v. *U.S.*, 214 F. 2d 862, by the court of appeals for the District of Columbia. The Durham decision specifically rejected the McNaghten rules as supplemented by the irresistible impulse test, which theretofore had been recognized in the District of Columbia, and adopted a new test derived from earlier decisions of the New Hampshire court. The Durham test, as expressed by the court, is "simply that an accused is not criminally responsible if his unlawful act was the product of mental disease or mental defect." Although supported by some lawyers and judges and by a larger number of psychiatrists, the Durham rule has also been criticized by some commentators. It was adopted by legislation in the Virgin Islands in 1957. Other efforts to formulate a new legal test of responsibility were made in the 1950s. Among the most important of these were proposals made by the royal commission on capital punishment (1949–53) in England and by the American Law institute's model penal code. The latter proposal was adopted by statute in Vermont and Illinois, and a version of it was accepted by a federal court of appeals.

Even when the accused's mental disorder is not so advanced as to result in irresponsibility, it may nevertheless affect the extent of his criminal liability. Some U.S. courts have permitted the accused to show that his mental condition rendered him incapable of forming the *mens rea* required for a more serious offense, thereby reducing the grade of the offense for which he is convicted. Thus, if the defendant is able to demonstrate that he was incapable of premeditating, his offense may be reduced from first- to second-degree murder. The "diminished responsibility" provisions of the English Homicide act, 1957, recognize a more comprehensive principle similar to that expressed by the law of Scotland and some continental countries. Section 2 of the act provides that a person who kills another shall not be guilty of murder "if he was suffering from such abnormality of mind . . . as substantially impaired his mental responsibility for his acts or omissions in doing or being a party to the killing." The effect of this section is to reduce an offense of murder to manslaughter.

6. Infancy.—Another aspect of criminal incapacity is that recognized in children of tender years. At the common law no child below the age of seven was regarded as possessing criminal responsibility. A presumption of incapacity applied to children 7 years of age or over and not yet 14. The presumption could be overcome by a showing that the child understood the nature and consequences of his conduct. English history reveals actual instances of the execution of capital punishment on children ten years of age and even younger. In most states of the U.S. the minimum age of capacity has been raised by statute. Illinois, for example, sets the minimum age at ten years. The criminal capacity of children has been further modified by the widespread enactment of juvenile-court laws. Under some of these laws the juvenile courts have exclusive jurisdiction over the delinquencies of children until they attain a specified age, usually 17 or 18. In other states, jurisdiction of the juvenile court is concurrent with that of the criminal court. Under such laws a child over the minimum age of capacity may be tried either as a delinquent in the juvenile court or as a criminal in the courts of general criminal jurisdiction. (*See* also CHILDREN'S COURT.)

7. Intoxication.—The Anglo-American law takes an ambivalent and unsatisfactory position on the significance of intoxication to criminal liability. Some of the early common-law commentators, such as Lord Coke writing in the 17th century, expressed the view that voluntary drunkenness, far from providing a ground for mitigation of penalties, should be regarded as an aggravation of the wrong. This extreme position seems never to have been taken by any court; but it is commonly said, even today, that intoxication is no defense to a criminal charge. The statement, however, does not mean that drunkenness has no significance in determining the existence or the degree of criminal liability. Anglo-American jurisdictions generally recognize that drunkenness may affect the capacity of the accused to form the *mens rea* required for the commission of an offense. Where this is true the accused may escape liability or be found guilty of a less serious offense. Thus, one so inebriated that he lacks capacity to form an intent to steal is not guilty of larceny even though he takes and carries away the goods of another. In homicide cases the chief significance of the intoxication defense is to reduce a charge of first-degree murder to one of second degree or, in English law, from murder to manslaughter, on a finding that the accused was incapable of premeditation. The Anglo-American law does not adequately reflect the increased knowledge, acquired chiefly since World War I, of the relationship between persistent drunkenness and some types of mental disorder. There is reason to believe that the law gives inadequate recognition to the fact that many

rimes committed in a state of inebriation are the product of seri-
us mental disease in the offenders. (*See* also LIQUOR LAW.)

8. Vicarious Liability.—The common law of crimes ordinar-
y proceeds on the assumption that "guilt is personal." Thus, in
eneral, a person may be held criminally accountable for the con-
uct of another only when he in some way participated in or con-
ributed to the conduct. During the 19th and 20th centuries, how-
ver, legislatures in England, the commonwealth countries and
he United States created numerous statutory offenses in which
he basis of liability is the existence of an employment relation-
hip between the accused and the person engaging in the criminal
ct. Perhaps the most common of these relate to the regulation
f the liquor trade. Thus, the owner of a retail liquor establish-
ent may be held liable for the sale of alcoholic beverages to a
inor or the sale of liquor after the closing hour, even though
he acts were committed by an employee contrary to the instruc-
ons and wishes of the defendant. In the case of *U.S.* v. *Dot-
erweich,* 320 U.S. 277 (1943), the U.S. supreme court affirmed
he conviction of a corporation president for introducing mis-
randed drugs in interstate commerce although there was no proof
hat the defendant actively participated in the criminal act or
ven knew of its occurrence. The facts encouraging the expan-
on of vicarious criminal responsibility are similar to those that
ncouraged creation of absolute liability; and the objections to
he one may be equally applied to the other. As in the case of
bsolute liability, some U.S. courts before the end of the 1950s
xpressed hostility to the unrestricted expansion of vicarious
riminal responsibility. Thus a Pennsylvania court held that the
nposition of a jail sentence on a tavern proprietor for the un-
uthorized acts of an employee violated the defendant's consti-
utional rights. A majority of the court, however, recognized the
ower of the state to impose a monetary fine on the proprietor in
uch circumstances. (*Comm.* v. *Koczwara,* 397 Pa. 575 [1959].)

9. Corporations and Associations.—The criminal responsi-
ility of corporate bodies and of such private associations as part-
erships and labour unions constitutes one type of vicarious
riminal responsibility. Ordinarily a corporation is held crimi-
ally liable for the act of an officer or employee, but a fine levied
n the corporate body involves loss to the stockholders, who, in
ost instances, did not participate in the criminal act and were
naware of its occurrence. The objections to vicarious responsi-
ility are less cogent in the corporate case, however, since the
tockholders do not suffer the stigma of being personally convicted
nd their loss is limited to the amounts of their investment in
he corporation.

Some statements made in the early history of the common law
eny the possibility of holding corporate bodies criminally liable
or acts of their agents. But beginning about the third decade
f the 19th century courts both in England and the United States
nposed criminal liability on corporations in a substantial num-
er of cases. These early cases recognized various limitations on
orporate responsibility, the most important being that a corpo-
ation might not be held liable for an offense requiring proof
f a criminal intent. This and other restrictions were quite gen-
rally abandoned during the course of the 19th century. By mid-
9th century the most important practical limitation on the scope
f corporate responsibility was the failure of the legislatures,
n defining certain offenses, to authorize penalties that could be
pplied to a corporation. Another question of importance
elates to the class of persons whose acts are attributable to the
orporation for purposes of criminal liability. It appears to be
he rule in New York and of some English cases that the conduct
ust be that of a director, officer or high managerial official. In
any U.S. cases, however, corporations have been held liable for
he criminal acts of minor employees. The criminal liability of
rivate associations other than corporations is much less clearly
efined. Federal criminal statutes, in particular, frequently au-
horize imposition of fines on such bodies, and in a number of
ases these penalties have been applied.

10. Parties to Crime.—A person may be held legally account-
ble for the conduct of another through the doctrines of accessory-
hip. The common-law doctrines were elaborate and cumbersome. The accessory before the fact was one who encouraged or advised another to commit an offense. The principal in the second degree was one present when the crime was committed who aided and abetted the principal offender. The party committing the criminal act was known as the principal in the first degree. In misdemeanour and treason cases all participants were treated as principals in the first degree. When the party who was persuaded to commit an offense lacked criminal capacity by reason of infancy or mental disorder, he was regarded as an "innocent agent"; and the person instigating the conduct was treated as a principal in the first degree. At common law an accessory could not be indicted as a principal in the first degree. An acquittal of the principal relieved the accessory from criminal liability. Although the common-law nomenclature is still generally employed in criminal legislation, the clear tendency of the modern U.S. law is to eliminate the common-law distinctions between accessories and the principal offender and, for most practical purposes, to treat all participants in an offense as principals in the first degree. Distinct from the foregoing categories is the accessory after the fact. Such a party does not share in the guilt of the principal in the first degree but is made punishable for concealing or obstructing the apprehension of one known by him to be a fugitive from justice.

11. Consent and Condonation.—The proposition, sometimes expressed, that consent of the victim to the criminal conduct of the accused is no defense requires considerable qualification. In cases of homicide, dueling and other instances of serious bodily injury, consent of the victim does not excuse the criminal behaviour. The English Homicide act, 1957, provides, however, that a killing by the survivor of a suicide pact shall be manslaughter, not murder. Prize fighting and other athletic contests involve behaviour which would constitute a criminal assault but for the acquiescence of the other participants. In a considerable number of serious offenses, lack of consent of the victim is, by definition, indispensable to commission of the crime. Thus, in forcible rape the intercourse must occur against the will of the woman. Larceny requires the taking of goods from the possession of the owner without his consent. Except in a few statutory offenses, the accused is not relieved of liability for a completed crime by the victim's subsequent condonation of the conduct.

12. Necessity and Coercion.—The doctrines of necessity relate to situations in which a person, confronted by the overwhelming pressure of natural forces, must make a choice between evils and chooses to engage in conduct, otherwise criminal, as the lesser of the evils. In the leading U.S. case of *U.S.* v. *Holmes,* 26 Fed. Cases 360 (1842), a longboat containing passengers and members of the crew of a sunken American vessel was cast adrift in the stormy sea. To prevent the boat from being swamped, members of the crew threw some of the passengers overboard. In the trial of one of the crew members, the court recognized that such circumstances of necessity may constitute a defense to a charge of criminal homicide, provided that those sacrificed be fairly selected, as by lot. Because this had not been done, a conviction for manslaughter was returned. The leading English case, *Regina* v. *Dudley and Stephens,* 14 Q.B.D. 273 (1884), appears to reject the necessity defense in homicide cases. This principle in some form has been recognized in the legislation of a number of continental countries, nations of the commonwealth, and of some states of the United States. The scope of the principle, however, has not been clearly or fully delineated in most Anglo-American jurisdictions.

The defense of duress or coercion relates to situations in which the accused acted under threats of imminent death or serious bodily injury by third parties. Such judicial authority as exists on the point states that the defense is not available when the accused has killed an innocent victim in order to save his own life. There are few instances in which the defense has been successfully advanced even in less serious cases, indicating that the requirements of exculpation on grounds of coercion are rigorously defined in actual application. At common law a presumption of coercion existed in most cases in which a wife committed an offense against a third party in the presence of her husband. It

is this rule which prompted the protest of Mr. Bumble in Dickens' *Oliver Twist:* "If the law supposes that, . . . the law is a ass—a idiot." The tendency of modern legislation is to eliminate this presumption. Analogous problems are posed by the commission of offenses by members of the armed forces acting under the orders of superior officers. The significance of superior orders to criminal liability is stated somewhat differently in the English and U.S. cases. Both appear to agree, however, that exculpation is not granted when the orders of the superior officer were patently illegal.

13. Self-Defense and Justification.—The Anglo-American law recognizes a number of particular situations in which the use of force, even deadly force, is excused or justified. The most important body of law in this area is that which relates to self-defense. In most U.S. jurisdictions deadly force may be employed whenever one reasonably believes that he is placed in imminent peril of death or serious bodily injury by the conduct of another and that the killing of the other is necessary to save his own life. Thus, justification may be granted when the killing was, in fact, not necessary, so long as the actor reasonably believed it to be so. On the other hand, an actual belief is not sufficient if it is found to have been unreasonable under the circumstances. A few U.S. jurisdictions hold that belief, even unreasonable belief, excuses; and the tentative draft of the American Law institute's model penal code asserts this to be the preferable view. U.S. jurisdictions are divided on the requirement of a "retreat to the wall." The cases in some states hold that one who has in no way provoked the difficulty must withhold the use of deadly force until retreat is impossible or serves to increase, rather than diminish, his peril. The federal courts and probably a majority of state courts permit the defendant to stand his ground and to kill when the requirements of self-defense are met. Most U.S. jurisdictions recognize the retreat requirement when the defendant has in some manner provoked the altercation which ultimately leads to the necessity of using deadly force. When the defendant provokes the difficulty initially by feloniously assaulting the deceased, rights of self-defense may not be asserted until the accused has fully withdrawn from the altercation and has clearly communicated his intention to desist.

The Anglo-American law of justification states varying requirements for the use of force in other situations. These include the use of force to protect third parties from harm, to prevent commission of a felony, to arrest a fleeing felon and to defend property or habitation from the aggressions of another.

C. Particular Offenses

Certain types of behaviour are universally recognized as being dangerous to the security of individual and social interests. All advanced legal systems condemn as criminal the sorts of conduct described in the Anglo-American law as treason, murder, aggravated assault, theft, robbery, burglary, arson and rape. With reference to minor police regulations, however, substantial differences in the definition of criminal behaviour occur even among jurisdictions of the Anglo-American system. Comparisons of the continental European criminal law and that based on the English common law of crimes also reveal significant differences in the definition of certain aspects of more serious crimes. The continental law, for example, frequently articulates grounds for mitigation involving considerations taken into account in the Anglo-American countries only in the exercise of discretion by the sentencing authority or in the behaviour of lay juries. This may be illustrated by reference to so-called "mercy killings" (*see* Euthanasia). The Anglo-American law of murder recognizes no formal grounds of defense or mitigation in the fact that the accused killed to relieve the agonies of one suffering from an apparently incurable disease. In many continental and Latin America codes, provision is made for mitigation of offenses prompted by such motives, and in a few instances a defense to the criminal charge is recognized.

1. Classification of Offenses.—Under the common law, offenses were classified into three principal categories: treason, felony and misdemeanour. Significant consequences relating to the penalties imposed and to the criminal procedures employed resulted from this division. U.S. jurisdictions generally distinguish between felonies and misdemeanours. Although the definition of felony is not uniform in the states, it is typically defined as a crime punishable by a term of imprisonment of not less than one year in the state penitentiary. Misdemeanours are often defined as offenses punishable only by fines or by terms of imprisonment in county or local jails. The distinction between felony and misdemeanour is less significant for the modern law, and many commentators have questioned its utility. Certain consequences continue to result from the distinction, however. Thus a convicted felon may suffer the loss of civil rights retained by the misdemeanant. Certain substantive doctrines take the distinction into account, such as that which authorizes the use of deadly force to effect the arrest of a felon, but not of a misdemeanant. In addition to felonies and misdemeanours, U.S. jurisdictions recognize a class of minor offenses that may be described as quasi-crimes. Such offenses are typically created by municipal ordinance or by county authority. Penalties are comparatively trivial. Often the right of jury trial is held not to extend to quasi-criminal proceedings, and the prosecution may not be required to establish guilt beyond reasonable doubt.

Crimes in England are classified into indictable offenses (which may be tried by jury) and summary offenses (those which may be tried summarily by magistrates sitting without juries). Indictable offenses are further divided into treasons, other felonies and misdemeanours. The remaining distinctions between treason and other felonies, however, were virtually obliterated by the Treason act, 1945. Classifications distinguishing offenses of greater seriousness from lesser crimes appear in the continental European codes. Thus the French Code Pénal distinguishes between *délit* and *contravention,* the German law between *vergehen* and *verbrechen.* (*See* also Felony; Misdemeanour.)

Other classifications of crimes have been employed for various analytical purposes. In the survey which follows, some of the major types of offenses are included in a classification of inchoate crimes, crimes against persons, crimes against property and crimes against government.

2. Inchoate Crimes.—The Anglo-American law defines several offenses that are sometimes labeled inchoate or preliminary crimes because guilt attaches even though the criminal purpose of the parties may not have been achieved. The first of these is an offense, usually a misdemeanour, known in England as incitement and most commonly in the United States as solicitation. The offense consists of urging or requesting another to commit a crime. With few exceptions the crime solicited must in England be an indictable offense. In the United States it is sometimes required to be either a felony or a misdemeanour involving breach of peace. The crime of solicitation is complete when the solicitation is made; the solicitor's liability does not depend upon commission of the requested offense. Criminal legislation may also prohibit certain specified types of solicitation. Examples include solicitation of a bribe or solicitation for immoral purposes, or, to take a more grave case, inciting members of the armed forces to mutiny. (*See* Bribery; Mutiny; Prostitution.)

Criminal attempts constitute a second and more important category in inchoate offenses. Attempt consists of conduct intended to accomplish a criminal result which fails of consummation but goes beyond acts of preparation to a point dangerously close to completion of the intended harm. The line between acts of mere preparation and attempt is difficult to draw in many cases. Criminal attempt is said to require a specific intent. Thus, although in certain situations murder may be committed without an intent to kill, attempted murder cannot be established without proof of such intent. Unlike the law of some European countries, no defense is granted in the United States to an offender who voluntarily desists from committing the intended harm after his conduct has reached a point beyond mere preparation.

Conspiracy is defined by the common law as an agreement between two or more persons to accomplish an unlawful objective or to achieve a lawful end by the use of unlawful means. The offense is ordinarily said to be complete when agreement is reached.

ut under some statutes, such as the federal general conspiracy aw of the U.S., liability does not attach until one of the parties o the agreement commits an overt act designed to advance the urposes of the conspiracy. In the absence of statutory provi- ions to the contrary, the unlawful end need not be one which would be criminal if achieved by an individual acting alone. Thus, greements to attain noncriminal ends conceived by the courts to e immoral or oppressive have been punished. Control of crim- nal activity involving group action is a problem of serious pro- ortions in all advanced societies. The Anglo-American law of onspiracy, however, is far from satisfactory. Vagueness char- cterizes the definition of all crucial elements of the offense, and he procedures and rules of evidence applied in conspiracy prose- utions often place the defense at serious disadvantage. The uropean codes define a variety of offenses involving conduct of roups. But in the breadth of its scope and its amorphous quality, he offense of conspiracy in the Anglo-American law is very nearly nique. (*See* also CONSPIRACY.)

3. Crimes Against Persons.—In any advanced system of riminal justice the minimization of crimes of violence is a matter f primary concern to the legal order. The most serious of these, f course, are the criminal homicides. Murder in the Anglo- merican system may be described as the killing of another hu- an being with malice aforethought. The phrase "malice afore- hought" has a technical significance and, in the course of time, as acquired meanings quite different from those commonly under- tood. Thus a killing may be said to be with malice aforethought hen the accused intended to kill either the victim or another, ntended to inflict serious bodily injury on the victim, did not ntend to kill but engaged in conduct of extreme recklessness, illed another in the course of committing some other felony, r killed a peace officer while resisting a lawful arrest. All of hese categories are subject to important qualifications and refine- ents. Most states of the U.S., beginning with the Pennsylvania tatute of 1794, have divided murder into degrees, reserving capi- l punishment for murder in the first degree. First-degree mur- er is variously defined but ordinarily includes premeditated and eliberate killings and often killings occurring in the course of ommitting certain violent felonies. The English Homicide act, 957, limits imposition of capital punishment to specified types f killings. The classifications of the English act, however, are ubstantially different from those made in most U.S. statutes.

The Anglo-American law defines a number of lesser homicide ffenses. Involuntary manslaughter ordinarily involves a killing aused by the reckless or grossly negligent conduct of the of- nder or a homicide resulting from commission of an unlawful t other than a felony. Voluntary manslaughter is ordinarily a lling in "heat of passion" by an accused who acted in response provocation of the victim, the provocation being of the kind hich the law regards as sufficiently serious to reduce the of- nse from murder to manslaughter. Many states of the U.S. cognize a lesser offense, sometimes called reckless homicide, re- ting chiefly to deaths resulting from automobile accidents. All e European codes distinguish various grades of criminal homi- de, the distinctions being based on considerations of the relative inousness or dangerousness of the offender's conduct. (*See* also OMICIDE.)

In addition to the criminal homicides the Anglo-American law fines other offenses against the person. Two of these, forcible pe and kidnaping (*qq.v.*) for ransom, have been made capital imes in some U.S. jurisdictions. Various sorts of assault and ttery (*q.v.*) are punished in all states of the U.S. The common- w offense of mayhem (*q.v.*) was committed when the accused it off or otherwise deprived another of the use of a limb or a ember, thereby impairing the ability of the victim to defend mself. The crime of mayhem, usually broadened to include her kinds of serious bodily harm, has been made part of the atutory law of many U.S. jurisdictions.

4. Crimes Against Property.—In a developing legal system, nong the first offenses to be defined and punished are those ainst property. Because of its antiquity and the fact that the lative importance of various forms of property alters as the economic system develops, the criminal law of property offenses is likely to contain anachronistic elements unless subjected to continuing revision by the law-making authority. These problems clearly emerge in the Anglo-American law.

"Theft" is usually employed as the generic term encompassing the more common property crimes. The basic theft offense in the English common law was larceny (*q.v.*). The criminal act in larceny consists of the taking and carrying away of goods from the possession of another without the latter's consent. The offender must have an intent to steal (*animus furandi*), defined as an intent to deprive the owner of his goods permanently. Although the general larceny formula continued essentially unaltered throughout the latter course of its development, the actual scope of the offense was expanded by a series of judicial holdings and legislative provisions. This enlargement was achieved principally through an increasingly liberal view as to when goods were in the possession of another. Despite this expansion, the law of larceny by the 18th century was inadequate to cope with all the problems of the new commercial and industrial society. In response to these needs parliament enacted the first general embezzlement statute (39 Geo. III, c. 85), in 1799. Since embezzlement (*q.v.*) is entirely a creature of statute and since provisions defining embezzlement offenses vary considerably among Anglo-American jurisdictions, no single definition is adequate. In general these provisions relate to misappropriation of the goods of another which have been delivered or entrusted to the possession of the offender. A third important category of theft in the Anglo-American law is the crime of false pretenses. Although the origins of the law of criminal fraud are to be found in the early common law, the modern offense of false pretenses derives in large measure from the statute, 30 Geo. II, enacted in 1757. The offense ordinarily consists of inducing another to part with ownership of goods by the false representations of the accused. Akin to false pretenses is the offense of obtaining credit by fraud. Finally, the Anglo-American law punishes the receiving of stolen goods by one who knows or believes them to be stolen and intends to deprive the owner permanently of his property. Since the receiver provides the market for stolen goods, prevention of such conduct is obviously crucial to effective discouragement of large-scale thefts. Because of difficulties of proof, however, prosecutions of receivers are subject to unusual problems.

The distinctions between the various categories of theft are often difficult to draw in particular cases. The result is that offenders sometimes escape merited punishment by showing that their conduct did not constitute the particular offense charged. Effective administration of justice in this area is further handicapped by the presence of outmoded and irrational limitations on the definition of theft offenses. A number of U.S. jurisdictions, such as Massachusetts, have enacted consolidated theft laws which define a single statutory offense containing the elements of all the major theft crimes and which permit convictions upon a showing that the offender's conduct fell within any of these categories. The tentative draft of the American Law institute's model penal code contains a notable effort to consolidate and rationalize theft law.

In addition to these major categories of theft, legislatures in all economically-developed nations have enacted a wide range of offenses relating to various aspects of modern commercial enterprise. Typical of these statutes are those adopted by U.S. state legislatures and the federal congress designed to eliminate frauds and to force full disclosure in the sale and issuance of corporate securities.

The law of advanced legal systems also makes criminal various types of conduct that constitute threats both to bodily security and to property. In the Anglo-American jurisdictions the most important offenses of this kind are robbery, burglary and arson. Robbery may be regarded as an aggravated larceny and consists of taking property from the person or presence of another by placing him in fear. U.S. statutes ordinarily authorize greater penalties when robbery is accomplished by use of a firearm or other dangerous weapon. Burglary (*q.v.*) at the common law was the breaking and entering of the dwelling house of another at night with

intent to commit a felony in the structure. In modern statutory law the offense has frequently been expanded to include buildings other than houses. The requirement that entry be made at night has sometimes been eliminated. Arson (*q.v.*) consisted of the malicious burning of the dwelling house of another. Modern law has, again, defined the offense to encompass burnings of other structures, including the dwelling house of the offender.

5. Crimes Against Government.—In the feudal system the most heinous offense was the breach of the allegiance owed by the vassal to his lord. So also, in the modern era, offenses threatening the security of the state are treated with exceptional seriousness. Treason is the only offense defined in the United States constitution and "consist[s] only in levying war against [the United States], or in adhering to their enemies, giving them aid and comfort" (art. iii, sec. 3). The same constitutional provision limits penalties and regulates the modes of proof in treason prosecutions. In addition to treason, a wide range of lesser "political crimes" have been defined in all countries, including sedition, theft of military and governmental secrets, and many more. The kinds of political crimes and particularly the procedures employed to enforce the law in these areas tend to reflect the political principles of the nation and the degree of tolerance afforded dissent. The definition of political offenses, however, is by no means a preoccupation only of totalitarian regimes. Increase in the number and expansion of the breadth of political crimes throughout the western world is one of the clear tendencies of 20th-century legislation. (*See* also TREASON and SEDITION.)

Another important category of offenses is those that may be described as crimes against public justice and governmental processes. In the United States these include such offenses as bribery of public officials, perjury (*q.v.*), exerting improper influence on members of juries, and alteration or destruction of public records. Some of such conduct is not only made punishable by the criminal law but is subject also to the contempt powers of the courts.

III. CRIMINAL PROCEDURE

The law of criminal procedure regulates the modes of apprehending, charging and trying suspected offenders, the imposition of penalties on convicted offenders, and the methods of challenging the legality of conviction after judgment is entered. The law in this area is called upon to advance and reconcile interests of the greatest importance. It must contribute effectively to the attainment of public peace and good order. At the same time, it must afford realistic protection to the rights of persons proceeded against by the system of criminal justice.

1. Constitutional Limitations.—The regulation of criminal procedure is one of the primary concerns of U.S. constitutional law. Certain protections against oppressive procedures, many of which derive from the common law and English constitutional history, are given explicit recognition in the federal bill of rights (*i.e.*, the first ten amendments of the United States constitution). Thus the 4th amendment prohibits unreasonable searches and seizures; the 5th amendment requires the use of indictment or presentment in cases of infamous crime, prohibits double jeopardy, and pronounces the general requirement of due process of law; the 6th amendment guarantees a speedy and public trial in criminal cases, the right of trial by jury, to be confronted by hostile witnesses, to have compulsory process to obtain favourable witnesses, and to be tried in the district in which the crime was committed; the 8th amendment forbids excessive bail and cruel and unusual punishments. The protections of the first nine amendments to the United States constitution, however, do not apply to the states; and the original constitutional document contained only a few provisions relating to state criminal procedures, including prohibitions of ex post facto laws and bills of attainder (art. i, sec. 10) and provisions regulating extradition (art. iv, sec. 2). The most significant limitations imposed by federal law on state procedures arise from the equal protection and due-process clauses of the 14th amendment, adopted in 1868. It was not until the decisions by the U.S. supreme court in such cases as *Moore* v. *Dempsey*, 261 U.S. 86 (1923) and *Powell* v. *Alabama*, 287 U.S. 54 (1932), however, that the 14th amendment was given an interpretation importantly limiting state systems of criminal procedure. Since that time the court has applied to the states many of the specific restraints of the federal Bill of Rights, although in some areas the limitations on state authority defined by the 14th amendment are much less restrictive than those imposed on the federal government by the Bill of Rights. In addition, the constitutions of the several states contain provisions regulating criminal procedure. Some of these protections are expressed in language identical or similar to that of the federal Bill of Rights. (*See* also BILL OF RIGHTS, UNITED STATES.)

2. Jurisdiction and Venue.—Although the criminal jurisdiction of state and federal courts is subject to constitutional limitations, the rules of jurisdiction applied in most states of the U.S. are derived from the common law and in some respects are more restrictive than might be permissible as a matter of constitutional authority. The jurisdiction of a court refers to its capacity to take valid legal action. Questions of jurisdiction may relate either to the subject matter of the prosecution, the geographical limits of the court's power or whether the defendant is properly before the court. Thus, in most states, minor offenses may be tried before a magistrate or justice of the peace. Such a tribunal lacks jurisdiction to try more serious crimes, such trials being within the competence of courts of general criminal jurisdiction.

In the United States, jurisdiction over criminal conduct is primarily limited to that which occurred within the territorial limits of the particular state. Thus, when one fires a bullet across a state line and kills a victim in another state, U.S. courts have held that only the latter state has jurisdiction. In some instances, however, state legislatures have extended jurisdiction to conduct occurring outside the state but which directly affects the interests of the state or its citizens. The territorial principle has also been modified in the federal courts. Federal statutes confer jurisdiction to try various cases, including those of treason, forging or altering ship's papers, enticing desertion from military service, and bribery of a United States official, even though the conduct occurred outside the national boundaries. Another federal statute extends jurisdiction of federal courts over crimes committed on U.S. vessels and in aircraft on or over the high seas. In England, as in the United States, jurisdiction is determined primarily by reference to the territorial principle. A different view is taken in many European countries, where jurisdiction is considered as existing over nationals of the state without regard to the place where they may have committed the offense. Finally, it is generally assumed that, except in the trial of petty offenses, the presence of the defendant before the court is essential to the court's jurisdiction. In many states, however, once jurisdiction has attached, it may not be defeated by the voluntary absence of the defendant. Rule 43 of the Federal Rules of Criminal Procedure provides that voluntary absence of the defendant does not defeat continuation of the trial "in prosecutions of offenses not punishable by death."

Even assuming that a court has jurisdiction over the subject matter of the prosecution and the person of the offender, the question must be asked whether the court constitutes the proper place or venue of trial. Constitutional provisions, such as that in the 6th amendment to the U.S. constitution, generally provide that the defendant shall be tried in the district or county in which the crime occurred. The right thereby created may be waived by the defendant; indeed, the accused may request a change of venue because of prejudice against him in the community or in the court. When offenses are committed on moving vehicles, such as trains or boats, it may be impossible to determine precisely where the crime was committed. Statutes permitting venue to be laid in any county or district through which the vehicle passed have generally been upheld. Other special venue laws have also survived constitutional attack. (*See* also JURISDICTION; VENUE.)

3. Arrest and Search.—The 4th amendment to the U.S. constitution and similar provisions of state law prohibit unreasonable searches and seizures. Since an arrest consists of the seizure of a person, the definition of valid arrest is subject to constitutional limitations. The constitutional criteria are held to be satis-

ied, however, by the common-law rules relating to arrest. At common law, arrest might be made either by warrant, issued by a magistrate on the basis of evidence creating reasonable belief that the person proceeded against had committed an offense, or, in some cases, without warrant. Arrests without warrant were held to be authorized in the following situations: A private person might validly arrest one whom he reasonably believed had committed treason or felony, provided that treason or felony had actually been committed. A private person could arrest a misdemeanant only when the offense involved a breach of peace and was committed in the presence of the former. Arrest powers of peace officers were said to be identical to those of private persons except that an arrest by an officer for treason or felony was valid even if no such offense had been committed, when the officer reasonably believed that the crime had been committed and that the arrested person was the guilty party. Modern legislation has often broadened arrest powers, particularly those of peace officers in misdemeanour cases. The constitutional validity of such statutes has ordinarily been affirmed by U.S. courts.

The legal consequences of illegal arrests are several. First, the arresting party may be held liable in a civil suit for damages. Second, since the use of force in effecting an arrest is usually justified only if the arrest is valid, the arresting party may be held criminally liable for injuries inflicted upon the person he seeks to apprehend. Finally evidence obtained in a search following illegal arrest may be rendered inadmissible in the criminal trial. This consequence is the result of the so-called "exclusionary rule," first recognized by the federal courts in the case of *Weeks* v. *United States*, 232 U.S. 383 (1914). In 1961 the U.S. supreme court ruled that the exclusionary rule must also be applied in state prosecutions. (*See* also ARREST; WARRANT.)

4. Extradition.—The process by which a party charged with a crime in another jurisdiction is apprehended and returned to that jurisdiction for trial is known as extradition. Procedures of extradition between sovereign nations are ordinarily regulated by treaty. The United States constitution deals with similar problems of interstate rendition among the various U.S. jurisdictions (art. iv, sec. 2, par. 2). These provisions direct that fugitives from the justice of another state be given up on the demand of that state. It has been held, however, that should the governor of the state of asylum refuse such a demand, the power of the federal government cannot be employed to compel him to comply (*Kentucky* v. *Dennison*, 24 How. 66 [1860]). If the governor orders compliance with the request of the demanding state, the arrestee may sue out a writ of habeas corpus (*q.v.*). In the subsequent judicial proceedings, issues are confined to whether the arrestee is the person named in the information or indictment, whether he was in the demanding state when the alleged offense was committed, and whether the indictment or information alleges with substantial accuracy an offense under the laws of the demanding state. The constitutional provisions, by requiring that the person proceeded against be a "fugitive" from the demanding state, create substantial problems. Thus an arrestee who became an accessory before the fact to a murder committed in another state is not subject to rendition to the state in which the murder was committed and in which he was not present. In order to meet this problem and to supplement the constitutional provisions, many states have adopted the Uniform Extradition act, which eliminates the "fugitive" requirement. The salutary reform achieved by the act has been imperiled in some states by an unduly restrictive interpretation of the statutory language (*People* v. *Werblow*, 241 N.Y. 55 [1925]).

Provisions somewhat similar to interstate rendition apply to persons charged with federal crimes in courts of the United States. Although the United States is a single jurisdiction and is thus not obliged to litigate the issue of transporting arrested persons from one federal district to another where prosecution is pending, early statutes and many decisions establish such a right in some cases. Rule 40 of the Federal Rules of Criminal Procedure distinguishes "nearby" districts from "distant" districts, the former including those in the state in which the prosecution is pending and those 100 miles from the place of trial. No hearing is necessary if the arrestee is in a nearby district. The hearing required if arrest is in a distant district is held before a United States commissioner and is similar to hearings on extradition except that, if the prosecution is based upon an information rather than an indictment, it must be shown that there is probable cause to believe the accused is guilty of the crime charged. (*See* also EXTRADITION.)

5. Interrogation and Confessions.—A confession is a statement made out of court acknowledging the speaker's guilt of an offense. In the later history of the common law a coerced or involuntary confession was not admissible in a criminal trial. The same result is reached by U.S. constitutional law. Some U.S. decisions regard the admission of an involuntary confession as a violation of the defendant's privilege against self-incrimination, but most base their holdings on the requirements of due process of law. The scope of the confession rule has been the subject of sharp controversy. The view expressed most frequently in the older cases regards the confession as coerced only when the methods used to obtain it cast doubt on its accuracy or reliability. Beginning in the 1940s, however, the U.S. supreme court broadened the confession rule to invalidate not only those confessions that were probably unreliable but also those obtained by police methods regarded as reprehensible and improper. A voluntary confession is competent evidence of guilt, but in most U.S. jurisdictions it is not regarded as sufficient evidence of guilt. Thus, the confession must usually be corroborated by other competent evidence.

In the federal courts, additional efforts have been made to control the interrogatory practices of the police. Thus, even a voluntary confession of the arrested party is inadmissible if the police delayed unreasonably in bringing him before a magistrate and if the confession was made in the period of unreasonable delay. Among the state courts only those in Michigan have applied a similar rule to state criminal proceedings. Despite the various restrictions on the interrogatory practices of U.S. law-enforcement officers, the effect of the "judges' rules" in England is to confine police questioning within much narrower limits. The most important of these restrictions requires that when the officer charges the suspect with an offense, the suspect must be cautioned that he need not answer and that any answers will be recorded for possible use as evidence. (*See* also EVIDENCE: *Privilege and Public Policy;* DUE PROCESS; THIRD DEGREE.)

6. Indictment and Information.—In the United States, criminal prosecutions are commenced by a formal accusation verified by oath. Accusations are of three types; complaint, indictment and information. A complaint is ordinarily made by a private citizen or police officer, and its use is confined principally to cases of petty crimes. An indictment is a formal document returned by a grand jury. An information is an instrument prepared by the prosecutor. The 5th amendment of the United States constitution requires use of the indictment in cases of capital or other infamous crimes in the federal courts, but rule 7 of the Federal Rules of Criminal Procedure permits prosecutions of all but capital cases to proceed by information if the accused waives indictment by a grand jury. Waivers are frequent, and most prosecutions of even serious offenses in the federal courts are by information. Throughout the 19th century many states of the U.S. abolished the grand jury and, subject to various regulations, authorized use of informations. That such procedures do not violate the 14th amendment was established in the leading case of *Hurtado* v. *California*, 110 U.S. 516 (1884). Even in states retaining the grand jury, provision is usually made for waiver of indictment in some cases. Although the grand jury has been virtually abolished in England since 1933, cases tried by petty juries are based upon indictment. In the English practice, a bill of indictment may be preferred by any person and, when signed by the appropriate officer of the court, becomes an indictment.

The indictment or information must sufficiently allege the relevant facts to establish the jurisdiction of the court in which the case is tried, to provide the defendant with notice of the charges against him so that he may prepare his defense, and to protect the defendant from being tried again for commission of the same offense. Failure of the indictment in any of these respects may

subject it to a motion to quash by the defendant. In an earlier period the indictment was characterized by language of great prolixity. The tendency of the modern law has been to simplify criminal pleading and to eliminate the effects of trivial and merely formal errors. Nevertheless, the essential purposes of the charging function must still be achieved. The reforms introduced by the Federal Rules of Criminal Procedure are of particular importance. Rule 12 provides that a defense motion to dismiss the indictment may reach any defect ascertainable prior to trial which previously had been the subject of numerous pleas and motions. With regard to most of these defects, the defendant's failure to enter a motion to dismiss constitutes a waiver. But if an indictment or information is so defective as to fail to show the court's jurisdiction or to charge a crime, these failures may be asserted at any time during the proceeding and by a motion in arrest of judgment after conviction. (*See* also INDICTMENT.)

7. Prosecution.—In the United States, unlike England, the prosecuting function is chiefly performed by public officials elected or appointed for this purpose. Nor is this a recent development, for the office of public prosecutor emerged in the colonial period of American history. In Scotland, management of prosecutions is placed in the hands of an official known as the procurator-fiscal, whose functions are supervised by the lord advocate. The English system, however, has historically been one predominantly of private prosecution; *i.e.*, proceedings are instituted by private individuals who employ solicitors and counsel to conduct the proceedings. In mid-20th century England, private individuals continued to initiate the great majority of prosecutions for such offenses as embezzlement and fraud. In most cases, however, prosecutions are initiated and conducted by the police, who frequently employ solicitors for this purpose. The office of director of public prosecutions was established by the Prosecution of Offenses act, 1879. The director is appointed by the home secretary and acts under the supervision of the attorney general. It is the obligation of the office to prosecute all capital cases and a variety of other cases including those of coinage offenses, offenses against the election laws and other crimes when such intervention is required in the public interest. The director is also charged with defense of criminal appeals in cases where he was responsible for the prosecution.

The prosecutor in the United States exercises a wide discretion. He cannot be compelled to initiate a prosecution. In extreme cases of nonfeasance, however, some states permit the appointment of special prosecutors to initiate and conduct proceedings in particular cases, and on occasion prosecutors guilty of abuse of discretion have been removed from office. The rules in the states governing dismissal of prosecutions by the state's attorney vary considerably. Such a motion, termed nolle prosequi ("not to be prosecuted") (*q.v.*), in about half the states requires consent of the court; in the remaining states, the prosecutor, like the attorney general of England, makes the ultimate decision and the court must grant the motion to dismiss. The states requiring acquiescence of the court to dismissal have usually discovered that, as a practical matter, the device does not seriously limit the prosecutor's discretion.

8. Double Jeopardy.—The 5th amendment of the United States constitution provides that no person shall "be subject for the same offense to be twice put in jeopardy of life or limb." Similar provisions are to be found in almost all state constitutions in the U.S. In general, once jeopardy has attached, an accused may not be tried again for the same offense, whatever the outcome of the first trial. Jeopardy is said to attach when the jury is sworn or, if the accused is tried without a jury, when the first witness is sworn. Certain exceptions to the general rule permit a second trial when the first proceeding is brought to a premature end by such circumstances as the illness or death of the trial judge or by failure of the jury to agree on a verdict. A new trial ordered by an appellate court when the criminal appeal was initiated by the convicted defendant does not constitute double jeopardy. In England, however, new trials are not ordered by the court of criminal appeal even when the conviction is quashed. New trials following an appeal by the state are not permitted in most U.S. jurisdictions, although such a procedure in a state court was held not to violate the 14th amendment in *Palko* v. *Connecticut*, 302 U.S. 319 (1937).

The most difficult problems of double jeopardy involve the question whether the second prosecution is for the "same" or a "different" offense. It is everywhere held that acquittal or conviction of an offense prohibits subsequent prosecution of a lesser included offense (*e.g.*, manslaughter is included in murder). The converse of the proposition is denied in a few states, however, and the protections against double jeopardy are there weakened by permitting prosecution of the more serious offense after conviction or acquittal of the included crime. The fact that offenses are defined in two different sections of the statutes does not prevent them from being regarded as the "same" offense for purposes of double jeopardy. The test applied in the federal courts is that two offenses are different if each offense requires proof of a fact that the other does not. Some of the state courts apply a broader test and hold that the offenses are the same if they arise from the same "transaction." Thus, an offender who sells illegal narcotics in his possession may not be convicted of both sale and possession. It has been held that if the same conduct constitutes a violation of the state and federal law, the offender may be prosecuted in the courts of both jurisdictions. By the beginning of the 1960s, however, an increasing number of state laws had prohibited state prosecutions following acquittals or convictions in the federal courts for offenses involving the same conduct.

9. Proof of Guilt and Fair Trial.—It is a basic principle of the Anglo-American law of crimes that guilt of a criminal offense must be established beyond a reasonable doubt. The proposition does not require absolute certainty of guilt by the fact finder, but it does assume a higher order of proof than that normally required in civil proceedings; *i.e.*, proof by a preponderance of the evidence. In some jurisdictions minor offenses, usually those defined by municipal ordinance rather than state law, may be established by a mere preponderance of evidence. Some states of the U.S place a burden of proof on the defendant to maintain certain special defenses, such as insanity. With these exceptions, the prosecution's burden of proof beyond reasonable doubt extends to all material elements of the crime. One of the material elements of a crime is the corpus delicti ("the body of the crime"), which means simply that commission of the crime charged must be proved. Contrary to popular belief, the corpus delicti requirement does not obligate the prosecution to produce the body of the victim in a homicide case; several reported decisions have resulted in conviction of the accused even though the victim's body could not be recovered, the death of the victim being established by circumstantial evidence.

One of the central concerns of the administration of criminal justice is to provide the accused with a fair hearing on the issue of guilt or innocence. A number of constitutional provisions in the U.S. refer expressly to various aspects of fair trial, notably the 6th amendment of the federal constitution with its provisions for trial by jury, speedy and public trial, confrontation and compulsory process. The right of jury trial, except in cases of certain trivial offenses, is recognized in both the federal and state courts, although in the latter juries of less than the 12 required at common law have been held not to offend the federal constitution. Decisions under the equal-protection clause of the 14th amendment have reversed state convictions when members of racial groups were discriminated against in the selection of grand and petit juries. In practice, juries are employed in a relatively small fraction of criminal cases. In most jurisdictions, considerably more than half the convictions follow upon pleas of guilty; and even when the defendant contests his guilt, he is ordinarily permitted to waive his right to jury trial. Rule 23 of the Federal Rules of Criminal Procedure permits the defendant to be tried without a jury if he "waives a jury trial in writing with the approval of the court and the consent of the government." In England, trial by jury is preserved in cases of indictable offenses, whereas petty offenses are tried summarily by magistrates. Under modern legislation, however, the two categories are not mutually exclusive

some indictable offenses may, under certain circumstances, be tried summarily, and petty offenses punishable by more than three months' imprisonment may be tried on indictment.

Since the 1930s the United States supreme court has considered a wide range of issues relating to fair trial in the state courts, arising under the due-process clause of the 14th amendment. Some of the most important of these relate to the rights of counsel. In England, the right of one accused of a felony to employ counsel and to be represented by him in court was not fully recognized until the 19th century. It was no doubt the purpose of the provisions of the 6th amendment, guaranteeing rights of counsel in the federal courts, simply to permit a defendant to employ and be represented by counsel of his own choice. In the case of *Johnson* v. *Zerbst*, 304 U.S. 454 (1938), however, the 6th amendment was interpreted as requiring the court to appoint lawyers in felony cases to represent defendants lacking means to employ counsel. This broad rule has not been applied to the state courts. By the beginning of the 1960s the supreme court had announced that due process requires appointment of counsel for indigent defendants in all state capital cases, but in other cases only when necessary to ensure a fair trial. Since World War II many states have expanded their programs of legal aid, and several provide counsel to the indigent in all felony cases and, occasionally, in trials for misdemeanours. In England, legislative provision is made for legal aid when the prisoner is too poor to secure assistance and when it appears desirable in the interests of justice that legal aid be provided. (*See* also JURY; PRACTICE AND PROCEDURE.)

10. Sentencing Practices.—In the United States, sentencing powers usually reside in the trial judge. Some jurisdictions authorize the jury to make recommendations to the court in capital cases and, under some statutes, the recommendations are binding on the judge. In a few states, juries have been granted additional sentencing powers and are required not only to return a verdict on the issue of guilt but to specify the term of imprisonment to be imposed. Sentencing statutes vary considerably in their provisions, some authorizing only sentences for a definite term of years and others providing for a term with stated maximum and minimum limits. In most states, parole boards, subject to various requirements, are authorized to release prisoners under supervision before expirations of the maximum periods of imprisonment. Under the Federal Rules of Criminal Procedure and the law of a few states, a presentence investigation by the probation service and a report to the trial judge must be made before imposition of sentence or the granting of probation, unless the court directs otherwise. Although the judge is not required to adopt any recommendation made in the report, the provision for investigation and a hearing to consider questions of mitigation or aggravation are regarded as aids to a sound individualization of the sentence within the limits of permitted discretion. The trial judge may suspend the execution of the sentence or he may place the convicted offender on probation for a definite time under prescribed conditions, which usually include supervision by a probation officer. (*See* also SENTENCE; PROBATION.)

11. Postconviction Procedures.—After conviction, a defendant may move in the trial court to arrest judgment or he may file a motion for new trial. Among the grounds most frequently asserted in such motions are that the verdict is not supported by the law or the evidence; that newly discovered evidence has come to light; and that the court erred in its rulings on the admission of evidence. In modern practice, the legality of the conviction may also be challenged by review in an appellate court. Criminal appeals were unknown to the common law. In the 19th century a limited form of review was established in England by the creation of the court for crown cases reserved (11 and 12 Vict., c. 78). It was not until the Criminal Appeal act, 1907, however, that appellate review of criminal convictions was placed on a modern and satisfactory basis.

Criminal appeals play a more important role in the administration of criminal justice in the United States than in England. It was not until 1879, however, that writs of error in criminal cases were authorized in the federal practice. Provisions for criminal appeals were made in many of the states at somewhat earlier dates. It has been held that the states are not under constitutional obligation to provide appellate review; but if criminal appeals are authorized, they must be conducted fairly and without discrimination. In addition, certain postconviction remedies performing specialized functions are available in most U.S. jurisdictions. The writ of habeas corpus may be employed to attack a judgment of conviction by challenging the jurisdiction of the trial court. The common-law writ of error *coram nobis* is recognized in some states and may result in the granting of a new trial upon a showing of facts not brought previously to the attention of the judge which might have altered the outcome of the trial had they been known to him. In some states and in the federal courts, statutory postconviction remedies are available, usually for the purpose of litigating alleged deprivations of the accused's constitutional rights at or before trial. (*See* also APPEAL.)

12. Continental Countries.—The criminal procedure of modern European countries presents many points of difference from that of countries in the Anglo-American tradition. These differences do not encompass fundamental objectives, however, for the continental law also seeks to advance public peace and order through methods which protect the legitimate interests of suspected or accused persons. The preliminary investigations of crime are principally in the hands of the police and public prosecutors. Judicial officers also participate in preliminary investigations to a degree unknown in most Anglo-American countries. Juries were introduced into continental procedure in cases of serious offenses as a result of their establishment in France after the French Revolution, and various modifications have occurred in the jury institution in the intervening years. Ordinarily the jury does not render a general finding on the issue of guilt but responds to a series of interrogatories submitted to it. Unlike the Anglo-American system which relies principally on examination and cross-examination by counsel, interrogation of witnesses is primarily the function of the presiding judge.

See CRIME; WAR CRIMES; CAPITAL PUNISHMENT; *see* also references under "Criminal Law" in the Index volume.

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CRIMINOLOGY is the study of the causation, correction and prevention of criminal behaviour. It is not a clearly distinct and integrated science but rather one that collects the contributions of diverse specialists who study crime (*q.v.*) and related phenomena. Accordingly, the term "criminologist" does not designate a particular occupation but is applied to certain sociologists, psychiatrists, psychologists, lawyers, police officials, prison administrators, parole and probation officers and others who specialize in some aspects of criminology. In Europe writers on criminology have come mainly from university faculties of law and medicine, while in the United States criminology specialists generally are in university departments of sociology. The study of scientific crime detection techniques in police training schools also has been called criminology or scientific criminology, although where it is taught in universities, and especially as it involves the application of the physical sciences to crime detection, it increasingly is termed criminalistics (*see* INVESTIGATION, CRIMINAL: *Scientific Aids*). The study of methods of handling convicted criminals is a branch of criminology, sometimes distinguished as penology but increasingly called correction.

Causation.—The explanation of crime has always been the central concern of criminological inquiry. Early 19th-century research attempted to relate fluctuations in the amount or nature of crime to variations in climate and other aspects of the physical environment. The rise of the theory of evolution led later to a stress on heredity as the cause of crime. Most influential in this orientation was the Italian physician Cesare Lombroso (*q.v.*), who described the so-called criminal type as having peculiarities of physical appearance, particularly skull deformities, which were said to constitute a throwback to primitive man. Opposing this

view, the French magistrate and psychologist Gabriel Tarde contended that crime was learned only from association with other criminals. Meanwhile, European socialist writers of the 19th century ascribed crime to poverty rather than heredity. Early in the 20th century a British investigator, Charles Goring, greatly weakened Lombroso's influence when he reported finding about as many cases of Lombroso's criminal physical traits among English university students as among English convicts. Goring and others still assumed criminality to be hereditary but ascribed it to mental deficiency not correlated with the physical stigmata that Lombroso postulated.

In the first quarter of the 20th century the U.S. psychiatrist William Healy was among the most influential of many who promoted the idea that crime results from many factors operating together, the so-called multicausal theory. Their research method was to prepare a case analysis of each individual offender, noting as causes of criminality any marked deviation from presumed normality in health, personality, school record, home or other conditions. The English psychologist Sir Cyril Burt applied the same method in London, with findings much like Healy's. In the 1940s Sheldon and Eleanor Glueck extended this approach by measuring several hundred attributes in 500 delinquents and in a matched sample of nondelinquents in the Boston, Mass., area. They concluded that delinquents differed from nondelinquents in more often being impulsive, aggressive, hostile, poor reactors in school and of mesomorphic (husky) body build and having inconsistent, discordant or criminal parents.

Since a tremendous variety of conditions may be demonstrated to be associated with some—or even most—crimes or criminals, the mere contention that crime has many causes has limited utility as a contribution to science or as a practical guide for dealing with criminals, unless rules for intervening factors are formulated. Therefore there have been continued efforts to set forth a single theory that may account for almost all crime or for specifiable types of criminal behaviour without being incompatible with the evidence that many conditions have some correlation with crime.

Psychoanalysts and psychiatric writers view crime as a symptom of disturbing experiences in the intimate relationships of the family during the early years of life. In interpreting criminal cases they focus on one or more of such personality attributes as weak ego development, with resulting impulsiveness of acts, gross emotional instability and lack of guilt feeling. Traditionally, psychiatrists refer to the latter symptom as the primary basis for diagnosing "psychopathic personality." Early use of this diagnosis added the adjective "constitutional" to imply that such apparent absence of conscience was caused by inherited mental defect or by brain injury, but post-World War II writers increasingly ascribe those symptoms to defective early socialization, and the term "sociopath" became widely preferred to "psychopath."

In the 1949 edition of his *Principles of Criminology*, the U.S. sociologist Edwin H. Sutherland first presented his differential association theory as a general explanation for crime causation. This theory views crime as the normally learned behaviour of individuals who are exposed so much earlier, more intensely, more frequently or longer to procriminal behaviour that its influences outweigh those of anticriminal behaviour. Conditions correlated with crime, such as broken homes, retardation in school, high delinquency neighbourhoods, idleness or other factors which were stressed in the multicausal theory, are seen as determining crime only as they affect an individual's associations with criminal or with anticriminal behaviour. This principle of explanation was applied by Sutherland to all classes of crime, including white-collar crime, an otherwise confusing phenomenon of the deliberate violation of law by responsible persons of respectability and high social status in the course of their ordinary occupations. Research by Donald R. Cressey suggests the inadequacy of the theory for explaining embezzlement (all that act is defined as criminal violation of trust committed by persons previously trustworthy), and Edwin M. Lemert's research suggests the theory's inadequacy in accounting for simple forgery, an offense frequently associated with chronic alcoholism. Sutherland's theory has never been tested to the satisfaction of many criminologists, but its proponents contend that it is useful in the interpretation of most larceny, burglary and robbery cases, which account for 90% of major offense arrests in the U.S. and about 85% of indictable crimes known to the police in England and Wales.

During the second quarter of the 20th century U.S. criminologists increased their concern with so-called organized crime and vice—business enterprises established to sell illegal commodities or services, such as gambling, prostitution, illegal liquor, narcotics and violent "protection." Such offenses, in which the presumed noncriminal is likely to seek the service of criminals, contrast with predatory crimes, in which there is clearly a victim who opposes the criminal. Large-scale criminal syndicates appear to have used wealth from the sale of alcoholic liquors during the prohibition period, and later from gambling, prostitution and the drug traffic, to invest in many legitimate enterprises and, in some cases, to enter politics. Their participation here becomes illegitimate when they employ violence or other illegal methods to combat their competitors. State and federal investigations and the hearings of U.S. senate committees in the 1950s, notably the so-called Kefauver committee, focused attention on the national ramifications of criminal organizations and led to some increased prosecution and regulatory legislation. Periodic scandals and exposés in other countries similarly illustrate the continuous need to be alert that crime does not become a part of the routine operation of respected business and governmental agencies.

Corrections.—The history of the treatment of convicted criminals may be summarized as a sequence of retribution, restraint and rehabilitation. In this succession, however, older principles never were completely abandoned when emphasis shifted to newer concerns.

Almost the sole principle in early action against convicted criminals appears to have been the imposition of suffering equal or greater than that which the crime created. Until well into the 19th century penalties consisted almost entirely of public degradation, corporal punishment, execution or banishment, accompanied by fines or confiscation of property.

The use of imprisonment as a penalty rather than merely for pretrial confinement was at first infrequent. It began to be reported in the 13th century when life imprisonment was ordered if mitigating circumstances barred the death penalty or when imprisonment was used as a means of assuring collection of fines (the offender being released when his friends or relatives paid the required amount). From the 16th to the 18th century imposition of imprisonment increased for lesser offenses, apparently motivated in part by a labour shortage concomitant with the growth of commerce. Prisoners were used extensively to operate galleys on coastal and inland waterways, and workhouses were created for "sturdy beggars." One of the first of these institutions, the Bridewell, which opened in London in 1555, has provided a nickname for similar establishments throughout the English-speaking world. In the 18th century a labour surplus developed, particularly in England, and in this period there was a great increase in punishment by death and by forced transportation to overseas colonies.

Only in the 19th century did imprisonment come to predominate among penalties for crime, its increase being associated with a reaction against the cruelty and ineffectiveness of capital and corporal punishments. This in turn seems to have reflected certain characteristics of the philosophy of the Enlightenment, particularly the increased respect for humanity and a heightened valuation of freedom, denial of which was viewed as one of the most severe penalties possible. The number of offenses punished by death in England as reported to have dropped from about 350 in 1780 to 17 by 1819, with imprisonment being the alternative penalty. The writing considered most influential in promoting such change was *Essay on Crimes and Punishments*, by Cesare Beccaria (q.v.), which appeared in 1764 and was widely translated and reprinted. It was long ascribed to Voltaire, who also was an influential critic of penal practice.

A distinctive feature of 19th-century law was the fixing of a precise duration of confinement as the appropriate penalty for each crime, in contrast to more indefinite periods prescribed earlier. The definite sentence principle reflected the philosophy of utili-

ism, which influenced law especially through the writings emy Bentham. He proposed to deter crime by a "hedonistic us" to determine penalties of restraint of freedom just suf- to make the pain consequent to committing a crime clearly the potential pleasure which might be gained from com- the crime. Any pain beyond this amount was considered essary, hence unjust. While this balancing would seem to matter of exacting retribution, it was justified in terms of chological theory of human behaviour. The criminal was d not as having to pay for his crime but as being adequately ned if he and others merely were deterred as a result of the of restraint. The psychology involved in this approach can ticized as unrealistic in assuming highly rational calculation e offender and in neglecting the offender's consideration of ances of not being apprehended. However, it paved the or other judicial and correctional developments concerned rving to change the mentality of offenders.

such development was that of the Quakers in Pennsylvania. this Pennsylvania system of confinement the prisoners, d of being housed and worked together in large halls, as was actice in earlier prisons, were kept in solitary confinement, only a Bible as reading matter, and were visited only by ers and other respected persons. The Walnut street jail iladelphia was modified to this pattern between 1791 and and the Eastern State penitentiary, the first institution de- purely for this solitary penitence, was opened at Phila- a in 1829. Opposition to the Pennsylvania system as being stly and as allegedly producing insanity was spearheaded porters of a system named after New York's Auburn prison. ucted in 1816. The Auburn system featured small cells ed for solitary sleeping only, with waking hours devoted to regate but silent work. The lock step and striped suit were Auburn innovations. Alexis de Tocqueville is perhaps the famous of many visitors from other countries sent to the d States specifically to study these penal developments. Auburn system soon predominated in American correctional ce, but the Pennsylvania system was most widely copied in e. The convict prison at Pentonville in London (1842) was ecturally modeled on Pennsylvania's Eastern State peniten- and became a prototype for more than 50 others, most of remained in use in the second half of the 20th century.

A rison opened at Elmira, New York, in 1876, was the first of ous establishments for young offenders to be called re- tories. On the whole, these institutions gave greater empha- n other prisons to augmenting the academic and vocational ion of inmates. In Great Britain the report of the Gladstone ittee of 1895 on the general failure to reform youth led to a of experiments culminating in 1908 with the establishment pecial program for youths in Borstal prison, near Rochester, Thereafter all institutions of a separate British system ons for selected 16- to 21-year-old inmates have been called ls. These institutions were distinguished at first by the to which they were staffed by idealistic members of the classes, who also provided extensive voluntary postrelease nce through local Borstal associations, but volunteer partici- declined sharply during the 1930s. In the United States deral Youth Corrections act (1950) copied the Borstal ce's guarantee of at least one conditional release from con- nt before the end of the sentence in all but extremely intrac- ases. (*See* also BORSTAL SYSTEM; REFORMATORY; PRISON.)

obably the most important correctional development of the th century was the introduction of probation and parole, are ways of serving penal sentences under supervision in the mmunity. The first use of probation (*q.v.*), which is im- by the court as an alternative to imprisonment, generally is d to the efforts of John Augustus, in Massachusetts, starting 1. Similar practice developed in many places, however, as growth of the suspended sentence. Parole, a conditional from prison after serving a portion of a sentence under ment, generally is traced to a ticket-of-leave system intro- in prisons of Australia and Ireland in the 19th century. ision of the offenders in the community is similar under both probation and parole, and either type of freedom may be revoked for violation of regulations, as for failure to endeavour to work regularly or to avoid known criminals. Increasingly, however, goals stressed in supervision have been not so much restriction of the offender as positive assistance and guidance. A distinctive feature of 20th-century crime correction, both in and out of prisons, has been the increased employment of psychiatrists, psychologists, social workers and sociologists for classifying offenders so that they may be placed in the available vocational, educational or treatment program best suited to their needs, and to provide counseling and other aid.

Systematic research in correction at first consisted mainly in exposing cruel or unsanitary prison conditions. The most influential undertaking of this sort was John Howard's *State of the Prisons in England and Wales*, which appeared in 1777. Donald Clemmer's *The Prison Community*, in 1940, was the first major sociological study of a prison, not followed by others until Gresham M. Sykes' *Society of Captives*, in 1958. Criminological prediction research, an effort to guide parole and probation selection by systematic tabulation of the postrelease behaviour of different types of offenders, began with a pioneer study by Ernest W. Burgess in 1928, followed notably by the efforts of Sheldon and Eleanor Glueck, Lloyd E. Ohlin and others.

The beginning of correctional research on a major scale in Great Britain was marked by the publication, in 1955, of *Prediction Methods in Relation to Borstal Training*, by Hermann Mannheim and Leslie T. Wilkins. In 1958 Wilkins also helped California establish an extensive state program. The growing government programs attempt to evaluate the treatment of criminals statistically by determining the extent to which those treated revert to crime and by conducting some controlled experiments in correctional practice. Evaluation research in the United States often is hampered by difficulties in procuring national arrest records of released offenders in order to know more completely how many discharged prisoners or probationers get into further difficulty with the law. However, this type of research is expected to produce more scientifically adequate foundations not only for correctional practice but for criminological theory as well.

Prevention.—The study of juvenile crime, commonly called delinquency, has led to programs endeavouring to prevent crime by altering conditions believed to foster delinquency. Variations in prevention programs reflect different emphases in theories of crime causation.

Psychiatric and psychological research on crime has provided a major impetus for the promotion of child guidance clinics as crime prevention undertakings. These have concentrated their attention primarily on neurotic and emotionally unstable children, whether or not they were involved in crime. Most clinics receive a disproportionate number of such children from middle-class homes, for middle-class parents are more likely than working-class parents to perceive of such children as requiring psychiatric attention. However, working-class homes provide a majority of delinquency cases brought into court.

A series of studies of juvenile delinquents by Clifford R. Shaw and Henry D. McKay, initiated in the 1920s and continued for over 30 years, led to their leadership in the neighbourhood approach to crime prevention. The principal findings of their research, which have passed the test of time fairly well, include the following points: (1) Delinquency is most concentrated in city slum neighbourhoods located in areas where land is changing from residential to commercial and industrial usage. (2) The children of new and impoverished migrants to the city (rather than the migrants themselves) have the highest crime rates in the city. (3) Because the least attractive areas are the most accessible to new and poor migrants for residence, these neighbourhoods remain the highest delinquency areas despite successive migrations that make the population of such neighbourhoods change in racial or nationality composition. (4) Delinquency usually is group behaviour (two or more associates are involved in at least 90% of thefts by juveniles reported to the courts). (5) Delinquent gangs, which are common in high delinquency areas, promote delinquency by providing their members with prestige and loyalty, which these

youth are ill prepared to attain in more conventional social institutions.

The crime prevention programs growing most directly out of delinquent-neighbourhood research are Shaw and McKay's Chicago Area projects. These recruit slum residents to participate in neighbourhood committees that operate social and recreational centres in which juvenile gangs are involved in noncriminal group activities. Shaw and McKay and their protégés in many communities contend that a few professional persons employed for a delinquency prevention program can reach more slum youth or high crime potential by working with neighbourhood committees and gangs as units than they can by endeavouring to counsel the delinquents as individuals. They also contend that local adults or fellow gang members can communicate with the youths more effectively than an adult outsider and that slum residents can be trained so that they can effectively administer their own programs to make delinquents noncriminal.

Various compromises between the area-project approach and the traditional psychiatric case-work method of dealing with delinquents predominated in delinquency prevention programs in the U.S. in the 1960s. Under such titles as "detached workers" and "street corner workers," trained social workers were employed by major city agencies to locate and work with delinquent gangs in the slums. However, there have been objections to depending too greatly on slum-neighbourhood residents for direction of delinquency prevention programs, because of the high mobility of the more capable adults in the slum, the limited resources of most adults there and their frequent location in new housing projects where there is no long-established community leadership. Indeed, some programs have stressed use of case workers to evaluate the adequacy of slum parents and to seek aggressively to alter delinquency-producing home influences before the children become too advanced in criminality. This so-called reaching out method has been particularly promoted by the New York City youth board. It finds support from research by the Gluecks and by Walter Reckless on nondelinquents reared in high delinquency areas, which indicates that the family is the main insulator of such youth against delinquent-neighbourhood influences. (*See* also JUVENILE DELINQUENCY.)

A quite different approach to crime prevention involves efforts to reduce the profits of organized and professional crime, to which young offenders often graduate. Many states and municipalities have crime commissions to investigate alleged inefficiency of the police and the judicial system or to suggest new legislation. Crime prevention also is claimed as the basis for movements to legalize certain activities, such as the liquor business where it is prohibited, off-track gambling and narcotics distribution, which when not legalized are exclusively a criminal monopoly. The legalization argument contends that dissociating vices from crime reduces the resources of criminals, their interest in recruiting the innocent and their ability to corrupt police and other officials, and at the same time permits more effective regulation and treatment of the vices. Opponents to these views argue that legalization makes potential sources of vicious habits more accessible, hence vice becomes more widespread and promotes crime by impairing a person's ability to meet the responsibilities of noncriminal life.

See CRIME; POLICE; INVESTIGATION, CRIMINAL; HABITUAL OFFENDERS; PROBATION; RECIVIDISM. *See* also references under "Criminology" in the Index volume.

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CRIMMITSCHAU (KRIMMITSCHAU), an industrial town of Germany which after partition of the nation following World War II was in the *Bezirk* (district) of Karl-Marx-Stadt, Saxony, German Democratic Republic. Pop. (1959) 31,728. The town is on the Pleisse river, 40 km. (25 mi.) W. of Karl-Marx-Stadt and 58 km. (36 mi.) S. of Leipzig. The Leipzig-Zwickau-Hof railway line passes through it. Crimmitschau is a textile centre. It has many factories producing cloth and knitted goods, spinning and weaving mills and textile manufacturing plants. The strike of the Crimmitschau textile machinery workers from Aug. 1903 to Jan. 1904 had the effect of mobilizing textile workers in the whole of Germany. A leader of the Crimmitschau women textile workers in this struggle was the pioneer for equal rights for women, Clara Zetkin (*q.v.*).

CRINOIDEA, a class of marine invertebrates of the phylum Echinodermata (*q.v.*); it comprises the attached, stalked sea lilies and the stalkless, free-living feather stars. The sea lilies, which flourished in former geological periods, are important index fossils.

See also references under "Crinoidea" in the Index volume. (EL. D.)

CRINUM, a genus of bulbous plants of the family Amaryllidaceae (*q.v.*) with fleshy leaves and a solid, leafless flower stalk, bearing a cluster of handsome white or red funnel-shaped regular flowers. There are 100 or more species, native to tropical regions, some well known in cultivation.

The swamp lily, *C. americanum* (not a true lily, however), of the southern U.S., is sometimes planted for ornament. *C. bulbiferum* (or *bulbispermum*) of South Africa is the best-known garden crinum.

CRIOBOLIUM, the sacrifice of a ram in the cult of the Phrygian nature and vegetation deities Attis and the Great Mother. Perhaps it was a ceremony instituted after the rise and on the analogy of the taurobolium (*q.v.*), which it probably resembled but was in honour of Attis. When it was performed in conjunction with the taurobolium, the altar was almost invariably inscribed to both the Mother and Attis, while the inscription was to the Mother alone when the taurobolium only was performed. The criobolium was sometimes performed alone.

CRIPPEN, HAWLEY HARVEY (1862–1910), convicted wife-poisoner, was hanged at Pentonville prison on Nov. 23, 1910 following one of the most sensational English murder trials in the 20th century. Crippen, a U.S. citizen holding a medical degree went to London in 1900. His wife, who affected the stage name of Belle Elmore, was a vivacious woman much absorbed in an unsuccessful career in the English music halls. Relations between Crippen and his wife deteriorated, and three years before the homicide, Crippen established an illicit liaison with Ethel Le Neve, a typist.

Mrs. Crippen was last seen alive at a social function on the evening of Jan. 31, 1910. Shortly thereafter Crippen falsely asserted that his wife had gone to the United States on family business, and later, that she had died of pneumonia. When Crippen's statements prompted investigation, he and Miss Le Neve, the latter disguised as a boy, attempted flight to America. A search of Crippen's home resulted in the discovery of mutilated human remains under the cellar floor. Crippen and Miss Le Neve were apprehended on an ocean vessel as it neared Quebec. This is believed to be the first occasion in which wireless telegraphy played a role in crime detection.

At his trial Crippen persistently and imperturbably maintained his innocence. The evidence against him, however, was overwhelming. It was established that the killing was accomplished by a lethal dose of hyoscine, a poisonous drug, and that Crippen

ad purchased five grams of the poison shortly before his wife's isappearance. The remains were identified as those of Mrs. Crip- en by an abdominal scar. They were wrapped in a pajama jacket aced to Crippen.

The trial was notable for the collapse of the medical testimony f the defense. The court of criminal appeal refused to disturb the onviction. Miss Le Neve was tried as an accessory after the fact ad was acquitted.

See F. Young (ed.), *The Trial of Hawley Harvey Crippen,* "Notable ritish Trials Series," 2nd ed. (1950). One of the numerous discus- ons of the Crippen case may be found in Sir T. Humphreys, *A Book f Trials* (1953). (F. A. A.)

CRIPPLE CREEK, a city near the centre of Colorado, U.S., a granite pocket 9,600 ft. above sea level, seat of Teller county nd the heart of a gold-producing district once the richest in the orld.

Gold was discovered in Poverty gulch, just northeast of the resent city, early in the year 1891 by Robert Womack, a cow- uncher, who died poor; and the Independence vein, on the site f nearby Victor, was struck on July 4, 1891, by W. S. Stratton, a arpenter, who left a fortune of $20,000,000. The gold output eached $2,000,000 in 1893 and mounted rapidly to exceed $18,- 00,000 in 1900.

From 1900 to 1910 it averaged $15,000,000 annually, the follow- ng decade it averaged about $10,000,000 and declined thereafter. ripple Creek became almost a ghost town. The rise in the price f gold to $35 per ounce in 1934, the digging of the Carlton drain- ge tunnel and the removal of the Golden Cycle mill to the dis- ict instilled new life. The gold production was about $2,000,- 00 annually after 1950.

Three railways reached Cripple Creek during the years 1893– 901. Following fires that razed the lumber city in the 1890s, it ose in brick and stone.

In 1894 and again in 1903–04 there were serious labour dis- rbances, attended by violence and loss of life. The population f the district declined from 29,000 in 1900 to fewer than 1,000 fter 1960. The city has become a favourite summer tourist re- ort. (L. R. Ha.)

CRIPPLES: *see* Rehabilitation, Medical and Vocational.

CRIPPS, SIR (RICHARD) STAFFORD (1889–1952), ritish statesman, chiefly remembered for his rigid austerity pro- ram as chancellor of the exchequer (1947–50), was born in Lon- on on April 24, 1889, the fourth son of Charles Alfred Cripps afterward Lord Parmoor) who was a distinguished ecclesiastical awyer. His mother was a sister of Beatrice Webb. He went to chool at Winchester and from there won a scholarship to New ollege, Oxford, but as he wished to study chemistry he went nstead to University college, London. During the early part of is life the bent of his mind remained strongly scientific and in World War I, being unfit for military service, he worked (1915–17) the explosives department of the ministry of munitions.

Cripps's health collapsed in 1917 and he was an invalid for two ears. In 1919 he returned to the bar (to which he had been called 1913) and rapidly built up a highly successful practice based ainly on patent cases, in which his scientific knowledge was of nsiderable use. In 1927 he became the youngest king's counsel f his day. During this period his interest in world problems only ound religious expression. He was (and remained throughout his fe) an active Anglican and a supporter of the World Alliance r Promoting International Friendship Through the Churches. lthough his father, originally a Conservative, had been a member f the first Labour cabinet, Stafford Cripps belonged to no political rty until 1929 when he joined the Labour party. In 1930, al- ough not a member of the house of commons, he was appointed licitor general by J. Ramsay MacDonald and received the knight- od which is customary for law officers. He was elected member parliament in 1931 for Bristol East, which constituency he presented until 1950.

When MacDonald formed his national government in 1931 ripps went into opposition with the bulk of the Labour party. owever, his relations with his colleagues during the 1930s were r from smooth. He reacted to the 1931 defeat by adopting a cataclysmic approach to socialism. In 1932 he helped to found the left-wing Socialist league. In 1935 he resigned from the Labour party national executive in opposition to the party's support for League of Nations sanctions against Italy. In 1936 he advocated a united front with the Communists and in 1938 he widened (and modified) his views to advocate a popular front and co-operation with anyone "from Churchill to Pollitt" who would stand up to Hitler. His persistence in this campaign led to his expulsion from the Labour party in 1939. During these years he was one of the most successful advocates at the bar.

In May 1940 Winston Churchill made Cripps ambassador to the U.S.S.R. He remained in Moscow until Jan. 1942. On his return he became a member of the small war cabinet, lord privy seal and leader of the house of commons, but in Nov. 1942 he transferred to a more administrative post—minister of aircraft production—which he held until the end of the war. He was then readmitted to the Labour party and joined C. R. Attlee's cabinet as president of the board of trade. In this capacity he launched Great Britain's postwar export drive, but he was also greatly occupied with the nondepartmental task of negotiating a settlement with India.

In Nov. 1947 (having been minister for economic affairs since early October) Cripps succeeded Hugh Dalton as chancellor of the exchequer. For the next three years he dominated the home policy of the Labour government. He concentrated on the balance of payments and investment, and he pursued a strict fiscal policy aimed at checking inflation by means of large budget surpluses. He earned the epithet of "austerity Cripps," but he gave moral leadership of unusual force to the country. He achieved a rapid rate of economic growth and a substantial improvement in Great Britain's trading position, but he was not able to prevent the devaluation of the pound in 1949. He was forced by illness to resign both from office and from parliament in Oct. 1950. He never recovered and he died at Zürich, Switz., on April 21, 1952. (R. J.)

CRISPI, FRANCESCO (1819–1901), Italian statesman, an extreme nationalist who began his political life as a radical and ended up as the champion of monarchic autocracy, was born at Ribera, near Agrigento in Sicily, on Oct. 4, 1819. In 1846 he established himself as an advocate at Naples. On the outbreak of the Sicilian revolution at Palermo (Jan. 12, 1848) he hastened to the island and took an active part in guiding the insurrection. On the restoration of the Bourbon government (May 15, 1849) he was excluded from the amnesty and compelled to flee to Piedmont. There he eked out a penurious existence by journalism. After the Mazzinian conspiracy at Milan (Feb. 6, 1853) he was expelled from Piedmont for his republican sympathies and took refuge at Malta. Expelled from Malta for his journalistic writing, he joined Mazzini in London and continued to conspire for the liberation of Italy. On June 15, 1859, he returned to Italy, after publishing a letter repudiating the aggrandizement of Piedmont and proclaiming himself a republican and a partisan of national unity. Twice in that year he went the round of the Sicilian cities in disguise to prepare for another revolution against the Bourbons of Naples.

Arriving in Genoa, Crispi worked with A. Bertani, N. Bixio, G. Medici and Garibaldi to organize the expedition of the Thousand (*see* Garibaldi, Giuseppe; Italy: *History*). Overcoming Garibaldi's hesitation by a stratagem, he secured the expedition's departure on May 5, 1860. Disembarking at Marsala on May 11, Crispi on the 13th, at Salemi, drew up the proclamation whereby Garibaldi assumed the dictatorship of Sicily, with the program "Italy and Victor Emmanuel." After the fall of Palermo, Crispi was appointed minister of the interior. As the chief Sicilian in the revolutionary army, he virtually took over politics and the administration, but was shortly afterward obliged to resign because of the struggle between Garibaldi and the emissaries of Cavour, who wanted the island's immediate annexation. Appointed secretary to Garibaldi, Crispi secured the resignation of A. Depretis, whom Garibaldi had appointed pro-dictator, and would have continued his fierce opposition to Cavour at Naples had not the advent of the Italian regular troops and the annexation of the Two Sicilies to Italy brought about Garibaldi's withdrawal to Caprera (an island off Sardinia) and Crispi's own resignation.

Entering parliament in 1861 as extreme left deputy for Castelvetrano (Sicily), Crispi acquired the reputation for being the most aggressive and most impetuous member of the Republican party, but in 1864 he made to the chamber a monarchical profession of faith in his famous phrase, "the monarchy unites us, the republic would divide us." Thus began his separation from Mazzini which marked an important point in the consolidation of the new state.

In 1866 Crispi refused to enter Bettino Ricasoli's cabinet. The following year he worked behind the scenes to make possible a Garibaldian invasion of the papal states, but in vain. Meanwhile in parliament he campaigned for universal suffrage and anticlericalism.

On the outbreak of the Franco-German War in 1870 Crispi sought to impede the projected alliance with France and to drive Giovanni Lanza's cabinet to attack and capture Rome. Urbano Rattazzi's death in 1873 induced Crispi's friends to put forward his candidature for the leadership of the left; but Crispi, anxious to reassure the crown, decided not to compete and supported the election of Depretis. After the advent of the left he was elected (Nov. 1876) president of the chamber.

During the autumn of 1877 Crispi went to London, Paris and Berlin, establishing cordial personal relationships with Gladstone and, above all, with Bismarck. The latter now became his model in politics. In Dec. 1877 Crispi at last achieved office and became minister of the interior in the Depretis cabinet. On Jan. 9, 1878, Victor Emmanuel's death enabled him to secure the formal establishment of a unitary Italian monarchy, the new monarch taking the title of Humbert I of Italy instead of Humbert IV of Savoy.

After only two months in office a storm of indignation was conjured up against Crispi in connection with a charge of bigamy, and he was compelled to resign. For nine years he remained under a cloud and in opposition to Depretis, but in 1887 he returned to office as minister of the interior in the Depretis cabinet, succeeding to the premiership on the latter's death (July 29, 1887). People now began to accuse him of lack of principle and an overmastering desire for power.

One of Crispi's first acts as premier was another visit to Bismarck. Basing his foreign policy upon the triple alliance as supplemented by the naval entente with Great Britain, he assumed a quite unnecessarily truculent attitude toward France and initiated a tariff war which did untold harm to Italy and from which he eventually had to climb down. At home he secured the adoption of new sanitary and commercial codes and reformed the administration of justice. Forsaken by his radical friends because of his growing conservatism and dictatorial behaviour, Crispi governed with the help of the right until on Jan. 31, 1891, his tactless conduct in parliament compelled him to resign. In Dec. 1893 the impotence of Giovanni Giolitti's cabinet to restore public order, menaced by disturbances in Sicily and in Lunigiana, led to a demand that Crispi should return to power. Crispi's fierce policy of social repression and his refusal to abandon a policy of active if over-expensive imperialism in Eritrea caused a breach between him and the radical leader F. Cavallotti, who then began against him a pitiless campaign of defamation. Grave financial irregularities were brought to light in the relations between Crispi's government and the big Roman banks. Yet strong support came to him from those who wanted the suppression of socialism in Sicily and an aggressive policy against Ethiopia. The general election of 1895 gave Crispi a majority, but a year later the humiliating defeat of the Italian army at Aduwa in Ethiopia brought about his resignation. Without doubt Crispi was heavily to blame for this defeat. Furthermore, at the end of 1897 the judicial authorities applied to the chamber for permission to prosecute Crispi for embezzlement. A parliamentary commission appointed to inquire into the charges against him discovered that Crispi, while personally not dishonest, had involved himself with shady financiers and had deliberately misled the public about certain financial scandals which implicated his friends. Crispi resigned his seat in parliament and withdrew from active politics.

Following in the wake of Bismarck, Crispi had reduced the powers and independence of parliament. He had outlawed socialism and imprisoned some of the deputies of the left. His exaggerated notions about national honour led to a much more bellicose foreign policy than Italy's economy could afford. His death at Naples, on Aug. 12, 1901, came when Giolitti was beginning a much more liberal policy both at home and abroad, but many people looked back with nostalgia to the expansive days of Crispi, and his exaggerated nationalism was to be revived in the not so distant future. Mussolini regarded him as a precursor of fascism.

An edition of Crispi's *Scritti e discorsi politici, 1847–90* appeared in 1890. This was followed by posthumous editions of his *Carteggi politici inediti* (1912), *Questioni internazionali* (1913), *Ultimi scritti e discorsi* (1913) and *Discorsi parlamentari* (1915).

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(D. M. Sh.)

CRISPIN AND CRISPINIAN, SAINTS, the patron saints of shoemakers, have a legendary history, traceable to the 8th century. It is said that they were brothers, of a noble Roman family and that they traveled to Soissons, where they supported themselves by shoemaking and made many converts. The emperor Maximian condemned them to death but they escaped from the ordeals imposed by his prefect, and at last Maximian had their heads cut off (*c.* 286). Their remains were buried at Soissons but were afterward moved, partly to Osnabrück and partly to the chapel of St. Lawrence in Rome. There are also relics at Fulda, and a Kentish tradition claims that their bodies were cast into the sea and floated ashore at Romney marsh. Their feast day is Oct. 25. In France, especially, it was for centuries the occasion of solemn processions and merrymaking, in which guilds of shoemakers took the chief part. In England the day acquired additional importance as the anniversary of the battle of Agincourt.

CRISPUS CAESAR (FLAVIUS JULIUS, or sometimes FLAVIUS VALERIUS) (d. A.D. 326), was the eldest son of Constantine the Great (*q.v.*) by his wife Minervina whom he divorced in 307. Educated by the Christian writer Lactantius Firmianus, he was given the title of *Caesar* on March 1, 317, and became titular ruler of Gaul. In the war against Licinius (*q.v.*) in 324 he commanded the fleet and won a decisive victory in the Hellespont, but in 326 when accompanying his father to Rome to celebrate the 20th anniversary of his accession, he was executed at Pola (mod. Pula in Yugoslavia). His stepmother Fausta was also executed shortly afterward; the story became current that she had denounced him to Constantine for attempted seduction and was herself denounced by the emperor's mother, Helena. The incident remains a mystery.

(A. H. M. J.)

CRISTEA, MIRON (1868–1939), first patriarch of the Rumanian Orthodox Church, who worked for unity in both church and state, was born at Topliţa, Transylvania, of peasant parentage on July 20, 1868. Educated at the theological seminary at Sibiu and at Budapest, he was elected bishop of Caransebeş in 1910. In 1918 he was a member of the delegation to Bucharest that sought the union of Transylvania with Rumania, and after the union he was unanimously chosen as primate (1919), becoming metropolitan of Walachia. He brought the principles of the ecclesiastical constitution of the metropolitan A. Şaguna (d. 1873) in Transylvania to bear on his work of consolidation. From 1926 to 1930 he was one of the three regents of the country during the ill health of King Ferdinand and the interregnum before the accession of King Carol. For the last year of his life he was prime minister under the latter. He was not however a "political prelate," but lent his name and influence to the highest office in the state in an attempt to achieve political stability and unity. From his enthronement as patriarch in 1925 his influence in promoting peace and unity came to be felt among Christians outside his own country and his own church. He visited the patriarch of Constantinople and other heads of orthodox churches on a journey to Palestine in 1927, and England at the invitation of the archbishop of Canterbury in 1936. He died in Cannes on March 6, 1939. (MT. P.)

CRISTÓBAL, Atlantic terminal port, town and territorial subdivision of the Panama Canal Zone, named, along with the adjacent Panamanian city of Colón, for Cristóbal Colón (Christopher Columbus). Convenient to extensive modern docks and other

aritime servicing facilities operated by the Panama Canal com- any are commodious anchorages in Limon bay, protected from orthers by breakwaters, making Cristóbal one of the key ports of ie Caribbean. Pop. (1960) 817. The Cristóbal district (1960 op. 11,499; area 140 sq.mi.) comprises the northwest section of ie Canal Zone. *See* PANAMA CANAL; COLÓN. (M. DUV.)

CRITIAS (*c.* 460–403 B.C.), Athenian orator, poet, philosopher nd statesman, prominent at the close of the Peloponnesian War. n his youth he had been a pupil of Gorgias and Socrates, and he as accused, with Alcibiades (*q.v.*), of complicity in the mutila- on of the Hermae in 415, for which he was imprisoned but after- ard acquitted. A member of the oligarchic government of the our Hundred in 411, he nevertheless retained his influence when e Four Hundred were overthrown and helped to secure the re- statement of Alcibiades. When Alcibiades was discredited in)7, Critias was attacked by Cleophon and exiled. He then went Thessaly, where he stirred up the *penestae* ("serfs") against eir masters and tried to establish a democracy. Returning to thens, he became one of the Thirty Tyrants who in 404 were ap- ointed by the Spartans after their victory in the Peloponnesian ar. He was killed in battle against Thrasybulus and the return- g democrats. Critias figures in the dialogues of Plato and some agments of elegies by him survive.

CRITICAL POINT, in physics, the point above or below nich certain physical changes will not occur. In the study of ange of state (*see* HEAT and THERMODYNAMICS) the properties the substance at this point are called its critical constants, ch as critical temperature, critical volume and critical pressure. t the critical point of a single substance, the properties of liquid id gas are identical and the curve of vapour pressure v. tem- rature ends at that point. In mechanics, the smallest angle hich an inclined plane must make with the horizontal in order at a body resting on it should slide is called the critical angle. ee FRICTION.) In optics, critical angle refers to the angle at hich rays incident to the interface between a medium of high dex of refraction and one of lower index are first totally reflected ternally. In an oscillating system the critical damping is the inimum amount of damping that will cause the value of its otential energy to fall to zero most rapidly without further cillation. (*See* CAPACITOR; INSTRUMENTS, ELECTRICAL MEAS- ING; VISCOSITY.) There are other instances of use of the word itical in the sense of "limiting"; *e.g.*, critical mass, which if ceeded will cause fissionable material to explode.

CRITICAL POINTS. In mathematics, a critical point of real-valued differentiable function of a real variable is a value of e variable at which the derivative of the function is zero. Geo- etrically, it is a point at which the graph of the function in rtesian co-ordinates has a horizontal tangent. Thus the function $a - x)$ has a critical point at $x = \frac{a}{2}$, since the derivative of e function, namely, $a - 2x$, is zero there. (*See* CALCULUS, FFERENTIAL AND INTEGRAL.)

A critical point of a real-valued differentiable function of several ay n) real variables is a point at which all the first partial deriva- es of the function are zero. Thus the function defined by $x,y) = ax^2 + 2bxy + cy^2$ has a critical point at $x = 0$, $y = 0$. eometrically, the n-dimensional plane tangent to the graph of the nction in $(n + 1)$-dimensional space is parallel to the n-dimen- nal plane of the independent variables. If the function in ques- n is the potential energy of a mechanical system with velocity ro, then a critical point of the function is an equilibrium point natural position of rest of the system.

Critical points of real-valued functions on more general kinds spaces, where generalizations of the derivative may not be avail- le, are defined in terms of concepts from topology.

Maxima and Minima.—The impetus to study critical points se in the search for maxima and minima in problems of geometry d mechanics. A function f, of one or many real variables, has a ative maximum at c if $f(c) \geqq f(x)$ whenever x is sufficiently ar c, and a relative minimum at c if $f(c) \leqq f(x)$. The maximum minimum is said to be "absolute" if the inequality holds for all ints x at which f is defined. An absolute maximum (minimum) is a relative maximum (minimum), but the converse need not be true. The adjective "proper" is applied to a maximum if the in- equality is $f(c) > f(x)$ when x is different from c; the adjective is applied similarly to a minimum.

In the geometric problem of finding the rectangle of maximum area with a fixed perimeter (say $2a$), the absolute maximum, with $0 < x < a$, of the function with value $x(a - x)$ already considered in the first paragraph must be found.

In the method of the calculus, to be illustrated here for a dif- ferentiable function of one real variable defined on a closed inter- val $a \leqq x \leqq b$, the maximum or minimum of f is found to occur at a or b or at a critical point of f. This shows the logical neces- sity for distinguishing which critical points are relative maxima, which are relative minima, and which are neither. In the mathe- matical argument, suppose f has a relative maximum at c with $a < c < b$. The argument for a relative minimum is similar. Then $f'(c) = 0$, *i.e.*, c is a critical point, for if $f'(c) > 0$ then on any interval about c there is a number x for which $x > c$ and $[f(x) - f(c)]/(x - c) > 0$, so that $f(c) < f(x)$. Similarly, if $f'(c) < 0$ there is a number x such that $x < c$ and $f(c) < f(x)$. In either case, there is a contradiction to the supposed maximum.

The first general method of investigating maxima and minima seems to have been published in 1629 by Pierre de Fermat. He used the principle that in the neighbourhood of a maximum or minimum the differences of values of the function are not affected by changes in the independent variable, a method closely re- sembling that of the calculus. The latter was invented later in the same century by Isaac Newton and by G. W. Leibniz, but ques- tions of distinguishing among critical points for a function of one variable were first settled by Colin Maclaurin in his *Treatise on Fluxions* (1742).

Particular cases of maxima and minima had been discussed much earlier. Euclid (*Elements*, Book iii) finds the greatest and least straight line from a point to a circle. Apollonius (*Conics*, Book v) shows that the greatest and least distances from a point to a conic section are measured along the normals (perpendiculars) from the point to the conic. Some remarkable theorems on maximum areas are attributed to Zenodorus, and are preserved by Pappus and Theon of Alexandria. They include the following:

1. Of polygons of n sides with a given perimeter, the regular polygon encloses the greatest area.
2. The circle encloses a greater area than does any polygon of the same perimeter.

Johann Bernoulli's famous problem of the brachistochrone, or curve of quickest descent of a particle from one fixed point to an- other under the action of gravity, was proposed in 1696 (*see* CURVES, SPECIAL). The function (time of descent) depends on a curve (the path) and not on one or several real variables. Of similar character is the problem, considered by Newton in 1686 in his *Principia*, of finding the shape of the surface of revolution which will meet the least resistance in moving in the direction of its axis through a resisting fluid. Such problems gave rise to an- other part of the theory of critical points known as the calculus of variations (*q.v.*).

For a function of one real variable having a continuous second derivative near c, the distinction of maximum and minimum can be made as follows. From Taylor's theorem with remainder,

$$f(x) = f(c) + \tfrac{1}{2} f''(\xi)(x - c)^2,$$

where ξ is an appropriate number between x and c. Suppose that $f''(c) \neq 0$. One then notes, for x near c, $f''(\xi)$ and $f''(c)$ have the same sign, so that f has a maximum at c if $f''(c) < 0$, and a mini- mum at c if $f''(c) > 0$. The function $x(a - x)$, according to this test, has a relative maximum at $x = a/2$. This argument breaks down if $f''(c) = 0$, but resolution is sometimes possible in terms of derivatives of higher order. Graphically, this test is made by distinguishing critical points where the graph is "concave down" ("concave up") as maxima (minima).

Index.—The situation for a function f of n real variables $(n \geqq 1)$ with continuous second partial derivatives near c is that f can have $n + 1$ principal kinds of critical points at c, rather than just relative maxima or minima. These critical points are distin-

guished by an invariant called the *index*. The critical point of f at c is termed "nondegenerate" if the determinant of second partial derivatives $|f_{x^i x^j}(c)|$ is not zero. In this case, the index h of c as a critical point can be distinguished in any of the following ways:

1. The quadratic form $Q(z) = \sum_{i,j=1}^{n} f_{x^i x^j}(c)\, z^i z^j$, which appears in the Taylor expansion of f about c, can be reduced by a nonsingular linear change of the variables z to a signed sum of squares with h negative signs.

2. The dimension of the plane of maximum dimension on which $Q(z)$ is negative for $z \neq 0$ is h.

3. The system $\sum_{j=1}^{n} f_{x^i x^j}(c)\, z^j - \lambda z^i = 0$ $(i = 1, \ldots, n)$ possesses a maximum number h of linearly independent solutions z corresponding to negative values of λ.

There are topological determinations of the index of a critical point which are very useful. A critical point of index n is a relative maximum, while one of index 0 is a relative minimum.

The critical point at $x = 0$, $y = 0$ of the function $g(x,y) = ax^2 + 2bxy + cy^2$ is nondegenerate if $ac - b^2 \neq 0$. The critical point has index 0 (is a relative minimum) if $a > 0$, $ac - b^2 > 0$; index 1 (is a so-called saddle point) if $ac - b^2 < 0$; index 2 (is a relative maximum) if $a < 0$, $ac - b^2 > 0$. Examples of these cases are furnished by $x^2 + y^2$, $-x^2 + y^2$, $-x^2 - y^2$ respectively.

In the example of potential energy, a proper maximum of potential energy corresponds to completely unstable equilibrium, while a proper minimum corresponds to completely stable equilibrium.

Global Theories.—The theory of critical points thus far described is a "local" theory, concerned with the behaviour of a function near a single exceptional point. There are also "global" theories "in the large" concerned simultaneously with all the critical points of a function.

Interest in critical points grew with the work of H. Poincaré and G. D. Birkhoff in the late 19th and early 20th centuries. Two theories arose, one by L. Lusternik and L. Schnirelmann and one by M. Morse. Each is concerned, for example, with a smooth real-valued function defined on a compact manifold (*see* MANIFOLDS), and each is intimately related to the topological structure of the manifold. Each theory says in its own terms that topological complexity of the manifold requires every smooth real-valued function defined on the manifold to have many critical points. Inversely, each says that the existence of a simple function on a manifold limits the complexity of the manifold.

For an elementary example of the Morse theory, consider the surface of the earth, with all natural bridges broken, as the manifold (it is a topological 2-dimensional sphere), and consider altitude above sea level as the function. Then the number of peaks (relative maxima, with index 2) plus the number of pits (relative minima, with index 0) minus the number of passes (saddle points, with index 1) is equal to two, the Euler-Poincaré characteristic of the topological sphere.

The Lusternik-Schnirelmann theory for a manifold X is summarized as follows. A closed subset of X is said to be "categorical" if it can be deformed (*i.e.*, "slid and shrunk") over X into a point. The category of X is the smallest number of categorical sets whose union (sum) is X. For example, the category of a spherical surface is 2, the two sets being, for instance, upper and lower hemispheres. The principal Lusternik-Schnirelmann theorem states that the cardinal number of critical points of any smooth real-valued function on X is at least the category of X. For example, every function on the sphere has at least two critical points. Further developments of the theory, such as those of L. Elsholts, are concerned with estimates of the category of a manifold.

The theory of Morse is more refined. Suppose that f is a smooth function on a manifold X of dimension n and that all critical points of f are nondegenerate. Let M_i denote the number of critical points of index i and let R_i denote the Betti number of X in dimension i (*see* TOPOLOGY, GENERAL). Then $M_i \geqq R_i$. More precise relations, which imply these, are as follows:

$$\begin{aligned}
M_0 &\geqq R_0 \\
M_0 - M_1 &\geqq R_0 - R_1 \\
M_0 - M_1 + M_2 &\geqq R_0 - R_1 + R_2 \\
&\cdots\cdots\cdots\cdots\cdots\cdots \\
M_0 - M_1 + \ldots + (-1)^n M_n &= R_0 - R_1 + \ldots + (-1)^n R_n.
\end{aligned}$$

Further developments of the Morse theory have included group-theoretic formulations such as that by R. Deheuvels, and strengthened inequalities by E. Pitcher which involve torsion coefficients as well as Betti numbers.

Each of the theories of critical points of a function on a manifold admits an extension to the extremals of an integral in the calculus of variations. In the latter field the Morse theory achieves great power.

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CRITICISM, reasoned and systematic discussion of the arts, explaining or evaluating their techniques and products. It is thus distinct from aesthetic perception, reaction or appreciation, with all of which it is often confounded. This article is restricted to the criticism of literature, which has engaged the efforts of more genius and presents in its history both greater variety and greater continuity than that of any other art. *See* also DRAMATIC CRITICISM.

The Greeks.—While the Sophists had analyzed tropes and figures, and while criticism was practised doubtless even earlier, Plato (*c.* 428–*c.* 348 B.C.) was the first theoretical critic. In his philosophy, all arts and sciences are as inferior to dialectic as their objects are to the "eternal ideas"; hence he treats poetry and rhetoric only generally, and in terms of criteria not of art but of ethics, politics and metaphysics. His view of knowledge as reminiscence implies that statements found in the Platonic dialogues are not to be taken as doctrines but as recollections of a truth once known, stimulated in the forgetful soul by dialectic; recapturings always incomplete, and relative to the stage of advancement both of the soul and the argument. Later critics, however, took his remarks on poetic inspiration and his strictures on poetry as rigid doctrine.

Plato applied the term "imitation" both to poetry and to the natural world, as copying the "Ideas"; Aristotle (384–322 B.C.) used it to distinguish the mimetic aspects of art. Plato, pursuing likeness, uses one method to find the one principle of all knowledge; Aristotle, pursuing differences, establishes sciences diverse in subject matters, principles and methods. In his view, thus, poetics is a science of the making of poetry considered as an imitative art; hence in *Poetics*, book i, he distinguishes the kinds of mimetic poetry according to the means (ch. 1), object (ch. 2), manner (ch. 3) and effect of imitation (ch. 4–5). Gathering these elements into a definition of tragedy (ch. 6) as an artistic whole, he reasons from it as from a principle to find the number, nature, relative importance and proper construction of the parts of tragedy: plot, character, thought, diction, music and spectacle (ch. 7–22). Epic he treats in terms of its differences from tragedy (ch. 23 ff.). Book ii of the *Poetics*, on comedy, is lost. His *Rhetoric* analyzes the three means of inducing conviction—character, emotion and proof—as they function diversely in political, legal and display oratory.

The Alexandrian Age.—In the Alexandrian age of philology and science (300–146 B.C.), poetics and rhetoric were severed from philosophy and pursued as autonomous studies or as department of grammar. After the disappearance of the Aristotelian texts in 287 B.C., the distinction between mimetic and didactic poetry was lost; much looser discussion ensued of the respective roles, in poetry, of nature and art, subject and style, instruction and pleasure. The decline of tragedy, the metamorphosis of epic into learned mimicry of Homer or into didactic treatises, the rise of romance and the growing preference for short forms such as elegy and idyll altered the body of literature on which criticism was exerted; such works as the *Homeric Problems* of Zeno set the fashion of allegory hunting which turned criticism itself into grammatical exegesis, and plot and character were treated as symbols. Significantly, the chief critics are, like Callimachus and Aristarchus, grammarians, editors, compilers; and Dionysius Thrax (fl. 10 B.C.), whose *Art of Grammar* was to have vast influence, lays claim

poetic criticism as the highest office of grammar.

Roman Rhetoric.—Roman conquest of Greece in 146 B.C. ifted the centre of learning from Alexandria to Rome, and the gh importance of persuasion in republican life raised rhetoric om a technique of proofs and styles to a master science of which etry, history and even philosophy were offshoots. Cicero (106–B.C.), whose works reflect this change in status, bases his theory the belief that oratory had founded and developed civilization. hile his technical remarks draw heavily from Aristotle, whose rks had been recovered, his conception of the ideal orator owes uch to the Platonic conception of the dialectician. For Cicero for Quintilian, whose *Institutio oratoria* (A.D. 93) prescribes the ole education of the orator, rhetoric is broadly humanistic, with les suggestive rather than rigid. Elegancies of style were not, wever, neglected by either, and were the special study of ionysius of Halicarnassus, Demetrius and "Longinus"; indeed, e latter's *On the Sublime* treats of a single quality of style—blimity—effecting transport rather than persuasion. Under the npire, rhetoric's usefulness diminished and it declined into eciosity and sophistry, as Cornelius Tacitus and others testify.

Medieval.—The early church, antiliterary and suspicious of ings pagan, wrought not so much a rejection as a transformation classical literature. Although Plato's censures of poetry were phrased by Tertullian, Augustine and Jerome, allegorical interetation soon found Christian truth contained in works that, read erally, seemed pagan fiction; and poetry, as didactic allegory—rhaps its chief role during the middle ages—easily entered the rvice of theology. With poetry a versified rhetoric of indirect atement, criticism became the exegesis of its enigmas; and the ssion for riddle reading, together with the loss of nearly all an-nt criticism save the *De inventione* of Cicero and the *Rhetorica herennium* attributed to Cornificius, confined medieval poetic a discussion of tropes and figures; and this conception of criti-m underlies the Vergilian commentaries of Macrobius, Servius d Fulgentius, the 12th- and 13th-century *poetriae* of Matthieu Vendôme, Geoffroi de Vinsauf and John of Garland, and the itical observations even of Dante Alighieri.

The Renaissance.—The way was prepared for Renaissance iticism by Laurentius Valla, Politian and other Italian humanists the 14th and 15th centuries. Recovery of such works of classical eory as Quintilian's (1416), Cicero's *Brutus* (1421) and *Orator* 422) and the translation of Aristotle's *Poetics* by Giorgio Valla 498) opened new ranges of method; the restoration of the great erary monuments, both Latin and Greek, afforded new models r recommendation. Moreover, literature itself had undergone btle development; out of popular origins had sprung new forms ch as the chivalric romance, the fabliau and the *novella;* drama d epic had revived; modern languages had all but supplanted tin as the medium of serious literary art. With all this change me the problems of change, coupled with newly inherited unttled questions of the past, to stimulate the efforts of Marco da, G. G. Trissino, A. S. Minturno, J. C. Scaliger and L. Castelro in Italy; Thomas Sibilet, Joachim du Bellay, Pierre Ronsard, an de la Taille and Jean Vauquelin de la Fresnaye in France; ger Ascham, Richard Willes, George Gascoigne, Sir Philip Sidy, William Webbe and George Puttenham in England.

Neoclassicism.—Thus arose a neoclassicism based upon Roman etoricians, Horace and Aristotle as interpreted by Italians of the th century and by Dutch and Germans of the 17th (Daniel insius, Justus Lipsius, J. Pontanus). In the fascination with ristotle's doctrine, his method, capable though it was of extension th the growth of literature, went unobserved; though 17th-cenry critics quickly discarded the medieval conception of poetry as tegory, the mimetic function was never fully disengaged from the dactic, even by Ben Jonson and John Dryden; and such rigid rmulations as the *Art poétique* of Nicolas Boileau (1674), dating poetic kinds as natural and permanent species, could ither constrain nor serve literary development; indeed, their al effect was to provoke attack on the theory of fixed species and teria, by David Hume, Samuel Johnson, Johann Friedrich hiller and others.

Criticism and Aesthetics.—With specific technical criticism discredited, criticism became increasingly qualitative, discussing poetic qualities rather than kinds, characteristics of parts rather than the structure of the whole. The rise of the "new science" of aesthetics (Alexander Baumgarten, 1750), the growing doctrines of taste and genius, the emphasis on imagination in art—begun by Francis Bacon and continued by Edmund Burke, Gotthold Lessing, Sir Joshua Reynolds, Kant and S. T. Coleridge—and the rise of romantic literature all co-operated to exorcise at last the spectre of didacticism; but criticism had grown ever more general, and 19th-century critical discussion, save for the particular insights of men such as Coleridge, turned on such generalities as the nature of poetry, poet, imagination, fancy, critic, etc. (Charles Ste. Beuve, Matthew Arnold, John Stuart Mill) and eventuated in impressionism (Walter Pater, Anatole France) or intuitionism (Benedetto Croce). (*See* AESTHETICS.)

The 20th Century.—As even these broad generalities came under attack, 20th-century critics strove to find new bases, drawing them from such sciences as psychology, anthropology, semantics and political theory. At mid-century, while the political, social and psychological aspects of literature had been somewhat clarified, aesthetic criticism was still qualitative, even in the hands of T. S. Eliot, and still centred, as in the Alexandrian age, on medium (I. A. Richards, William Empson, Cleanth Brooks) or on subject matter (Maude Bodkin); and the vogue of symbolism, fostered by the success of W. B. Yeats and Eliot, threatened to reduce poetry once more to didactic allegory and its criticism to grammatical exegesis.

As the foregoing survey shows, criticism does not in its history exhibit a steady logical development of principles laid down in antiquity, nor indeed the fortunes of a continued debate. It has strict unity neither of subject matter, method nor aim. Its continuity lies in the attempts of men to deal with a changing body of literature in terms of changing aspects of concern, for changing aims, through methods dictated by such concerns and aims and hence altering with them. Its character is, furthermore, affected by the circumstances of a given time: the state of a language or literature, the body of available doctrines, methods and models, the interpretation and application of these. So viewed, the history of criticism affords support neither for the skeptic who would see in it a prolonged contest, futile because the questions involved are unanswerable, nor for the dogmatist who would find in it a gradual progress toward his dogma. Criticism presents neither a single fully developed theory of literature nor a chaos of contradictions. It has had, like other departments of knowledge, its share of confusion and error caused, in its case, largely by shifts in the meanings of terms, the separation of doctrines from the methods which developed them and misapplications of method. Yet it is a fact often overlooked that criticism has usually solved the problems posed to it in each period, although the problems are not always posed and resolved to the satisfaction of later generations.

The subject matter of the arts is necessarily inexact, and hence not amenable to the methods of exact science; but the failure to provide, even by the 20th century, full and sound theories of rhetoric and poetics is not due to inexactness in the subject. It is due rather to certain human tendencies: the tendency to regard art as finite and completely developed, whereas, like all that depends upon invention, its capacity for development is infinite; the tendency to forget that sound theoretical bases are not nullified by the emergence of new forms and devices, or, conversely, to forget that theory must expand with art; the tendency to ignore differences of kind and function (*e.g.*, to treat mimetic poetry as didactic); the tendency to confuse validity with universality, and hence to insist that a rule must be universally or absolutely true because it is true specifically and conditionally, or, conversely, to insist that a rule is utterly false because it is not true universally or absolutely. These tendencies, repeatedly resulting both in the premature framing and the premature rejection of theories, are the chief hindrances to critical progress, and are likely still to prevent our full realization of the vast fund of knowledge achieved by critical discussion over the centuries. (E. J. O.; X.)

The "New Criticism."—In 1941 John Crowe Ransom coined the term "new criticism" for what is in certain essential respects a

return to the Renaissance rhetoricians' principle that a poem is an arrangement of words, to be apprehended in their interaction. It is not that plot, character and theme do not exist, but that for the reader of the work only the words on the page make them exist.

The particularity of insight required by this re-emphasis on the specific assisted in the final separation of the critic from the literary theorist. Most of T. S. Eliot's *Selected Essays, 1917–1932*, originally written as reviews, differed from adjacent reviews by the rigour with which details were examined and the economy with which quotations were juxtaposed to imply much exact comment. "Comparison and analysis," Eliot wrote in 1923, setting in circulation a formula borrowed from Remy de Gourmont, "are the chief tools of the critic."

In Eliot's work the "scale of values" with which critics are often credited is conceived to be not like the marks on a ruler, *i.e.*, a set of graduations achieved in isolation from anything to be measured, but like the scale of C, *i.e.*, a group of sounds so arranged as to clarify their relations. Ezra Pound's *ABC of Reading* (1934) expounds the view that critical skill is nourished chiefly by knowing what has been done in the arts, and consists principally in the ability to see what is before one. "I should like if possible," wrote Pound, "to sharpen your perceptions, after which your taste can take care of itself." Eliot's essay on Philip Massinger makes his "decadence" concrete in specific and demonstrable terms. Similarly, F. R. Leavis' *Revaluation* (1936) outlines several chapters of English literary history entirely in terms of particular instances, related and affiliated.

Naturally, such work allies itself with pedagogy: with sharpening the reader's ability to read. I. A. Richards' *Practical Criticism* (1929) demonstrated conclusively that many people professing interest in poetry have only the most rudimentary ability to apprehend it, and are arrested in the extremely complex business of reading by various partial satisfactions which Richards was able to codify. His pupil William Empson demonstrated in *Seven Types of Ambiguity* (1930) how subtle and evanescent effects can frequently be dissociated into multiple meanings that have been instantaneously apprehended and fused. In Empson's wake a great deal of ingenious exegesis, often interesting but not always relevant, was manufactured on behalf of a wide variety of poets.

The new criticism, despite its Alexandrian tendencies, gave new definition to the scope of criticism and achieved the most varied body of critical writing since the 18th century. (HH. K.)

See also references under "Criticism" in the Index volume.

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CRITIUS AND NESIOTES (fl. late 5th century B.C.), Greek sculptors of the time of the Persian wars. When Xerxes carried away to Persia the statues of Harmodius and Aristogiton made by Antenor (*q.v.*), Critius and Nesiotes were commissioned to replace them. By the help of coins, vases, reliefs and fragments at Naples, now correctly restored, and Rome, it has been possible to identify Roman copies of the Tyrannicides of Critius; and to them well apply the words in which Lucian describes the works of Critius and Nesiotes, "closely knit and sinewy, and hard and severe in outline." Critius also made a statue of the armed runner Epicharinus. Perhaps the finest copy of the Tyrannicides is that in the Museo Nazionale in Naples; a reconstructed statue of Aristogiton is in the Museo dei Conservatori in Rome.

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CRITOLAUS (2nd century B.C.), Greek philosopher, was born at Phaselis in Lycia. He studied under Ariston of Ceos and may have been his direct successor as head of the Peripatetic school; if so, his headship was of long duration, but the date of his death is not known. He was one of the three ambassadors, representing different schools of philosophy, whom the Athenians sent to Rome in 156–155 B.C. to protest against a fine of 500 talents imposed on their city. It was his policy to restore to favour, where possible, the original doctrine of his school: thus, he defended against the Stoics the belief in the eternity of the world and of the human race, using for this purpose arguments similar to those of Aristotle and Theophrastus and maintaining the belief in ether. But in ethics he went some way to meet the Stoic views; for instance, he defined the highest good in phraseology partly taken from Zeno, declared pleasure to be an evil and held that the goods of the soul entirely outweigh the goods of the body and those of external fortune.

See E. Zeller, *Aristotle and the Earlier Peripatetics*, Eng. trans., vol. ii, pp. 479 ff. (1897); H. von Arnim, "Kritolaos," in Pauly-Wissowa, *Realencyclopädie*, vol. xi (1922); and K. O. Brink, "Peripatos," *ibid.* supp. vol. vii (1940). (D. J. A.)

CRITTENDEN, JOHN JORDAN (1787–1863), U.S. statesman best known for his efforts at compromise on the eve of the American Civil War. Crittenden was born near Versailles, Ky., on Sept. 10, 1787. After attending school in Jessamine county he studied law and in 1807 graduated from William and Mary college. He then opened law practice in Logan county and in 1809 was appointed territorial attorney general in Illinois. During the War of 1812, after he had returned to his native state, he combined military service with membership in the Kentucky legislature. His service in the U.S. senate began in 1817 and continued at irregular intervals until his death in 1863.

Crittenden supported his fellow Kentuckian, Henry Clay, for the presidency in 1824 and continued to have great respect for Clay and his policies for the rest of his life. With Clay, he opposed the financial policies of Andrew Jackson and of Martin Van Buren. He campaigned for William Henry Harrison in 1840 and resigned from the senate to become U.S. attorney general upon Harrison's election. Along with other Whigs in the cabinet, he resigned in Sept. 1841 in protest against the attitude toward the Bank of the United States taken by John Tyler, who had become president upon the death of Harrison.

As a "Conscience Whig," Crittenden opposed the annexation of Texas, opposed taking a belligerent attitude toward Great Britain over the Oregon boundary and refused to give more than lukewarm support to the Mexican War. In 1848 he was elected governor of Kentucky. In spite of his lifelong friendship with Clay, he supported Zachary Taylor for president in 1848, for he was convinced that Clay could not win election. This led to a misunderstanding between Clay and Crittenden that lasted until just before Clay's death in 1852.

Crittenden opposed the Kansas-Nebraska act of 1854 in congress and when this issue led to the breakup of the Whig party, he joined the American, or Know-Nothing party in 1856. Later he joined the Constitutional Union party, campaigning for John Bell and Edward Everett in 1860.

After Lincoln's election, he introduced his "Crittenden resolutions" in Dec. 1860. These proposed that the Missouri Compromise (*q.v.*) line be restored and continued to California, that slavery be guaranteed indefinitely in the District of Columbia, and that slaveholders be reimbursed for runaway slaves not returned. The compromise effort was eventually defeated by Lincoln's stron stand against any extension of slavery into the territories, and b radical Republican leadership in congress.

Early in 1861, Crittenden returned to Kentucky to try to sa his state for the Union. In March, and again in May, he demande that Kentucky remain in the Union, although he urged its neutra ity in the war. On May 27 he acted as chairman of the Frankfo convention of border state leaders, which asked the South to reco

der its position on secession. He then returned to congress, this me to the house of representatives. He opposed the confiscation ts, the Emancipation Proclamation and the military regime in entucky. In the meantime, one of his sons, Thomas L. Crittenn, had become a major general in the Union army; another, eorge B. Crittenden, a major general in the army of the Confedacy. Crittenden was preparing to run for re-election to congress the time of his death in Frankfort, Ky., July 26, 1863.

See A. M. B. Coleman, *Life of John J. Crittenden*, 2 vol. (1871); A. Keith, *The Life of John J. Crittenden of Kentucky* (1926).

(J. M. Wo.)

CRIVELLI, CARLO (*c.* 1430/35–*c.* 1493/95), one of the ost striking figures of 15th-century Venetian painting, was born Venice but left that city after being sentenced to prison and ereafter worked chiefly in the March of Ancona, and especially in d near Ascoli. He was probably an offspring of the Vivarini hool and was influenced by Squarcione's academy at Padua. He gned as "Carolus Crivellus Venetus"; from 1490 he added Miles," having been then knighted (*Cavaliere*) by Ferdinand II Naples. Among his earliest works are the "Madonna" in the erona museum and an altarpiece at the Municipio of Mazza ermana (1468). The National gallery in London has fine exames of Crivelli; in Berlin is a "Madonna and Saints" (1491); in e Vatican gallery a "Dead Christ"; and the Brera of Milan conins several examples, among which is his masterpiece of later ears, "The Coronation of the Virgin" (1493).

ALINARI

"DEAD CHRIST" BY CARLO CRIVELLI; *c.* 1485. IN THE VATICAN GALLERY, ROME

Crivelli's works are of marked individuality—hard in form, finite in outline; stern, forceful, energetic, but often glowing th colour and sumptuous, fantastic ornamentation. He died tween 1493 and 1495. It is surmised that Carlo was of the me family as the painters Jacopo and Vittorio Crivelli. Pietro amanni was his pupil.

See B. Berenson, *Venetian Painters of the Renaissance* (1899).

CRNA GORA: *see* MONTENEGRO.

CROAGH PATRICK (CRUACH PHADRAIG, "the rick of St. atrick"), a splendid quartzite peak, lies to the southwest of Westort at the head of Clew bay in Mayo, Republic of Ireland. It rises a sharp pyramid to 2,510 ft. from a plateau 800–1,100 ft. high hich stands over a coastal lowland nearly a mile wide. From the p can be seen the head of Clew bay, varied by scores of drumlins, th the hills of north Mayo beyond. The mountain, having some chaeological remains, has acquired a mass of legend. It is said have been visited by St. Patrick who, according to one report, re began his Irish ministry and banished snakes from the coun- with his bell. He blessed Connemara but, thinking it bleak, he nt on elsewhere. In modern times, Croagh Patrick has become e scene of an annual pilgrimage, the last Sunday in July (Garland nday), in which thousands of people take part. Starting from urrisk, 5 mi. W. of Westport, many go up the mountain barefoot, d the course is marked by the Stations of the Cross and by stats; on the summit is a tiny chapel made from cement carried up bags by pilgrims.

(T. W. FR.)

CROATIA (HRVATSKA), a country of southeastern Europe, polically organized since 1946 as one of the six republics of federal Yugoslavia. Comprising as it does the territories of Dalmatia and most of Istria (Austrian provinces before World War I) as well as the formerly Hungarian Croatia-Slavonia, it extends in a crescent from the fertile plain between the Danube, Drava and Sava rivers in the east to the Gulf of Venice in the west and then southward along the Adriatic coast to the frontier of Montenegro. It is bounded on the north by Slovenia and by Hungary and on the east by Serbia; within the crescent, its frontier marches with Bosnia-Hercegovina, which moreover as a narrow corridor to the Adriatic crosses Croatian territory north of the point where it joins Montenegro. Area 21,829 sq.mi. Population (1961) 4,148,122.

The people (*see* YUGOSLAVIA) are mainly Croats and Roman Catholics. Their position has exposed their social life and culture to influences from central Europe, from the Balkans and from the Mediterranean, Italian influences being prevalent in Dalmatia and Istria. Zagreb is the capital, Rijeka (Fiume) the chief port. Other major ports are Zadar, Sibenik, Split and Dubrovnik.

Croatia-Slavonia's economy used to be based primarily on agriculture and cattle breeding. After World War II, however, industry made rapid progress. While the timber industry maintained its earlier importance, the expansion of light industry and the discovery of rich oil fields considerably changed the character of the country. The peasant population, which amounted to 82% in 1919, numbered 52% in 1960. The hardy people of the mountainous littoral of Istria and Dalmatia are traditionally either wine and olive growers or fishermen and seafarers, but there too more attention was paid after World War II to the industrial exploitation of natural resources (hydraulic power, coal and bauxite) as well as to shipbuilding and to tourism (especially in Dalmatia).

HISTORY

The Croats (*Chrobati, Hrvati*) migrated in the 6th century A.D. from White Croatia, a region which is now Ukraine between the Southern Bug and Dnieper rivers, to the lower Danube valley. Thence they continued toward the Adriatic, where they conquered the Roman stronghold Salona in 614. After settling in the former Roman provinces of Pannonia and Dalmatia and liberating themselves from the warlike Avars, they began to develop independently. The farming Croats continued their former way of life under their *zupani* or tribal chiefs, who performed administrative, judicial and military functions, undisturbed by the municipal life surviving in the old Roman colonies in coastal towns under Byzantine protection. In the 7th century, when they were converted to Christianity, a bishopric for all Croatian lands was established at Nin (north of Zadar). Shortly afterward they received the privilege of using their national language in church services—a ritual right still preserved in some coastal dioceses. Under pressure from the neighbouring Frankish and Byzantine empires, the tribal organization of the Croats gradually gave way to larger units, and in the 8th century there existed two Croatian duchies, one in Dalmatia along the Adriatic coast, the other in Pannonia. After the Frankish-Byzantine peace of 812, Pannonian Croatia became a part of the Frankish empire and the Dalmatian duchy recognized nominal Byzantine supremacy. In the middle of the 9th century the Pannonian Croats liberated themselves and joined the Dalmatian duchy, which also shook off foreign domination. By 880 Branislav (879–892) became the first independent *dux Croatorum*.

The Croatian Kingdom.—One of Branislav's successors, Tomislav, annexed the Dalmatian cities and in 925 received the royal crown from Pope John X. Tomislav and his heirs made strenuous efforts to defend their kingdom both from the short-lived Bulgarian empire in Pannonia and from Venice, which was spreading its power along the Dalmatian coast. The Byzantines helped Stjepan Drzislav (969–997) to liberate the coastal towns from Venice but succeeded in re-establishing their own influence on the Adriatic. Petar Kresimir (1058–74) altered this situation. He broke off relations with Byzantium, strengthened Croatia's ties with the papacy and enlarged the state boundaries. Croatia then reached the peak of its power. It spread southward along the Adriatic coast from the river Rasa in Istria to the rivers Tara and Piva in Montenegro, eastward to the Drina and northward to the Drava and to the Danube. Nevertheless, Kresimir's policy divided

the nation into a Latin group which upheld the king and a national group which enjoyed popular support in opposing the king's policy. This division became fatal during the reign of Dimitrije Zvonimir (1076–89), who was crowned in Split by the legate of Pope Gregory VII. Invited by the pope to participate in a war against the Seljuk Turks, Zvonimir convened a great assembly to win his subjects over to this campaign. The people accused him of being a papal vassal and killed him. Anarchy and civil war followed, and with it the decline of the Croatian kingdom. The Byzantines again secured their position in Dalmatia, and in 1091 Laszlo I of Hungary occupied most of Pannonian Croatia, claiming the Croatian throne as Zvonimir's brother-in-law.

Laszlo's deputy Almos founded a bishopric at Zagreb in 1094, and this soon became the centre of ecclesiastical power. Petar Svacic, who resided at Knin, was proclaimed king by the Dalmatian Croats in 1093, but the pope considered him a rebel and invited King Kalman of Hungary to unseat him. Kalman invaded Croatia, and Svacic fell in 1097 in the defense of his country. He was the last king of Croat blood. After prolonged warfare Kalman negotiated a treaty, the so-called *pacta conventa*, with the Croats' representatives. They elected him their king and he pledged himself to respect Croatian state rights. In his coronation sermon in Biograd (near Zadar) in 1102 Kalman swore that Croatia and Hungary would remain two independent kingdoms under St. Stephen's crown and that the king would personify this union. Only Bosnia, a part of the Croatian kingdom, refused to submit to a foreign monarch.

Union With Hungary.—Henceforth for eight centuries Croatia was connected with Hungary. Their relationship often changed. Some kings attempted to abolish the personal union and to integrate Croatia into Hungary, while on other occasions the Croats selected their kings independently of the Hungarians. Several Croatian *bans* or viceroys, members of the feudal nobility, conducted semi-independent policies, particularly on the Adriatic coast, or became hereditary rulers in Bosnia. The reign of the Hungarian national dynasty, the Arpads, was instrumental in introducing feudalism on a western pattern in Croatia. In 1301, on the extinction of the Arpads, the Croats crowned Charles Robert of Anjou-Naples as their king at Zagreb. This broke the personal union with Hungary until the Hungarians also accepted him in 1310 (as Charles I of Hungary). After the death of Louis I of Hungary and Croatia and several years of dynastic conflicts, the Croats in 1403 crowned the Neapolitan prince Ladislas at Zadar. It was to secure financial means to fight Sigismund, his rival in Hungary and later Holy Roman emperor, that Ladislas sold Dalmatia (*q.v.*) to Venice, which ruled it for the next four centuries. The appearance of the Turks in the Balkans in the 15th century imposed a period of hard struggles on the Croats. Bosnia, which under Tvrtko Kotromanic (1353–91) became an independent kingdom, fell to the Turks in 1463. The battle at Krbavsko Polje (1493), where most of Croat forces perished, was followed by the defeat of Louis II of Hungary and Croatia at Mohacs (1526), after which the greater part of Pannonian Croatia shared the fate of central Hungary and fell under Turkish domination. The once wide Croatian kingdom was reduced to *reliquiae reliquiarum* ("relics of relics"). Zagreb became a border fortress, and henceforth the Croatian capital.

The Habsburg Period.—In preference to the Hungarian candidate John Zapolya, the Croatian estates sitting at Cetin on Jan. 1, 1527, elected the Habsburg Ferdinand of Austria (the future Holy Roman emperor Ferdinand I) as king. They confirmed the succession to him and his heirs in return for the promise of common defense and his respect of their prerogatives. For the next century Croatia was a bastion defending central Europe from the Turks. The Vojna Krajina (Ger. *Militärgrenze*), a military frontier zone on Croatian territory, was formed in 1578. As this zone was subject directly to the emperor in Vienna, it meant a further loss for the Croats.

Turkish invasion instigated a partial change in the ethnic aspect of Croatian lands. Large numbers of Croats abandoned their homes and moved northward seeking safety, some even going out of Croatia altogether into Austria. In partly depopulated areas the rulers settled German and Hungarian soldiers and craftsmen or granted certain privileges to the Serbs who escaped from the Balkans and took refuge in the Vojna Krajina to become defenders of the Habsburg empire. As the Turks were driven back in the 17th century the Habsburgs revealed absolutist tendencies. They attempted to curtail the state rights and autonomy of Croatia and Hungary and to reduce them to mere provinces under centralized royal power. The Croatian and Hungarian nobility jointly resisted such encroachments on their prerogatives and finally plotted an anti-Habsburg movement aiming at the political independence of their countries. The plot failed. Its Croatian leaders, Count Petar Zrinski (whose grandfather had been the heroic defender of Sziget against Sultan Suleiman in 1566) and Duke Krsto Frankopan, were beheaded at Wiener Neustadt in 1671 and their estates distributed among alien nobility. This meant a further invasion of Croatia by foreigners.

In 1712 the Croatian diet accepted the Pragmatic sanction declaring that in default of male heirs the succession to the throne could be assumed by a Habsburg princess. The Hungarians accepted it 12 years later, after receiving imperial guarantees of the indivisibility of the lands of St. Stephen's crown. Because of this stipulation the Hungarians considered Croatia as annexed territory while the Croats claimed that they were an associated kingdom. This controversy upset the old relationship between Croatia and Hungary.

The Rise of Croatian Nationalism.—After the annexation of Rijeka (Fiume) to the crown of St. Stephen in the 1770s, the Hungarians began trying to give their language official status in Croatia. This provoked a forceful reaction and a sudden awakening of the Croats' national consciousness. The French Revolutionary Wars and the Napoleonic establishment of the Illyrian provinces of the French empire, which after 1806 included Dalmatia and a part of Croatia south of the Sava, fomented national sentiments. Beside the progressive measures of the period, particularly in economy and education, the beneficent administration made possible the appearance of the first newspaper in the Croatian language.

After the fall of Napoleon relations between Croats and Hungarians soon became critical. To strengthen their opposition to the germanizing policy of the Habsburgs, the Hungarian revolutionaries strove to consolidate the lands of St. Stephen's crown and to establish a Magyar national state from the Carpathians to the Adriatic. The Croats refused to renounce their nationality or to accept any violation of their autonomy in the national interest of the Hungarians. In open defiance of Hungarian claims, Count Juraj Draskovic proposed in 1832 to the Hungarian parliament a national and cultural program for Croatia. It expressed the ideas of the "Illyrian movement," organized by Ljudevit Gaj, which aimed at the union of all South Slavs (Yugoslavs) within the Habsburg federation. Nevertheless, in April 1848, the Hungarian parliament approved laws which radically affected Croatia's autonomous position. Instigated by the *ban*, Josip Jelacic, in Sept. 1848, the Croatian diet rejected the Hungarian laws and accepted a series of national laws of a revolutionary character. It broke off ties with Hungary and affirmed the independent position of Croatia including Rijeka and the Vojna Krajina. It also abolished serfdom and proclaimed the equality of all citizens. After abortive attempts to compromise with the Hungarians Jelacic led his troops into Hungary. His success was of little avail for Croatian rights and interests. In defending the Croats from Magyar nationalism he saved the Habsburg empire from the Hungarian revolt.

After 13 years of imperial absolutism and political lethargy reorganization of the Habsburg empire was planned by the centralist patent of Feb. 26, 1861. The Croatian diet, claiming that the events of 1848 dissolved their legal bonds with Hungary, protested against the patent and demanded a federalist constitution. Thereupon the diet was dissolved in 1865 and no new diet was elected. In 1867, the crown and the Hungarians reached their "Compromise" (*Ausgleich*), whereby the Germans and the Hungarians were established jointly as the dominant nations of the new dual monarchy of Austria and Hungary, Croatia having been assigned to the Hungarian part. In April the emperor Francis Joseph convoked a new diet inviting it to send a delegation to Budapest to attend his crowning as king of Hungary. The diet refused and in May was dissolved again. In 1868, however, the Croats and the

ungarians concluded a compromise of their own, the *nagodba,* hereby the triune kingdom of Croatia, Slavonia and Dalmatia was cognized as a distinct political nation with its own territory, ough still part of the Hungarian as opposed to the Austrian unit. spite of this, Dalmatia was not united with Croatia-Slavonia and mained an Austrian province. Croatia obtained autonomy in me affairs, education, judiciary and later in agriculture. The cal government was headed by a *ban* proposed to the emperor Budapest but responsible to the Croatian diet. The diet was presented in the common parliament in Budapest. The Croatian nguage was given official status throughout the land. The *na-dba* was accepted by a corruptly elected diet and remained valid til 1918.

Croatian opposition to *nagodba* expressed itself in two different ovements, both initially inefficient because of the very restricted ectoral right. Josip Strossmayer, bishop of Djakovo and leader the National party, developed the Illyrian movement into a ltural South Slav community under Croatian leadership, but cked dynamism to make it a program of political action. The bellious Ante Starcevic's program called for resistance to Aus-ian and Hungarian interference with Croatian national interests d aspired to self-determination and ultimate freedom of the roats. His Party of Rights requested the union of all Croatian ovinces of the empire, including Dalmatia and Bosnia-Herce-ovina. Starcevic's program instilled a fighting spirit into Croatian olitics. Hungary tried to restrain Croatian opposition by ap-ointing Count Karoly Khuen-Héderváry as *ban* in 1883, but 20 ears of his policy of magyarization only exacerbated Croatian-ungarian relations. The year 1903 was a turning point in Croa-an politics. The political leaders in all Croatian provinces became tensively active, seeking to concentrate their forces and to or-nize them into new parties and initiating co-operation with the erbs in Croatia. A program of action—the "Rijeka resolution"—as proposed by Ante Trumbic and Frano Supilo in 1905 and ac-pted by many Croatian politicians and by Serbian representatives Croatia. In 1906 the Croatian-Serbian coalition won a sweeping ectoral victory and henceforth became an important political fac-r. Another achievement of decisive consequence was the organi-tion of the Croatian Peasant party by the brothers Ante and jepan Radic. Realistic and aware of social problems, they stimu-ted an interest in politics among the peasants.

The governing circles in Budapest and Vienna refused to palliate is seething discontent with timely concessions. The Hungarians tensified their oppression either by appointing in Croatia under-igs subservient to Budapest or instigating persecutions and trials. 1907 the *ban,* Levin Rauch, having failed to secure a majority, spended the diet. In 1909 the leaders of the Croatian-Serbian alition having been accused of treason, brought an action for libel ainst the historian Heinrich Friedjung in Vienna, in which it was own that the documents on which the charges of treason were sed had been forged and supplied to Friedjung by Austro-ungarian officials. In 1912 Rauch's successor Nikola Tomasic spended the constitution. This was followed by the appointment a royal commissar, whose dictatorial methods only cemented roatian-Serbian solidarity in the empire.

Some influential court and military circles in Austria expected counteract Croatian political evolution by proposing trialism stead of dualism. By trialism all the South Slav lands of the em-re would have been united under the name and leadership of oatia, which would have had status equal to that of Austria or ngary. This failed because of Hungarian opposition. Most oats saw by then that within the Habsburg empire there could no satisfactory solution of their problem.

The Yugoslav Union.—Serbian and Montenegrin victories er the Turks in the Balkan Wars of 1912–13 encouraged the oats to envisage freedom in an independent Yugoslav union that uld include Serbia and Montenegro, but in 1914, when the arch-ke Francis Ferdinand was assassinated at Sarajevo, relations be-een the Croats and the Hungarians appeared to be calm, thanks the policy of compromise pursued by the Croatian-Serbian coali-n, which in 1913 had become the government party in Croatia. e unsettled problem of Croatia's status, however, prepared the way for Yugoslav revolutionary action. With the outbreak of World War I the Austro-Hungarian authorities introduced measures of extreme severity throughout their South Slav provinces.

In his coronation speech in 1916 the emperor Charles recognized Croatian integrity in relation to Hungary, thereby establishing the equality of both countries under St. Stephen's crown. Then the Yugoslav club in the Vienna parliament, in May 1917, demanded the union of all the South Slav provinces under the Habsburg crown. Among the Croats, meanwhile, the movement for a Yugoslav union was gaining strength, with Starcevic's Party of Rights as its protagonist. The centre of Croatian politics, however, was the Yugoslav committee in Paris and London. This had been organized in 1915 by a group of Croatian, Serbian and Slovene politicians from the empire, led by Trumbic. Its program was the complete separation of the Croats, Serbs and Slovenes from the Habsburg empire and their union with independent Serbia. The committee became one of the decisive factors in the settlement of the Croatian problem. On July 20, 1917, Trumbic and Nikola Pasic, the Serbian prime minister, signed the declaration of Corfu which established the basic principles of a future Yugoslav state. In March 1918, at their meeting in Zagreb, the South Slav political leaders of the Habsburg empire declared themselves openly in favour of an independent Croatian-Serbian-Slovene state, thus approving the Corfu declaration. On Oct. 29, 1918, the Croatian diet broke off all ties with Hungary and Austria and proclaimed an independent Croatia which entered into a state union with other South Slav provinces of the empire, to be governed by a national council. On the request of council's emissaries, on Dec. 1, 1918, the Serbian prince regent Alexander proclaimed the union of this state with Serbia and Montenegro. Yugoslavia (*q.v.*) came into being.

Dominated by the Serbs, the new Yugoslav regime showed amalgamating tendencies. These immediately encountered strong opposition from the Croats, who resented encroachments on their national individuality and traditional autonomy. Against the centralizing policy of the Belgrade government they demanded a federal organization of Yugoslavia. After the election of 1920 the Peasant party under Stjepan Radic led Croatian opposition. The assassination of Radic and some of his political collaborators in the Belgrade parliament on June 20, 1928, produced a serious crisis. King Alexander attempted to remedy this by introducing a dictatorial regime in Jan. 1929, but failed to achieve his objective. The Croats organized a solid national front around the Peasant party and obstinately persisted in their demands. Finally, as conflict between Serbs and Croats was preventing the consolidation of Yugoslavia, the Belgrade government had to give in. On Aug. 26, 1939, a settlement, the *sporazum,* was reached whereby Croatia united with Dalmatia and parts of Bosnia-Hercegovina became an autonomous *banovina* within Yugoslavia.

The Independent State of Croatia.—Croatian nationalists who aimed at complete independence remained dissatisfied with the *sporazum.* In World War II, after Yugoslavia had been occupied and dismembered by the Axis powers, an Independent State of Croatia was proclaimed in Zagreb on April 10, 1941, and recognized four days later by Hitler and Mussolini. It embraced Croatia-Slavonia, part of Dalmatia and Bosnia-Hercegovina, covered an area of 39,660 sq.mi. and in all had about 6,663,000 inhabitants. Since Vladimir (Vladko) Macek, the leader of the Peasant party, refused the German offer to head the new state, it was entrusted to Ante Pavelic (1889–1959), head of the Fascist terrorist organization Ustasa. A nationalist fanatic, Pavelic re-entered Croatia from Italy, where he had spent 12 years of exile plotting revolution. He ruled his puppet state as a *poglavnik* (leader) and introduced a dictatorial regime characterized by methods of extreme brutality and violence. An attempt was made in 1944 to bring Croatia over to the side of the Allies, but it was mismanaged; its leaders, Ante Vokic and Mladen Lorkovic, were arrested and shot by Pavelic's henchmen.

The Independent State of Croatia survived the capitulation of Germany for a few days only. Pavelic fled to Austria in May 1945 and later to Argentina. The puppet state gave place to the people's republic of Croatia within Communist Yugoslavia.

The People's Republic.—The Communists, in the course of

their resistance to the German and Italian occupying forces in World War II, had organized local committees in the territories over which they won control and in 1943 they had subjected their committees to the Anti-Fascist Council of National Liberation of Croatia (Z.A.V.N.O.H.). In May 1945, after the occupation of Zagreb by the partisans, this council became the people's government and Croatia became again an integral part of Yugoslavia. According to the constitution of Jan. 31, 1946, the government's authority "derives from the people and belongs to them"; all natural resources, capital, commerce and means of production were brought under public ownership and managed by the government or by public bodies. Private property remained only on a restricted scale. Peasant holdings were limited to approximately 20 ac.

Organization.—The supreme republican authority in Croatia is the *sabor* (parliament), consisting of two chambers: the house of representatives and the council of producers. The *sabor* appoints its executive council, which enjoys autonomous powers in certain specific matters or executes directives from the central Yugoslav government in Belgrade. National committees in the communes, towns and villages have the status of lower governmental agencies in the republic of Croatia. The communes are self-governing communities in an economically interdependent territory; the towns and villages are basic units where public opinion may be expressed in local affairs. Industrial, financial and commercial enterprises are run on behalf of all the workers by workers' committees, but the director, a government nominee, can veto any committee decisions. Collective farms are run in a similar way.

See also references under "Croatia" in the Index volume.

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CROCE, BENEDETTO (1866–1952), the foremost Italian philosopher of his time, was born on Feb. 25, 1866, at Pescasseroli, Aquila, of an Abruzzese family, the seat of which had been transferred to Naples by his grandfather. There Croce was educated at a Catholic school. In 1883, having lost both his parents in an earthquake, he went to live in Rome with his paternal uncle and guardian, Silvio Spaventa. He entered the university, but did not pursue his studies there. Returning to Naples in 1886, he occupied himself for several years with researches into local history and antiquities. His contributions to philosophy began with two essays (1893 and 1895) on the nature of history and on the method of literary criticism, the leading ideas of which he developed in two later papers in 1900 and 1905. Between 1896 and 1900 he published also a group of essays on points of Marxian economic doctrine. Shortly after, in 1902, he began the systematic exposition of his "Philosophy of the Spirit," divided into four volumes: *Aesthetic; Logic; Philosophy of Conduct (Economics and Ethics)*; and *Theory and History of Historiography*.

In 1903 he founded the periodical *La Critica*, in which, during the course of the following 41 years, he published, part by part, nearly all his writings and reviewed all the most important historical, philosophical and literary work that was being produced in Europe at the time; and from 1945 until his death he continued this activity in the *Quaderni della "Critica,"* of which 20 numbers appeared at irregular intervals. He became a senator in 1910 and was minister of education in Giovanni Giolitti's last cabinet (1920–21).

In 1925 he drew up the anti-Fascist intellectuals' manifesto, and in 1926 his house was sacked by Fascists; but Mussolini never dared to forbid him to publish. In 1943 Croce refounded the Liberal party, of which he was made president. He was minister without portfolio in the governments of Pietro Badoglio and Ivanoe Bonomi (1944) and a member of the consultative council (1945) and of the constituent assembly (1946–47). In 1947 he founded the Istituto Italiano di Studi Storici (Italian Institute of Historical Studies) in a wing of his own house in Naples. Within a decade this institute was to produce some notable works in the Crocean tradition. Croce died in Naples on Nov. 20, 1952.

Philosophy.—The philosophy of Croce, often erroneously classed as "Hegelian," had its avowed sources in the ideas underlying the literary criticism of Francesco de Sanctis and, more generally and remotely, in those foreshadowed in the *Scienza Nuova* of G. B. Vico—both, like himself, Neapolitans. More significantly, it arises from and perpetually returns to his own personal experience in his lifelong and multifarious activity as a student of literature and history. Here he finds himself in vital touch with concrete reality and deliberately confines his reflections to the content of actual or enacted history with a view to its interpretation. Thus he asserts the identity of concrete philosophy with history and defines the task of abstract philosophy as the discovery and formulation of the immanent methodology of history. From the common domain of both he excludes any supposed "realities" which transcend experience; and he abstains from speculation about such "realities" or about primal origins and ultimate ends. History as enacted and occurring and history as interpreting what is thus "given" he views as the work of one spirit, which there expresses and embodies itself. In every part and moment of history that spirit is wholly and indivisibly present and active. Its presence and operation are not confined to human history, but extend in all directions to the utmost bounds of experience. The spirit which is thus omnipresent throughout the whole content of experience is indivisibly one, but its unity is also a quaternity, and it has in its structure four eternally distinct and distinguishable "grades," the ordered circle of which in its life or progress it perpetually traverses, so endowing or filling itself with experience and ever enriching its being. Its four functions in their conjoint exercise generate the contents of experience, within which we can and must distinguish four corresponding grades, stages, kinds or realms, namely the several subject matters of aesthetic, of logical, of economic and of ethical theory, which together without addition constitute the whole of philosophy.

In its total cognitive function this spirit manifests itself as art, the first or "dawn" form of knowledge. In this grade it expresses itself in individual embodiments; in so expressing itself it at once creates and beholds what it creates and has for its objects (which are also its works) whatsoever in experience presents a characteristic individuality. In its second cognitive grade, as logic or abstract philosophy, it expresses, brings to existence and to view, and so knows whatsoever is universal. Uniting, as it cannot but do, both functions and thus becoming concrete in history, it effects a deductive synthesis between what is individual and what is universal; in doing so, it wins actual understanding of the real and enters upon a course of knowledge which runs from sense perception up to explicit history.

The history which thus comes to be understood is wholly the work of the same spirit in the exercise of its total practical function, which has two corresponding grades, in the lower or earlier of which it enacts what is individual, in the higher or later what is universal, or rather, in its actual or concrete exercise, enacts both in one and so fills the stage of history with its deeds. Still more actually or concretely, it is active at once as making or creating and as knowing or understanding its own history, which is its whole self. The only reality which can truly be called absolute is a history without beginning and without end, self-begotten and self-explaining.

Croce developed and applied this fundamental doctrine in extraordinarily various and often highly novel and even paradoxical ways, which excited widespread interest and evoked abundant criticism and opposition. Against his critics he carried on a sustained and skillful polemic. His influence as a philosopher has been compared by many people with that which Hegel exercised in the 19th century, but the strongly nonacademic and antimetaphysical character of his thought make its effect very different. It is to students of history and to critics of art and of poetry that Croce's antisystematic attitude has proved most congenial, and the expansion of his influence seems likely to be in direct proportion to the usefulness of particular doctrines of his to their work. For a portrait of Croce *see* ITALIAN LITERATURE.

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(J. A. SM.; R. FL.)

CROCE, GIOVANNI (*c.* 1557–1609), the leading Venetian mposer of his day, was born at Chioggia, near Venice. His acher, Giuseppe Zarlino, secured him a place in the choir of St. ark's, Venice. By 1585 he was a priest; in 1595 he became as-stant choirmaster at St. Mark's and in 1603 won the competition r the choirmastership. He died in Venice, May 15, 1609. Croce's adrigals and canzonets (publ. in 7 books, 1585–1607), though nservative, were widely admired for his light touch and alert ythms.

Croce's sacred music (published 1591–1610), including Masses d motets, Magnificats, psalms, etc., shows a development from e manner of Palestrina to the polychoral style associated with onteverdi, using solo voices, instrumental rhythms and *basso ntinuo.*

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(B. L. TR.)

CROCHETING: *see* NEEDLEWORK: *Crocheting.*

CROCIDOLITE: *see* ASBESTOS.

CROCKET, in architecture, a small, independent, sharply ojecting medieval ornament, usually occurring in rows, and corated with foliage. In the late 12th century, when it first ppeared, it had the form of a ball-like bud, with a spiral out-ne, like an uncurling fern frond; but in the later Gothic period it ok the form of outcurved, fully developed leaves reaching, the 15th century, complex, involuted richness. Crockets are ed especially on the inclined edges of spires, pinnacles and bles, and are also found on capitals, cornices and, occasionally, ound arches.

CROCKETT, DAVY (DAVID) (1786–1836), American fron-ersman who became a legendary figure of rather fantastic dimen-ons, was born in a pioneer cabin in eastern Tennessee on Aug. 17, 86. His father, having little means, hired him out to more osperous backwoods farmers, and Davy's schooling amounted to o days of tutoring with a neighbour.

Successive moves west to middle Tennessee brought Davy close the area of the Creek War, in which he participated from 1813 1815, and which broadened his personal contacts. In 1821 he as elected to the Tennessee legislature, winning popularity rough campaign speeches studded with yarns and homespun etaphors. In the legislature an opposing speaker referred to him the "gentleman from the cane," alluding to the dense canebrakes western Tennessee where Davy hunted bear and coons during e winter. This image of the rough backwoods legislator caught e popular imagination during Crockett's lifetime and after his ath.

Following a second term in the state legislature in 1823, Davy n for the United States congress. He failed to be elected in 1825, n in 1827 and 1829, lost in 1831, barely won in 1833 and suf-red his final defeat in 1835, as a result of concentrated opposition the party of Andrew Jackson. Thereupon he headed west to exas, joined the American forces and died with those who were ughtered at the Alamo by a Mexican army under Santa Anna March 6, 1836.

During his first congressional term Crockett broke with Andrew ckson and the new Democratic party, Davy desiring preferential eatment for the squatters occupying land in western Tennessee. he Whigs early courted and publicized Crockett, in the hope of eating a popular "coonskin" politician to offset Jackson. In 34 he was conducted on a triumphal speech-making tour to Whig rongholds in the east. From the many stories appearing in news-pers and books during his congressional years the legend rapidly grew of an eccentric, but shrewd, "b'ar-hunting" and Indian fighting frontiersman.

Actually Crockett engaged in several business ventures, and delivered his speeches in fairly conventional English. A series of Crockett almanacs, appearing from 1835 to 1856, developed the legend along the lines of old world folk epics. In the same period a popular play, *The Lion of the West*, presented the backwoods Crockett in the character of Nimrod Wildfire. A sudden revival in 1955, occasioned by Walt Disney television films about Crockett, spread his name across the United States and to other countries.

The *Autobiography* of David Crockett, which he wrote in 1834 with Thomas Chilton, representative from Kentucky, played up the backwoods scene and said little about politics. It helped introduce a new style of vigorous, realistic writing into American literature.

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CROCKETT, SAMUEL RUTHERFORD (1860–1914), Scottish novelist who belonged to the "kailyard school" of writers who made exaggerated use of Scottish dialect, was born at Little Duchrae, near New Galloway, on Sept. 24, 1860. He graduated from Edinburgh university in 1879 and in 1886 became minister of Penicuik, but eventually abandoned the ministry for novel writing. *The Stickit Minister* (1893) and *The Lilac Sunbonnet* (1894) followed the vogue for novels in Scottish dialect set by J. M. Barrie. Later he published a series of retold versions of the tales of Scott. Crockett died on April 21, 1914, at Avignon, France.
See M. M. Harper, *Crockett and Grey Galloway* (1907).

CROCKFORD, WILLIAM (1775–1844), proprietor of Crockford's club, was the son of a London fishmonger and for some time he himself carried on that business. After winning a large sum of money, either at cards or by running a gambling establishment, he built, in 1827, a luxurious gambling house at 50 St. James's street, which he organized as a highly exclusive club. Crockford's quickly became the rage: every English social celebrity and distinguished foreign visitor hastened to become a member. Hazard was the favourite game, and very large sums changed hands. Crockford retired in 1840; he had acquired fabulous wealth, but subsequently lost much of his gains in unfortunate speculations. He died in London on May 24, 1844.

CROCODILE, a common name for reptiles of the family Crocodylidae, order Crocodilia; the similar term crocodilian is applied to any of the Crocodilia, including also the alligators, caymans and gavials. The true crocodiles, almost exclusively tropical reptiles, are found in greatest variety in South America, where about ten species occur. In size crocodiles range from the Congo dwarf (*Osteolaemus osborni*), averaging 3 ft. long, to the salt-water (*Crocodylus porosus*) of southeastern Pacific distribution, averaging 12–15 ft. *Crocodylus acutus* is the only crocodile that ranges into the U.S., along the Florida Keys. *See* CROCODILIA. *See* also ALLIGATOR.

A. W. AMBLER FROM NATIONAL AUDUBON SOCIETY
CROCODILE BIRD (PLUVIANUS AEGYPTIUS)

CROCODILE BIRD (*Pluvianus aegyptius*), a ploverlike courser which derives its name from its frequent association with the Nile crocodile (*Crocodylus niloticus*) from the mouth and hide of which it picks and devours parasites. It is also of service to the crocodile by uttering warning cries on the approach of danger. *See* also PLOVER.

CROCODILIA, an order of the vertebrate class Reptilia. The common name crocodilian is applied to any member of the group, though more specific names such as crocodile, alligator and gavial

(*qq.v.*) are used for certain subgroups. The Crocodilia are members of the Archosauria, or ruling reptiles, the subclass including the dinosaurs. The first recognizable crocodilian appeared in the Triassic (about 175,000,000 years ago), and though the order once flourished, it now includes only about 25 species.

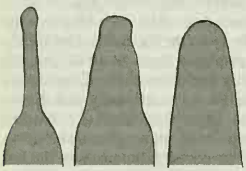
The present-day Crocodilia are placed into three families: Crocodylidae, the true crocodiles; Alligatoridae, the alligators and caymans; and Gavialidae, the true gavial. The last is distinguished by its extremely long, slender snout, by the large number of teeth (more than 22 in each jaw), and by the separation of certain skull bones (nasals and premaxillaries) that are joined in members of the other two families. Both the Alligatoridae and the Crocodylidae have less than 22 teeth in each jaw. In the Alligatoridae the teeth of the lower jaw fit inside those of the upper jaw, whereas in the Crocodylidae the teeth of the two jaws form a single interdigitating row when the jaws are closed. In crocodiles the fourth tooth of the lower jaw fits into an indentation of the upper jaw and is exposed to view when the mouth is shut (*see* fig. 1). In alligators and caymans this tooth is hidden from view when the mouth is closed, as it fits into a pit of the upper jaw.

FROM ROGER CONANT, "A FIELD GUIDE TO REPTILES AND AMPHIBIANS," 1956

FIG. 1.—AMERICAN CROCODILE (CROCODYLUS ACUTUS), SIDE VIEW SHOWING PROTRUDING 4TH TOOTH, ONE OF THE FEATURES THAT DISTINGUISHES THE CROCODILES FROM THE ALLIGATORS

Crocodilians are rather uniform in appearance. All of them have a heavy, cylindrical body; a large, triangular head; short legs; and a very strong tail, flattened from side to side. The thick, scaly skin has large, flat plates on the belly and large, keeled ones on the back. Various genera and species differ from this generalized description only in minor ways, one of which is in the outline of the head and snout (*see* fig. 2).

Although persistent popular reports place the maximum length of present-day crocodiles at 30 ft., authenticated record lengths do not exceed 23 ft. Even the largest species rarely reach such lengths. Most of the big adults of the two largest species, the saltwater crocodile (*Crocodylus porosus*) and the gavial (*Gavialis gangeticus*), fall between 12 and 15 ft. Adults of four other species, the black cayman (*Melanosuchus niger*), Nile crocodile (*Crocodylus niloticus*), American crocodile (*Crocodylus acutus*) and Orinoco crocodile (*Crocodylus intermedius*), commonly exceed lengths of ten feet. Two species of smooth-fronted caymans (*Paleosuchus*) and two species of African dwarf crocodiles (*Osteolaemus*) are less than six feet as adults.



FROM "THE MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY," 1960. REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 2.—DORSAL VIEW OF CROCODILIAN HEADS: (A) GAVIAL; (B) CROCODILES; (C) ALLIGATORS AND CAYMANS

With the exception of the American alligator (*Alligator mississipiensis*) and the Chinese alligator (*Alligator sinensis*), all contemporary crocodilians are confined to the tropics and subtropics. All are amphibious in habit, living in and along lakes, marshes and rivers. Though a number of extinct forms were marine, today only one species, the salt-water crocodile of the East Indies and adjacent areas, habitually swims out to sea.

All crocodilians are powerful swimmers, the heavily muscled, flattened tail driving them through the water while the limbs are held pressed against the sides.

Valves prevent water from entering certain body openings while the animal is submerged. The nostrils, which are at the tip of the snout, are surrounded by muscles that by their contraction close these openings. At the rear of the head the ear openings are protected by muscular flaps that can be pressed tightly against the surrounding surfaces. Because the skin is directly attached to the skull without muscular padding and because there are no fleshy lips, water cannot be prevented from entering the mouth, but it is kept out of the throat by a large muscular flap that closes off the rear of the oral cavity.

Crocodilians frequently float at the surface of the water, with only the tip of the snout and the eyes (atop the head) projecting. In this position, too, the valve at the throat is closed. A pair of bony tubes runs through the skull from the nostrils to a point behind the level of the throat valve. With this apparatus a crocodilian can breathe as long as the tip of the snout is above the surface of the water.

In the floating position a crocodile waits for potential prey, often a small mammal, to come to the water's edge to drink. When it sees the prey, the crocodile submerges, almost without a ripple, and cautiously swims toward the animal till it is only 20 feet or so away; then the crocodile abandons caution and with one or two powerful beats of its tail is upon the startled quarry. The prey, seized between the crocodile's gaping jaws, is pulled into the water and drowned. Small prey is crushed to death in the crocodile's viselike grip.

Most crocodilians feed on fishes, turtles, birds and mammals, including animals that are too large to swallow whole. Once large prey—as big as a deer or cow in the case of the largest crocodiles—is drowned it is dismembered. This is often accomplished by the crocodile's spinning rapidly on its longitudinal axis while gripping a limb of the prey until the limb is twisted off the body. Baby crocodilians usually feed on insects and other small invertebrates. The diet changes as the crocodilians grow, gradually including more and more vertebrates and larger prey. The gavial and the slender-snouted species of crocodiles, such as the so-called false gavial (*Tomistoma schlegeli*), feed almost exclusively on fishes, which are caught by rapid sidewise motions of the snout.

A few species, notably the salt-water crocodile and the Nile crocodile, are known to attack and eat men on occasion. Not all adults of these species will attack a man, but large individuals must be considered dangerous animals.

Food is swallowed in large chunks, as crocodilians are unable to chew. Mechanical reduction of the food into smaller bits takes place in the heavily muscled stomach and is promoted by the grinding action of gastroliths, or stomach stones, which the crocodilian picks up from the stream bed. Powerful contractions of the stomach move the gastroliths among the chunks of food.

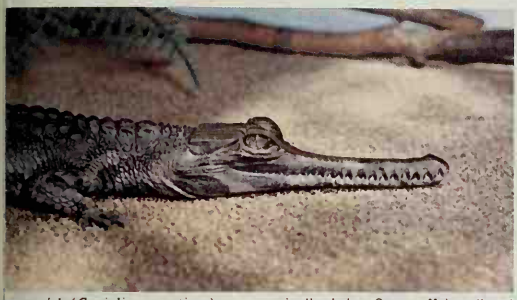
All crocodilians reproduce by means of eggs that are laid on land. The female American alligator makes a moundlike nest of mud and decaying vegetation. When completed, the nest is usually about three feet high and six feet across. The whitish, hard-shelled eggs, about three inches long and 20 to 70 in number, are laid in a hollow in the centre of the nest and then covered with debris. The Nile crocodile deposits its 30 to 50 eggs in sand. The nest, excavated by the female in a river bank, is usually 1½–2 ft. deep. Heat to promote incubation is provided by the sun in the case of sand nests or by decaying vegetation in the case of the alligator's mound nest. The female loosely guards the nest against egg predators. In the southern United States, raccoons and other animals may dig up and eat the eggs.

After the young hatch, which takes approximately nine weeks for the American alligator, the female is attracted to the nest by the peeping calls of the hatchlings; she helps them to leave the nest by scratching away the debris cover. At hatching the young are roughly three times the length of the egg. They are immediately able to fend for themselves, and the female pays no further attention to them. Growth in the early years is rapid and in the large species approximates one foot each year. After the first five or six years the animal grows much more slowly.

Crocodilians are long-lived. Individuals of both species of alligators have been known to live more than 50 years in captivity, and many American alligators have been kept more than 30 years. Although the maximum recorded life of a true crocodile in captivity is 22 years (for an Orinoco crocodile), presumably crocodiles are potentially capable of living even longer. Probably few crocodilians live more than 30 years in the wild, where they must contend with enemies at all times.

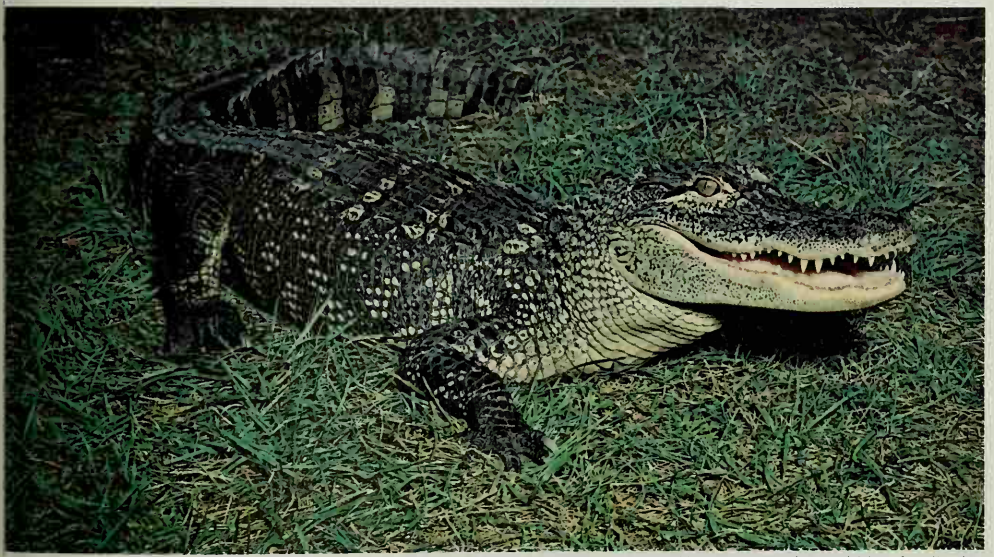
The most menacing of the crocodile's enemies is man. Many species of crocodilians are facing extinction at the hands of hid

ectacled cayman (*Caiman sclerops*), whose length rarely exceeds six feet, is widely distributed throughout the Amazon and Orinoco basins, the Guiana region d northeastern Brazil



ue gavial (*Gavialis gangeticus*), common in the Indus, Ganges, Mahanadi and rahmaputra river systems of Indian region of southern Asia

Siamese crocodile (*Crocodylus siamensis*), found in southern Vietnam, Thailand and the northern part of the Malay peninsula



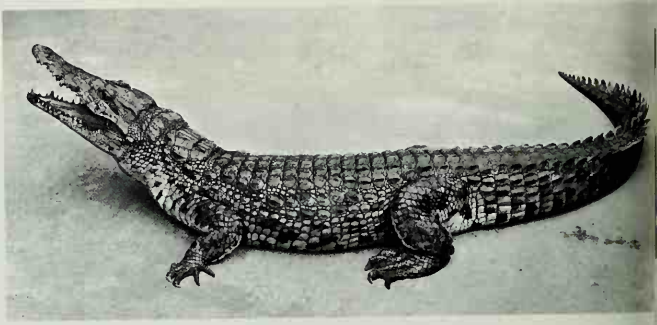
merican alligator (*Alligator mississipiensis*), one of the two species of crocodilians found in the U.S., inhabits the swamps, rivers and lakes of southeastern S., from the Carolinas to Texas

REPRESENTATIVE CROCODILIANS

OTOGRAPHS, (TOP, BOTTOM) JOHN H. GERARD, (CENTRE LEFT) HYMEN MARX, (CENTRE RIGHT) JOHN MARKHAM

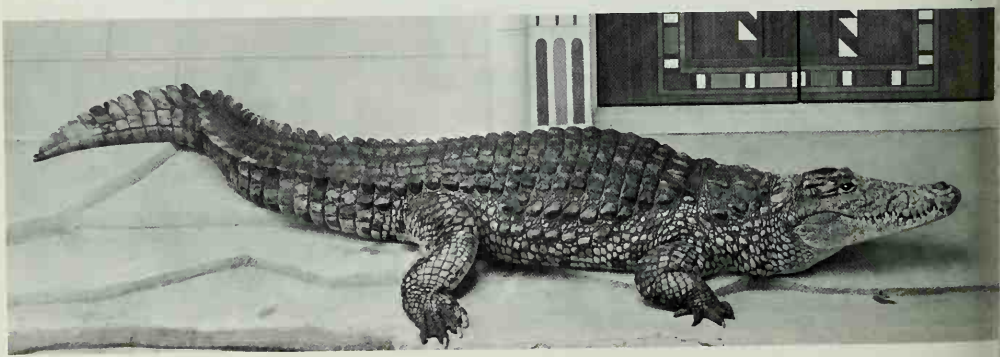
CROCODILIA

Above: habitat grouping of American crocodiles (*Crocodylus acutus*), of southern Florida and the Keys, Greater Antilles and southern Mexico to Colombia and Ecuador. (Museum reconstruction)



Right: salt-water or estuarine crocodile (*C. porosus*), one of the largest of crocodilians, is found in northern Australia and along east coast of India to the Philippines

Below: common African or Nile crocodile (*C. niloticus*), ranges in Africa from the Cape of Good Hope to Tunisia and occasionally along east coast of the Mediterranean



CROCODILES

BY COURTESY OF (TOP) CHICAGO NATURAL HISTORY MUSEUM, (CENTRE, BOTTOM) NEW YORK ZOOLOGICAL SOCIETY

llectors. The skin, especially that of the belly, forms a valuable ather used for fine luggage. In parts of Africa, the Nile crocodile searched out and killed because of its attacks on cattle.

See also REPTILES and references under "Crocodilia" in the Inx volume.

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CROCOITE, a mineral consisting of lead chromate, is iden-al in composition ($PbCrO_4$) with the artificial product chrome-llow used in paint. It is found as well-developed crystals of a ght hyacinth-red colour, which are translucent and have an amantine to vitreous lustre. On exposure to light much of the nsluccency and brilliancy is lost. Crystals were first found in e Urals in 1763 in quartz veins traversing granite or gneiss. old is often found associated with this mineral. Crystals far spassing in beauty any previously known have been found in e Adelaide mine at Dundas, Tasmania. They are long, slender sms, three or four inches in length, with a brilliant lustre and our. In the United States crocoite has been found in Cali-nia and Arizona. Crocoite crystallizes in the monoclinic system. e streak is orange-yellow; hardness 2.5 to 3; specific gravity 0. (L. J. S.)

CROCUS. A genus of over 80 species of popular ornamental nts of the iris family (Iridaceae; *q.v.*), from Eurasia, especially the drier regions, containing about a dozen species widely culti-ted for ornament. The thickened underground stem, the so-led "bulb," is actually a corm (*see* STEM).

Crocuses as garden plants are divided into at least two groups: (1) the familiar spring-flowering species; and (2) the autumn-flowering sorts that are not so well known. Of the first group, which should be planted in the autumn for next season's bloom, the most popular are *C. vernus,* the common crocus of most gardens, initially violet or blue, but now in many other colours; *C. moesiacus,* the Dutch crocus, with yellow flowers; *C. susianus,* the cloth-of-gold; and *C. imperati* from Italy, which is one of the earliest to bloom and has lilac o white, purple-striped flowers.

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CROCUS VERSICOLOR

Of the autumn-blooming species (not to be confused with the a umn crocus; *see* COLCHICUM) the finest is the saffron crocus (*C. sativus*) with white or lilac flowers, the orange stigmas of vich are the source of saffron (*q.v.*). Corms of fall-blooming ocuses should be planted in midsummer for bloom eight weeks ter. (N. TR.; X.)

CROESUS, last king of Lydia (*c.* 560–*c.* 546 or 540 B.C.), of t Mermnad dynasty, succeeded his father Alyattes after a strug-g with his half brother. He is said to have acted as viceroy and mander in chief before his father's death. He completed the quest of Ionia by capturing Ephesus and other mainland cities, b lack of sea power forced him to give up his project of subduing t islanders, whom he enlisted as allies. He also allied himself wh Sparta. His wealth was proverbial. He was a client of the ocle at Delphi, where a number of rich gifts of his were seen by Herodotus. Various legends were told about him by the Greeks, o of the most famous being that of Solon's visit to him with the le on it conveyed of the divine nemesis that waits upon excessive sperity (Herodotus i. 29, *et seq.*). (The story is discredited, however; *see* SOLON.) After the overthrow of the Median empire Croesus found himself confronted by the rising power of Cyrus the Great, and along with Nabonidus of Babylon took measures to rest it. A coalition was formed between the Lydian and Babylonian kings; Egypt and Sparta promised troops, and Croesus took the initiative by invading Cappadocia. After a supposedly indecisive battle at Pteria he returned to Sardis to gather the forces of the confederacy. Cyrus followed him, took him completely by surprise, and stormed Sardis (*c.* 546 or 540). From Bacchylides it may be gathered that Croesus hoped to escape his conqueror by burning himself on a funeral pyre, but that he fell into the hands of Cyrus. A different version of the story is given (from Lydian sources) by Herodotus (followed by Xenophon), who makes Cyrus condemn his prisoner to be burned alive; Apollo, however, came to the rescue of his worshiper with a rainstorm, and the name of Solon uttered by Croesus resulted in his deliverance. According to Ctesias, who uses Persian sources, and says nothing of the attempt to burn Croesus, he subsequently became attached to the court of Cyrus and received the governorship of Barene in Media. Herodotus makes him accompany Cyrus' successor Cambyses to Egypt. Fragments of columns from the temple of Artemis at Ephesus now in the British Museum have upon them a dedication by Croesus in Greek. *See* also LYDIA; and for his coinage, NUMISMATICS.

CROFT, SIR HERBERT, BART. (1751–1816), English author, who planned a revised edition of Johnson's *Dictionary,* contributed a life of Edward Young to his *Lives of the Poets* and achieved notoriety by *Love and Madness,* a collection of love letters which included material on Thomas Chatterton. His scholarly and linguistic gifts were shown in a critical French dictionary and in a number of other books in French. Croft was born on Nov. 1, 1751, at Dunster Park, Berkshire. He became vicar of Prittlewell, Essex, in 1786, but spent much time in France, and died in Paris, April 26, 1816. His plan for revision of Johnson's *Dictionary* was frustrated by lack of money, like many of his ventures.

Croft's *Love and Madness, a Story too true, in a series of letters between Parties whose names could perhaps be mentioned were they less known or less lamented* (1780), was a collection of letters supposedly exchanged between Martha Ray, the mistress of Lord Sandwich, and a clergyman who was in love with her and eventually shot her. It is less interesting for its revelations of this forgotten story than for its inclusion of Chatterton's letters and of a memoir based on then unpublished material.

CROFT, WILLIAM (1678–1727), English organist and composer chiefly of church music, was born at Nether Ettington, Warwickshire, and received a musical education at the Chapel Royal under John Blow. He was organist of St. Anne's, Soho, from 1700 till 1712, of the Chapel Royal from 1707, on the death of Jeremiah Clarke, and of Westminster abbey from 1708. In 1700 he collaborated with Clarke, Blow, Francis Piggott and John Barrett in a *Choice Collection of Ayres for the Harpsichord or Spinnet.* In 1724 appeared his *Musica sacra, or Select Anthems in Score* containing a setting of the burial service of the Church of England that remains in use in the 20th century. Croft's occasional anthems, such as "I will give thanks," for the victory at Blenheim (1704), contain some of his best writing. He also wrote incidental music and works for violin, voice and harpsichord. He died at Bath on Aug. 14, 1727. (C. A. L.)

CROFTER, a term used, particularly in the Highlands and islands of Scotland, to designate a tenant who rents and cultivates a small holding of land or "croft." This Old English word, meaning originally an enclosed field, seems to correspond to the Dutch *kroft,* a field on high ground or downs. By the Crofters' Holdings (Scotland) act, 1886, a crofter was defined as the tenant of a holding who resides on his holding, the annual rent of which does not exceed £30 in money and which is situated in a crofting parish. The law relating to "crofters," *i.e.,* those holding crofts in the "crofting counties" of Argyll, Caithness, Inverness, Orkney, Ross and Cromarty, Sutherland and Zetland, was consolidated in the Crofters act of 1955, which also established a Crofters' commission for developing and regulating the crofting way of life. (A. D. G.)

CROGHAN, GEORGE (1720?–1782), American colonist, Indian agent and trader, who migrated from Ireland to Pennsylvania in 1741. He settled on the Pennsylvania frontier near Carlisle. His early success in the Indian trade—the exchange of textiles, hardware and other items for furs and skins—was facilitated by his mastery of Indian customs and languages. He was also aided by his association with William Trent, an educated young trader,

who had established business connections with Philadelphia merchants who supplied goods for the Indian trade. The rapid extension of Croghan's trading enterprises into the villages of the Ohio Iroquois, the Delawares, the Shawnees and the Miamis led to his appointment as an Indian agent for the province of Pennsylvania in the 1740s.

After the outbreak of the French and Indian War in 1754, Croghan's far-flung trading business collapsed. In 1756 he accepted an appointment as deputy for Sir William Johnson, British superintendent for the northern Indians. As Johnson's chief deputy, a post he held for 15 years, Croghan in the 1750s and 1760s conducted extensive negotiations with the northern tribes, who complained of abuses in the fur trade and encroachments on their lands. He appears to have had a part in negotiating most of the important Indian treaties of the period. When he was sent to the Illinois country to open it for British occupation, he met the great Ottawa chief Pontiac for final peace negotiations and at the same time planned a land speculation project for the Illinois area. Croghan later represented the British government at the important treaty at Ft. Stanwix, N.Y., in 1768, and retired from the Indian service four years later. During the American Revolution he was loyal to the patriot cause, although his land speculation designs caused him to be under suspicion of disloyalty. He cleared himself of charges in 1778 but was unable to establish his title to thousands of acres in western Pennsylvania. He also lost huge landholdings in New York through forced sales and mortgages.

Throughout his career Croghan was involved in many land speculation schemes and trading enterprises that left his name on many 18th-century maps. He died impoverished on Aug. 31, 1782. Croghan's chief contribution to American history is his record as an Indian agent in the period before the American Revolution. He demonstrated that he was, in many respects, the ablest peacemaker in this period of Indian diplomacy in the North American wilderness.

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CROISSY, CHARLES COLBERT, Marquis de (1625–1696), French statesman who, as Louis XIV's foreign minister from 1679, was chiefly concerned with the policy of annexation through "chambers of reunion," was the younger brother of the great Jean Baptiste Colbert (*q.v.*). He began his career in the office of the minister of war, Michel le Tellier. In 1656 he bought a counselorship at the *parlement* of Metz, and was appointed intendant of Alsace. He was made president of the sovereign council of Alsace in 1657 and served as *président à mortier* in the *parlement* of Metz (1662–63). Having also held other intendancies (1661–67), he was in 1668 made intendant of Paris, but he delegated this charge until 1675. During this time he represented France at the conference of Aix-la-Chapelle (1668) and went on a mission to London (1670–74) to secure Charles II's co-operation against Holland. In March 1675 he was sent as an envoy to Nijmegen.

The intendancy of Alsace, his duties at Metz and a diplomatic mission to Vienna (1660) had made Colbert de Croissy acquainted with the complex affairs of the Holy Roman empire. In Alsace he had drawn up a detailed statement of the king's rights and had tried to strengthen the royal authority there so as to put the country's affairs in order, thus starting the process which transformed the mosaic of towns and fiefs into a province ready for incorporation into France. Likewise, during the Nijmegen negotiations (1675–78), he obtained the confirmation of the French king's rights in Alsace, despite the resistance of the emperor's envoys. He was then made secretary of state for foreign affairs (1679).

Colbert de Croissy's purpose was to claim all territories that had been feudally dependent on provinces already ceded to France under the recent treaties. This was not a new theory, but to apply it effectively was a difficult undertaking. To do so, "chambers of reunion" were set up at Douai, Besançon, Breisach and Metz. These studied the evidence of feudal dependence and thereupon declared the several territories to be reunited with France. The consequent reunions were considered by the empire as annexations in time of peace. Historians still debate whether the original responsibility for this policy belongs to the marquis de Louvois or to Colbert de Croissy. Louvois seems to have had much to do with its application in Alsace, but even there the program had already been prepared by Colbert de Croissy. From all angles, Colbert de Croissy identified himself with the policy as a whole.

To counteract the resentment provoked by the annexations, Colbert de Croissy sought alliances with German princes within the empire (*e.g.*, Brandenburg in 1681) and also concluded one with Denmark (1683), but these lapsed. The League of Augsburg was formed against France, and by 1688 war had become inevitable (*see* Grand Alliance, War of the). After Colbert de Croissy's death, at Versailles on July 28, 1696, Louis XIV recalled the more moderate Arnauld de Pomponne to the ministry of foreign affairs.

Colbert de Croissy's papers are in the archives of the French ministry of foreign affairs. Some are printed in the *Recueil de instructions données aux ambassadeurs et ministres de France*, 1 vol. (1884–1901). Other documents are edited by F. A. M. Mignet in *Négociations relatives à la succession d'Espagne*, vol. iv. (1842)

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CROKER, JOHN WILSON (1780–1857), British politician and writer famous for his critical severity as a reviewer and fo his rigid Tory principles, was born at Galway, Ire., on Dec. 2(1780, the elder son, by his second marriage, of John Croker, sur veyor general of customs and excise for the port of Dublin. H graduated at Trinity college, Dublin, in 1800 and after a perio at Lincoln's Inn he was called to the Irish bar in 1802.

In 1804 his anonymous verse satire *Familiar Epistles to Freder ick E. Jones, Esquire, on the Present State of the Irish Stag* achieved great success and notoriety, as did also a number c anonymous prose pamphlets on Irish society and affairs, includin the satirical *Intercepted Letter From Canton* (1804) and the mor serious *Sketch of the State of Ireland, Past and Present* (1808 which advocated Catholic emancipation.

In 1807 Croker entered parliament as member for Downpatric and made his first speech, unprepared, on the day he took h seat. From the first he had the backing of the duke of Wellingto then Sir Arthur Wellesley and chief secretary for Ireland, and th friendship between them continued unbroken until the duke death. Croker was given a leading part in the Tory defense of th duke of York against the charges of Colonel Wardle and in 181 his abilities were recognized by Spencer Perceval in his appoin ment to the office of secretary to the admiralty, which he held unt 1830, when the Whigs returned to power. Croker's official caree began with a spectacular exposure of a colleague's misappropriatio of public funds. He built up the importance of the office, resiste the attempts of the duke of Clarence (afterward William IV) t make himself, as lord high admiral, independent of the admiralt council and encouraged nautical science and exploration.

Croker played a leading part in the opposition to the Refor bill, replying frequently to Macaulay's advocacy, and he refuse to sit in the reformed parliament. After 1832, however, he r mained in close contact with the Tory leaders, especially S Robert Peel, until the latter's conversion to the repeal of the co laws split the party. From 1831 to 1854 Croker was the chi political writer for the *Quarterly Review*, with which he had be connected from its foundation and to which, between 1809 a 1854 he contributed about 270 articles on a great variety of su jects. In politics a staunch Tory of the older school, Croker wro with intense party feeling and his reputation suffered from t attacks of his political opponents, especially Macaulay. T quarrel produced Macaulay's unfair review of Croker's editi of Boswell's *Life of Johnson* (1831) and Croker's later damagi criticism of the first two volumes of Macaulay's *History of En land* (1849).

His literary tastes were largely those of the 18th century, as ıay be seen from his severe criticisms of Keats's *Endymion* and ennyson's *Poems* of 1832. For some years before his death he ıd been accumulating material for an annotated edition of Pope's orks; this passed to Whitwell Elwin, who began the edition later ɔmpleted by W. J. Courthope. Croker was a frequent reviewer f contemporary history and memoirs and an authority on the rench Revolution; at his death his valuable collection of docuıents on this subject was left to the British museum, London. le edited *Letters to and from Henrietta, Countess of Suffolk* 1824) from the *Suffolk Papers* (then in his possession and later equeathed to the British museum), also John, Lord Hervey's *Memoirs of the Reign of George II* (1848), the *Letters of Mary epel, Lady Hervey* (1821) and *Walpole's Letters to Lord Hartɔrd* (1825). Croker did much to further public encouragement of ıe arts and sciences, was concerned in the purchase of the Elgin Iarbles (1816) and was principal founder of the Athenaeum club. le died at Hampton, Middlesex, on Aug. 10, 1857.

See L. J. Jennings (ed.), *The Croker Papers*, 3 vol. (1884); Myron . Brightfield, *John Wilson Croker* (1940). (R. G. Cx.)

CROKER, THOMAS CROFTON (1798–1854), Irish antiuary whose collections of songs and legends formed a storehouse ɔr writers of the Irish literary revival, was born at Cork, Jan. 15, 798. During rambles in southern Ireland, 1812–16, he collected gends, folk songs and keens, some of which he sent to Thomas Ioore, who acknowledged a debt to him in his *Irish Melodies*. This collection formed the basis of Croker's *Fairy Legends and raditions of the South of Ireland* (1825–28), which was praised ıd translated into German by the brothers Grimm, and by Sir Valter Scott, who described Croker as "little as a dwarf, keenved as a hawk, and of easy prepossessing manners." After 1818 roker lived in England, working as clerk in the admiralty until 850. His later works included *Popular Songs of Ireland* (1839), ıd publications for the Percy society of which he was co-founder 1840). He helped to found the Camden society (1839) and the ritish Archaeological association (1843). He died in London, ug. 8, 1854.

CROLL, JAMES (1821–1890), Scottish scientist best known ɔr his theory that the glacial ages were caused by a change in the ccentricity of the earth's orbit combined with the precession of the quinox, was born near Cargill, Perthshire, Jan. 2, 1821. He was lf-educated, but in 1859 was made keeper of the Andersonian useum in Glasgow, and from 1867 to 1880 was in charge of the dinburgh office of the geological survey of Scotland. He wrote me books, much discussed in their day, including *Climate and ime, in Their Geological Relations* (1875) and *Climate and Cosology* (1885). His *Autobiographical Sketch of James Croll, With Memoir of His Life and Work* was edited by J. C. Irons (1896). roll died near Perth on Dec. 15, 1890.

CROLY, GEORGE (1780–1860), British author and Anglin clergyman whose vigour and eloquence as a preacher were apɔarent also in his poetry and prose, although marred by a turgid ıd extravagant style, was born in Dublin on Aug. 17, 1780. Edu ted at Trinity college, Dublin, he received a curacy in the north Ireland. About 1810 he moved to London, where he wrote for erary journals and published several poetical works, including *aris in 1815* (1817) in the manner of Lord Byron's *Childe Harold*. *alathiel* (3 vol., 1828) was his chief novel, but he wrote many her prose works on history, religion and biography, all in an elabate and unreal style lacking in humour and imagination. Through his patron, Lord Brougham, in 1835 Croly received e living of St. Stephen's, Walbrook, London, where he died on ov. 24, 1860.

CROLY, HERBERT DAVID (1869–1930), U.S. author, itor and political philosopher, was born in New York city, n. 23, 1869. Both of his parents were widely known journalists. lucated in public and private schools of New York city and at ırvard university, he spent his early adult years editing or conbuting to architectural journals. His first book on social and litical problems, *The Promise of American Life* (1909), was also most important; it influenced both the "New Nationalism" of e Republican president Theodore Roosevelt and the "New Freedom" of the Democratic president Woodrow Wilson. In 1914 Croly founded the weekly *New Republic*, "*A Journal of Opinion*," gathering about him a distinguished staff. The paper, which began publication just after the opening of World War I, gained rapidly in circulation, partly because it was supposed (incorrectly) to be a mouthpiece for President Wilson. When the terms of the treaty of Versailles were published in 1919, Croly denounced them, an act that cost his paper half its circulation.

Croly was the first important writer to attack American complacency and to argue that democratic institutions must constantly be revised to fit changing situations. While a true democrat, he believed in dedicated leaders of superior quality; it was said of him that "he sought Jeffersonian ends by Hamiltonian means." In his last years, disillusioned by Pres. Warren G. Harding's "return to normalcy," he gave his attention chiefly to philosophic and religious questions.

Croly's other works include *Progressive Democracy* (1914), biographies of Marcus A. Hanna (1912) and Willard Straight (1924) and several books on architecture. He died in New York city on May 17, 1930. (B. Bl.)

CRO-MAGNON MAN, the name originally given to a small number of human skeletons of prehistoric age found in a rock shelter at Cro-Magnon near Les Eyzies in the Dordogne department of France. It has since been used with reference to a prehistoric race of such men which inhabited western Europe, and is generally associated with the Aurignacian culture.

The original discovery at Cro-Magnon was made in 1868, when workmen engaged in constructing a railway from Périgeux to Agen unearthed remains of more than five human skeletons, together with animal bones, sea shells in the form of necklaces and stone tools. Louis Lartet, a geologist, carefully excavated the site and published his findings that year. The stone tools were similar to those which had been discovered in 1860 at Aurignac by Lartet's father, Édouard, and which were given the name Aurignacian. The skeletons themselves were fragmentary, but three crania were fairly well preserved and, in particular, one of a senile man, popularly known as "le Vieillard." This important discovery was the first to be made of human fossils in a recognizable archaeological context acknowledged to be of pre-Neolithic age—in fact, the first man of the Paleolithic to be scientifically excavated.

Distribution.—The discovery was important not only because of its early date but because the skeletons proved to be typical of a race widespread throughout Europe at this time, most common in France, but stretching north to Belgium and from Wales to eastern Europe. These early discoveries of Old Stone Age man were made toward the end of the 19th century, and grouped together by French archaeologists as the race of Cro-Magnon. This wide area has now proved to contain a rather varied number of slightly differing peoples throughout the length of the later Old Stone Age, and the term Cro-Magnon is more generally used with reference to people occupying southwestern France in the Aurignacian period. Skeletal remains of this period have been discovered at Combe Capelle, Menton, Les Cottes, Isturitz and elsewhere.

Origin.—Placed in their historical context, the physical or anatomical characteristics of these people are very striking because they are entirely different from the distinctively specialized Neanderthal man (*q.v.*), whom they follow and replace chronologically. In a short space of time—geologically speaking—Neanderthal man was entirely replaced in this same geographical area by men of the Cro-Magnon type, whose physical characteristics, origin and culture were entirely different from those of the earlier inhabitants. This change occurred just after the coldest stage of the first glaciation of the last ice age when, in many archaeological sites, the Mousterian culture of Neanderthal man was replaced by the Aurignacian culture of the Cro-Magnon people. Since there is no true cultural or anatomical continuity in these western European sites between these two groups, it has generally been assumed that either the extremely cold climate or the more intelligent and skilled Cro-Magnon people caused the annihilation of Neanderthal man. The available archaeological and anatomical evidence suggests that the Cro-Magnon type of man evolved farther east, in Asia, and moved westward into Europe to replace its earlier inhabitants. Farther

east, some degree of anatomical continuity can be traced between the two groups.

Physical Characteristics.—Cro-Magnon man contrasts with Neanderthal man (*Homo neanderthalensis*) by being entirely modern in physical characteristics. In classification he falls into the "caucasoid" subspecies of modern man, *Homo sapiens sapiens*. These early Europeans had only a few characteristics which would serve to distinguish them from some modern western and north Europeans. In particular, they had a large brain (1,550–1,750 c.c.) and were tall and muscular in comparison to modern man (average brain size 1,350 c.c.). The skull was large, pentagonal and dolichocephalic (long-headed). The face was broad and short, with well-separated and low, broad, rectangular orbits; the mouth rather narrow and prognathous; the *foramen magnum* (the opening in the skull for the spinal column) relatively long. The original Cro-Magnon fossils were described by P. Broca and F. Pruner-Bey in 1868. They are to be seen in the Musée de l'Homme, Paris.

Ecology.—Cro-Magnon man was a food gatherer and subsisted primarily by hunting. After the first glaciation of the last ice age the glaciers moved back northward, the arctic conditions being replaced in turn by a tundra and steppe fauna and flora. The open plains were well stocked with bison, musk oxen and horse, while the cooler regions carried the great mammoth, the woolly rhinoceros, reindeer and many other animals. Working with his fellows in groups, man had mastered the art of hunting these large and dangerous animals, and possibly the commonest method of capture was to stampede a herd of animals over a cliff, or into a narrow ravine. Besides being a source of meat, the animal skins supplied man with clothing and shelter, the fat was used for oil lamps, and the bones and ivory made possible an enormous development in toolmaking. The rivers were certainly full of fish, and Cro-Magnon man was developing techniques for catching them.

During the winter and in the later colder periods, the overhanging rock shelters and cave mouths, which are so common in limestone areas, provided shelter. Perhaps the need for this shelter, and the increasingly complex material culture, served to some extent to anchor this otherwise nomadic people. In these shelters the dead were placed in shallow graves, and in this characteristic the Cro-Magnon people resembled Neanderthal man, who also must have believed in an existence after death, which is indicated by the burial custom. Red ochre was probably used extensively as a body paint, as in modern tribes, as well as to colour the bodies of the dead.

Material Culture and Date.—Today it is usual to associate the Cro-Magnon race with the Aurignacian industry in its original sense, for it has more recently been divided into the Châtelperronian, Aurignacian and Gravettian industries. It is convenient to treat as one race these men who occupied Europe subsequent to the first glaciation of the last ice age, becoming more numerous toward the end of this period, and who were responsible for this culture sequence. In the early 1960s there was still insufficient evidence to distinguish the "races" of Grimaldi, Predmost and Chancelade, as had been done by some authors. Cro-Magnon man was not only responsible for a very fine stone and bone industry but for the first art. Small engravings, reliefs and sculptures of animals have been found, as well as statuettes in mammoth ivory and fine-grained rock depicting grotesque female figures, often apparently pregnant, and very likely designed to affect magically the fertility of the tribe. Bone implements are sometimes decorated with geometric patterns. Most striking, however, are the superbly painted caves, some of which, including the famous cave at Lascaux, are probably of late Aurignacian date. The art, however, had a definite function, and the animals depicted in the caves were undoubtedly intended to influence magically the success of the hunting expeditions upon which the survival of the community depended. But these artistic achievements show a sensitivity of observation, a technical ability and a creative consciousness which prove Cro-Magnon man to have been a highly evolved human being, both physically and mentally. Radiocarbon age determinations from certain sites in France suggest that the earliest known Cro-Magnon skeletal remains date from about 30,000 years B.C., though cultural evidence suggests that the Cro-Magnon race entered western Europe 5,000–10,000 years earlier.

Theories on Fate.—The Cro-Magnon people were from time to time invaded by others coming from the east. New populations, bearing new culture traits, moved westward and occupied successively the former strongholds of Cro-Magnon man. But the Cro-Magnon folk survived, and the modern dolichocephalic inhabitants of western Europe are not far removed anatomically from their prehistoric forebears. There seems no reason to doubt that these modern groups are descended to some extent from people similar to those whose skeletons have been discovered in these Upper Paleolithic sites. A close resemblance to Cro-Magnon man has been noticed by anthropologists in certain living groups in the Dordogne, and in Scandinavia, parts of Spain and the Canary Islands. Thus, human skeletons bearing the Cro-Magnon characteristics occur throughout the Solutrean, Magdalenian and later prehistoric cultures until the present day. They have been found in many sites besides those of Aurignacian date cited above. *See* also ARCHAEOLOGY: *Prehistory;* MAN, EVOLUTION OF.

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CROMARTY, GEORGE MACKENZIE, 1ST EARL OF (1630–1714), Scottish statesman who held political office in Scotland both before and after the revolution of 1688–89, was born at Innerteil, Fife, in 1630 and educated at Aberdeen university. He joined the Scottish rising on behalf of Charles II in 1654 and was in exile until the Restoration, when he became a lord of session with the title of Lord Tarbat (1661). The king's commissioner in Scotland was the earl of Middleton, who had led the rising in 1654 and Mackenzie, as a member of parliament, worked with him against the earl of Lauderdale. The latter's predominance in Scottish affairs kept Mackenzie out of office from 1664 to 1678, but he subsequently became lord justice general (1678), lord clerk register and again a lord of session (1681). From 1682 he was a leading member of the government of Charles II and James VII (James II of England) in Scotland. In 1689 he was arrested, but soon made his peace with William III for whom he acted in framing the church settlement and mediating with the episcopalian party and the Highland clans. Again in office as lord clerk register (1692–96), a secretary of state (1702–04) and lord justice general (1705–10), he was, in the last phase of his inconstant career, an advocate of the union of 1707. He received his earldom in 1703 and died in Ross-shire on Aug. 17, 1714. (GN. D.)

CROMARTY, a small burgh and seaport of Ross and Cromarty, Scot., 38½ mi. E.N.E. of Inverness by road. Pop. (1961) 605. It is situated in the Black Isle near the mouth of the Cromarty firth under the shelter of the South Sutor—one of the headlands which guard the entrance to the fine landlocked harbour. Before the union of the shires of Ross and Cromarty it was the county town of Cromartyshire and gave the title to the earldom of Cromarty. A flourishing fishing industry was once carried on, but this practically disappeared and the town became a summer resort. The parish is rich in historical legends and folklore. Behind the town stands a monument to Hugh Miller (1802–56), the geologist and writer, and the thatched cottage in which he was born is now maintained by the National Trust of Scotland. Sir Thomas Urquhart, translator of François Rabelais, was born where Cromarty house now stands; the Saltire society has placed a tablet to his memory in the old parish church which is an early post-Reformation building. The former shire of Cromarty was incorporated with Ross-shire in 1889. Its nucleus consisted of the lands of Cromarty in the north of the peninsula of the Black Isle. To this were added from time to time the various estates scattered throughout Ross-shire—including the districts around Ullapool and Little Loch Broom and a tract to the north of Loch Fannich—which was acquired by the ancestors of Sir George MacKenzie (1630–1714), afterward Viscount Tarbat (1685) and 1st earl of Cromarty (1703). Desirous of combining these properties into one shire, Viscount Tarbat procured their annexation to the sheriffdom of Cromarty in 1685 and 1698. (*See* ROSS AND CROMARTY.) Invergordon, 5 mi. W.N.W. on the opposite coast, is

egular communication with Cromarty by motorboat. At Invergordon is a naval base which gained notoriety as a centre of a naval mutiny in 1931. Nigg, across Nigg bay from Invergordon, has a church with a strange sculptured stone possibly dating to the 7th century.

CROME, JOHN (1768–1821), English landscape painter, founder and chief representative of the "Norwich school"—often called Old Crome, to distinguish him from his son—was born at Norwich on Dec. 22, 1768, the son of a weaver. During his apprenticeship to a house painter he sometimes painted signboards, and devoted what leisure time he had to sketching from nature. Through the influence of a rich art-loving friend he was enabled to become a drawing master, and in this he was engaged throughout his life. About 1790 he was introduced to Sir William Beechey, from whom he gathered additional knowledge and help in his art. In 1805 the Norwich Society of Artists took definite shape. Crome was its president and the largest contributor to its annual exhibitions.

Crome first exhibited at the Royal academy in 1806. With few exceptions his subjects were taken from the familiar scenery of his native county, which he depicted with techniques largely derived from his study of Dutch painters, particularly Hobbema. Fidelity to nature was his dominant aim. His most important works are: "Mousehold Heath, near Norwich"; "Clump of Trees, Hautbois Common"; "Oak at Poringland"; the "Willow"; "Coast Scene near Yarmouth"; "Bruges, on the Ostend River"; "Slate Quarries"; the "Italian Boulevards"; and the "Fishmarket at Boulogne." He executed a good many etchings, and the great charm of these is in the beautiful and faithful representation of trees. He died at Norwich on April 22, 1821. His son, John Bernay Crome (1794–1842), was his assistant in teaching, and the younger Crome's best pictures were in the same style. A collection of "Old" Crome's etchings, entitled *Norfolk Picturesque Scenery*, was published in 1834, and was reissued with a memoir by Dawson Turner in 1838, but in this issue the prints were retouched by other persons. *See* also PAINTING: *Baroque Through Impressionist Painting: Great Britain.*

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CROMER, EVELYN BARING, 1ST EARL (1841–1917), British administrator and diplomat whose 24-year rule in Egypt profoundly influenced its development as a modern state, was born at Cromer hall, Norfolk, on Feb. 26, 1841, of a family distinguished in political life and merchant banking. He was commissioned in the royal artillery in 1858 and spent the first years of his service in the Ionian Islands, Malta and Jamaica. Returning to England he passed through the staff college and was posted to the war office. He went to India in 1872 as private secretary to his cousin, Lord Northbrook, the viceroy. In 1877 he was appointed British commissioner of the Egyptian public debt office which had been set up to deal with the liabilities of the khedive Ismail. Baring's ability in financial administration quickly won him a dominant place on the board, and when in 1879 the Ottoman sultan deposed Ismail, Baring became the British controller general in the Anglo-French dual control. In 1880 he returned to India as financial member in the viceroy's council, remaining there until 1883. He proved a wise financier during a period of economic stringency and was knighted for his work.

After the defeat of the nationalist rising under Arabi Pasha in 1882, Egypt was occupied by the British, and Sir Evelyn Baring returned as British agent and consul general with plenipotentiary and diplomatic rank. Egypt was still dislocated by the revolt, while in the Sudan the mahdist rebellion was gaining momentum. So great had been the losses in men and equipment there that Baring felt the tottering Egyptian finances could not bear any further strain. He advised the abandonment by Egypt of all its Sudanese possessions except the towns of Wadi Halfa and Sawakin. The British government shared his views, and the policy of abandonment, much criticized in Great Britain and Egypt, was forced on the ministry of Mohammed Sharif Pasha which resigned in protest on Jan. 1884. The British government proposed the appointment of Maj. Gen. C. G. Gordon to superintend the evacuation of the Egyptian garrisons. Baring, who questioned Gordon's suitability for this task, hesitated, but in view of the strength of popular feeling in Great Britain, reluctantly consented to the appointment against what he afterward felt to have been his better judgment.

With the evacuation of the Sudan completed, Baring resumed the reorganization of the Egyptian government services and in 1885, against opposition from the bondholders, obtained a loan for irrigation. Gradually his prudent handling of the Egyptian economy began to show a positive result and in 1889 the budget yielded a surplus. He now overhauled the railways, the administration of justice and state education. In his relations with the Egyptian ministers there was little question of consultation; his suggestions had the force of commands. He was raised to the peerage as Baron Cromer in 1892. The death in 1892 of the khedive Mohammed Tewfik with whom he had worked well, and the succession of the young Abbas Hilmi, who not unnaturally chafed under Cromer's tutelage, complicated his work.

The crushing defeat of an Italian army by the Abyssinians at Aduwa in March 1896 and the advance of Belgian and French expeditions toward the Nile suggested that the time was opportune for an Egyptian reoccupation of the Sudan. Dongola was occupied in Sept. 1896, and on Sept. 2, 1898, an Anglo-Egyptian force under Sir Horatio Herbert (afterward Lord) Kitchener broke the mahdist power at the battle of Omdurman. Great Britain, which had contributed substantially to the reconquest of the Sudan, demanded a share in its administration. The former Egyptian possession was placed under an Anglo-Egyptian condominium, devised by Cromer, which not only excluded the capitulations (*q.v.*) and the presence of foreign consular agents, but also denied to Egypt any real partnership in the joint government. The signature of the condominium agreement of 1899 by Cromer and the Egyptian prime minister, Butrus Ghali Pasha, was resented in Egypt. Cromer was created a viscount in 1899 and an earl in 1901. He took a leading part in the negotiations which led to the Anglo-French settlement of 1904 whereby France gave Great Britain a free hand in Egypt, and in the dispute with Turkey over Sinai in 1906.

Cromer's outstanding ability, his forceful character and his preeminent position in Egypt inevitably made him a controversial figure. While he enjoyed the friendship of prominent Egyptians such as Sheikh Mohammed Abduh, the great reformer, he failed to come to terms with the new generation of Egyptians who blamed him for withholding political reforms and neglecting education. But if he diverted the bulk of the available revenue to railways, irrigation and agriculture, he did so from a deep conviction that economic and social progress must come before the political and cultural wants of the intelligentsia whom in any case he distrusted. It is significant of his attitude that, while he was at pains to study Turkish, the language of the ruling elite, he did not consider it necessary or even advisable to learn Arabic, the language of the people. He was therefore out of touch with the Egyptian middle class from which most of the younger nationalist leaders were drawn.

In June 1906 a British officer was killed in a fracas with Egyptian villagers at Dinshaway during a pigeon shoot. The heavy sentences imposed by the judges disturbed Egyptian public opinion and, though Cromer was abroad at the time and had nothing to do with the trial, popular indignation made him the scapegoat. The widening rift between the British representative and articulate Egyptian opinion persuaded Sir Henry Campbell-Bannerman's ministry to adopt a more accommodating policy in Egypt. Cromer, overworked and exhausted, resigned in 1907 and was succeeded by Sir Eldon Gorst. He spent his retirement in literary pursuits and took some part in politics as leader of the free-trade wing of the Unionist party. In 1916 he presided over the Dardanelles commission, but the strain was too great and after one of the meetings he collapsed. He died in London on Jan. 29, 1917.

Cromer's published works include *Modern Egypt*, 2 vol. (1909), a defense of his Egyptian mission, and *Abbas II* (1915), a polemical biography. His annual reports on Egypt, 1884–1906, present an official account of his stewardship. *See* EGYPT: *History.*

See Lord Zetland, *Lord Cromer* (1932). (R. L. HL.)

CROMER, an urban district and seaside resort of Norfolk, Eng., lies 25 mi. N. of Norwich by road. Pop. (1961) 4,895. The

town is near the end of the Cromer ridge, but the high yellow-brown cliffs on which it stands are being rapidly washed away into sandy beaches, revealing signs of prehistoric man. About 2.5 mi. inland is a Roman camp. The fine 14th century church of St. Peter and St. Paul has a lofty tower (160 ft.) that once served as a lighthouse, and a window designed by Sir Edward Burne-Jones. Cromer is a coast guard and lifeboat station with a lighthouse.

CROMPTON, SAMUEL (1753–1827), English inventor of the spinning mule, was born on Dec. 3, 1753, at Firwood near Bolton, Lancashire. From an early age he worked about the farm and spun cotton at Hall-i'th'-Wood, to which his family had removed. The defects of the spinning jenny inspired him with the idea of devising something better, and for five or six years the effort absorbed all his spare time and money, including what he earned by playing the violin at the Bolton theatre. About 1779 he succeeded in producing a machine which, by simultaneously drawing out and twisting the cotton roving fed into it, reproduced mechanically the actions of hand spinning and enabled yarn of the finest quality to be made. It was known as the muslin wheel or the Hall-i'th'-Wood wheel, and later was called the mule because it was a cross between Richard Arkwright's spinning machine and James Hargreaves' spinning jenny; it combined the drafting rollers of the one with the traveling carriage of the other. Unlike the jenny, however, the spindles were mounted on the carriage but the roving creel and drafting rollers were fixed.

After Crompton's marriage in 1780 a demand arose for the yarn which he made at Hall-i'th'-Wood, but he could not afford to take out a patent. He therefore decided to reveal the secret of his machine on the promise of a number of manufacturers to pay him for its use, but all he received was about £60. He then resumed spinning on his own account, but with indifferent success. In 1800 a sum of about £500 was raised for his benefit by subscription, and in 1812, when there were already at least 360 mills using 4,600,000 mule spindles, parliament allowed him £5,000. With this money he embarked in business, first as a bleacher and then as a cotton merchant and spinner, but without success. In 1824 friends bought him an annuity of £63. Crompton died at Bolton on June 26, 1827.

See G. J. French, *The Life and Times of Samuel Crompton* (1859); H. C. Cameron, *Samuel Crompton* (1951). (K. R. G.)

CROMWELL, HENRY (1628–1674), fourth son of Oliver Cromwell and the ruler of Ireland during the Protectorate, was born at Huntingdon on Jan. 20, 1628, and educated at Felsted school. He served under his father in the latter part of the first phase of the Civil War. In 1650 he took some troops to assist Oliver in Ireland and was one of the Irish representatives in the Nominated (or Barebone's) parliament of 1653. In Aug. 1654 he was appointed major general of the forces in Ireland and in December was made a member of the Irish council of state. On the departure for England of the lord deputy, Charles Fleetwood, in Sept. 1655, Henry was left for practical purposes the ruler of Ireland although he was given the title of lord deputy only in Nov. 1657. He had no voice in Irish policy, but his enforcement of the Cromwellian settlement was moderate and successful. Disapproving strongly of the excessive power in the hands of the army leaders, especially the Anabaptists, he diverged from Fleetwood's policy in protecting the interests of the English settlers and in holding the scales evenly between the different Protestant sects. By strict economy he overcame the financial problems of government, and successfully managed the reduction of the army in Ireland despite several months' arrears of pay. The earl of Clarendon attests Henry's undoubted popularity in Ireland.

On the succession of Richard Cromwell to the office of protector at his father's death (1658), Henry, although appointed lieutenant and governor general of Ireland, was reluctant to remain there. Having rejected proposals to assist in the restoration of Charles II, he was recalled to England in June 1659 just after his brother's fall. He resigned office at once, and although he lost some property at the Restoration, he was allowed to keep the estate he had bought in Ireland. His last years were passed at Spinney abbey in Cambridgeshire, where he died on March 23, 1674. In 1653 he married Elizabeth (d. 1687), daughter of Sir Francis Russell, and left five sons and one daughter.

See R. W. Ramsey, *Henry Cromwell* (1933).

CROMWELL, OLIVER (1599–1658), lord protector of the Commonwealth of England, Scotland and Ireland from 1653 to 1658, was born at Huntingdon on April 25, 1599, the second son of Robert Cromwell and Elizabeth Steward. Oliver's paternal great-great-great-grandfather, Morgan Williams, is said to have belonged to a respectable Glamorgan family and to have accompanied King Henry VII from Wales. Morgan's son married Katherine Cromwell, whose brother Thomas became Henry VIII's chief minister. Consequently the family name was changed from Williams to Cromwell. Oliver's father, being a younger son, had a modest income, but at one time served as a member of parliament and held important local offices in Huntingdonshire.

Early Years.—Oliver Cromwell was educated at the Huntingdon free school and at Sidney Sussex college, Cambridge. He left Cambridge when he was 18, possibly because of his father's death (1617), and at 21 married Elizabeth, daughter of Sir James Bourchier, an Essex merchant. Both at school and at Sidney Sussex, which is said to have been a "nursery of Puritans," Cromwell imbibed the Puritan approach to life, but his "conversion" did not take place until he was about 28, a practising farmer and the father of five children. Although he later wrote: "You know what my manner of life hath been . . . I was a chief, the chief of sinners," there is no evidence, except much later stories, for supposing that in his youth he was guilty of anything more than high spirits. Essentially he was an outdoor man, fond of riding and sport.

In the 1620s Cromwell must have been in straitened circumstances, because two-thirds of the income of his father's estate had to go to Oliver's mother, but an uncle, Richard Cromwell, left him a little property in 1628 and he later received a more substantial inheritance from his mother's brother Thomas Steward. It was because of this that in 1636 Oliver and his family went to live at Ely in Cambridgeshire, having previously farmed near Huntingdon and St. Ives. At Ely he took a large part in local affairs. Already in 1628 he had been elected member of parliament for the borough of Huntingdon, but after 1629 there were no parliaments for 11 years.

When, however, Charles I was compelled to call in turn the so-called Short and Long parliaments in 1640, Oliver Cromwell was elected for the borough of Cambridge. He was then aged 41, a reasonably successful farmer with some experience of administration but no real training as a soldier.

Parliamentary Opposition.—The only speech that Cromwell is known to have made in the house of commons in 1628–29 was when he took part in an attack on the bishops. In the parliaments of 1640 many of his friends and relations were members and he undoubtedly belonged to the group that supported John Pym and John Hampden in their vehement criticism of the king's policies. Cromwell was fairly prominent in the early months of the Long parliament, speaking in several debates and serving on various committees. He was particularly critical of "innovations," by which he meant any form of ritualism, in the Church of England and was soon to become a leader of the "root and branch" party; *i.e.*, those who wanted to abolish the archbishops, bishops and other officers of the existing church hierarchy. He is not known to have taken any part in the debates on the earl of Strafford's attainder, but he moved the second reading of a bill for annual parliaments. He acquired some proficiency as an orator, but is said to have had a "sharp and untuneable" voice.

On the whole, religious questions took a secondary place in the first year of the Long parliament and Cromwell expressed concern that so little had been achieved in the matter of reform. The "root and branch" bill met with resistance and its opponents —the nucleus of the future royalist party—showed their unwillingness to strip the king of all his ancient prerogative powers during the prolonged debate on the Grand Remonstrance (Nov. 1641). After the Remonstrance had been carried by only 11 votes Cromwell is said to have told Viscount Falkland, a fellow member, that if it had been rejected "he would have sold all he had the next morning and never seen England any more." This is the only basis

or a story that Oliver Cromwell once thought of settling in the ıew world.

MILITARY CAREER

The Civil War: 1642–43.—In Jan. 1642, after the king's unsuccessful attempt to arrest five members of parliament for reason, Cromwell moved that a committee should be appointed o consider means of putting the kingdom in a state of defense that is, against the king). In March he was concerned with Ireand, where rebellion had broken out the previous autumn, and ubscribed £500 to buy land there as a contribution to a war chest. Ie served during the summer on a committee whose business was o prevent troops being recruited for the king in Yorkshire, and hen on another committee for raising military and naval forces or parliament. In Aug. 1642, after the king had rejected parament's final terms for a settlement, Cromwell rode down to his onstituency to prevent plate, money, horses or arms being sent rom the university to the king. He seized the castle, impounded uch of the college plate and disarmed the local residents. By is prompt action he secured Cambridgeshire for the parliamentary ide.

On Sept. 13, 1642, Oliver Cromwell received orders to muster troop of cavalry which he had raised in Huntingdonshire and Cambridgeshire and it is presumed that this force joined the parlamentarian army in the midlands. Cromwell seems to have rrived late at the battle of Edgehill (Oct. 23) and then to have ithdrawn on London with the rest of the army. Later his troop eturned to East Anglia and he was appointed a member of both ıe Eastern and the Midland associations. Cromwell, who was romoted from captain to colonel in Feb. 1643, then concentrated n training a double cavalry regiment of 14 troops (later known s the "Ironsides"). He laid great stress on training and morale. oon after the setback at Edgehill he told his cousin John Hampen, "You must get men of a spirit, a spirit that is likely to go on s far as gentlemen will go or else I am sure that you will be eaten still." He insisted upon having "honest and religious men" ı his regiment and tried to ensure that they received prompt pay nd adequate clothing, but both as colonel and later as general e believed in rigorous discipline.

During 1643 Cromwell and his regiment were busy in the eastern ounties. He wanted not only to secure them as a base for parliaent, but by taking Newark in Nottinghamshire to increase the ressure upon the royalists in Yorkshire and cut them off from ıe king's headquarters at Oxford. His first clash with the enemy as at Grantham, south of Newark, on May 13 when his cavalry harged "at a pretty round trot," killed 100 and took 45 prisoners. is superior officers were, however, unwilling to attack Newark ıd by midsummer almost the whole of Yorkshire had been lost) the royalists who sent a force south to attack Peterborough. In ıe cavalry fight at Gainsborough (July 28) Cromwell reformed is men in a moment of crisis in the face of an unbeaten foe. e was commended for his "discretion and valour" and at the ıme time was appointed governor of Ely. When the parliamenarian offensive was resumed in Lincolnshire Cromwell commanded ıe vanguard at the battle of Winceby (Oct. 11), where his horse as killed under him as he led a downhill charge. During the ter part of this campaign he met Sir Thomas Fairfax, whose ilities he respected, but he thought poorly of others of his fellow fficers who he did not believe had their hearts in the war.

"The Great Independent."—In 1644 parliament appointed dward Montagu, earl of Manchester—the richest magnate in romwell's native county of Huntingdonshire—to take command f the new army of the Eastern association. Cromwell became his cond-in-command with the rank of lieutenant general; in fewer an two years, though he was no more than an amateur, his pow's of leadership and his natural skill as a cavalry officer had oved him far up the military ladder. Manchester described him "a very wise and active head, universally well loved as religious id stout" though "a known Independent and favourer of the cts." Cromwell's reputation as "the great Independent"—that one believing in the right of the individual Christian congrega-on to choose its own ministers—was, in fact, already established. A Calvinist and a fatalist, he tried to interpret God's will for himself. Providence, he thought, showed the way by the nature of events. His own regiment, even his original cavalry troop, was reckoned by him to be a "church" moved by the spirit of God. Thus while he was opposed to the Anglican ecclesiastical hierarchy and to all ritual services and ceremonies, he was equally anxious to avoid fastening a rigid Presbyterian system of a Scottish pattern upon the English Puritan congregations. Consequently Cromwell was reluctant to accept the alliance concluded by parliament (1643) with the Scottish covenanters. He agreed, however, to serve on the Committee of Both Kingdoms, which subsequently became responsible for the direction of the war. With the death of John Pym at the end of 1643 and the failure of the earl of Essex as commander in chief, Cromwell was becoming recognized as one of the outstanding Puritan military leaders. He enhanced his reputation during the campaign of 1644.

Campaign of 1644.—At the beginning of 1644 Cromwell carried out harassing operations between Cambridge and Oxford. It was at this time that the second of his four sons, Capt. Oliver Cromwell, died; his eldest, Robert, had died before the war. Soon after, Cromwell had a quarrel with Manchester's third-in-command, Maj. Gen. Lawrence Crawford, a Scotsman whom he accused of punishing junior officers merely for their religious opinions. Most of Manchester's army were Independents or sectarians who looked to Cromwell to protect their freedom of conscience. After acting as a covering force while Manchester stormed Lincoln in May, Cromwell and his cavalry joined the forces besieging York in June and on July 2 formed the left wing at the battle of Marston Moor (*q.v.*) where the king's army suffered its first major defeat of the war. Cromwell and Fairfax, supported by the Scots under David Leslie (afterward Lord Newark), shared the honours of the battle because two of the higher commanders fled the field believing all was lost. The victory was not followed up. Manchester returned to Lincoln and remained inactive for a month; he refused either to move against Prince Rupert, who was in northwest England, or to besiege Newark. Cromwell grew restless; he quarreled with Crawford and was reprimanded by Manchester. He succeeded, however, in inducing parliament to instruct the assembly of divines, which was then considering the future organization of the national religion, to provide an "accommodation" for "tender consciences," and he received the thanks of the house of commons for his services at Marston Moor. In October he took part in the second battle of Newbury, where unfavourable ground prevented his cavalry from making much impression on the royalist defenses. Though he pursued the king toward Oxford, the enemy safely escaped the grip of a larger army.

The New Model Army.—Disgusted by these failures, Cromwell resumed his seat in the house of commons in Nov. 1644 and delivered an attack upon the earl of Manchester. Manchester then declared in the house of lords that Cromwell was a "factious and somewhat inert officer." The Presbyterian leaders even proposed to bring Cromwell to trial as an "incendiary." Thus to military differences were added religious animosities. The charges against Cromwell were not upheld, and he now made the statesmanlike proposal that all should apply themselves to winning the war. He agreed to a suggestion that henceforward no officers who were members of either house of parliament should be allowed to hold any office or command and that a new army should be formed under an impartial nonpolitical general. So the "New Model army" was set up, absorbing the army of the Eastern association; Sir Thomas Fairfax was appointed commander in chief and Cromwell prepared to resign his commission and retire from active warfare. However, the commander in chief was allowed to make new appointments subject to the approval of parliament, and although, after two extensions of his command, Cromwell returned to Ely ready to give up his commission, the post of lieutenant general in the New Model army was significantly left vacant by Fairfax. It seems obvious that Fairfax recognized Cromwell's extraordinary gifts and popularity as a soldier and was determined to re-employ him. At any rate on the eve of the critical battle of Naseby (*q.v.;* June 14, 1645) Fairfax ordered Cromwell to join his army as lieutenant general, even though the house of lords

had not confirmed the appointment. In his dispatch written after the battle Cromwell gave credit to the new commander in chief and his men as well as to God and reminded the house of commons that "he that ventures his life for the liberty of his country" deserved to be protected in his own liberties, including liberty of conscience.

Cromwell now accompanied Fairfax to the southwest and took part in the battle of Langport (July 10) where a royalist army under Lord Goring was beaten. Then he helped to sooth the "clubmen" of Dorset who were anxious to keep both the contending parties out of their county. After being present at the siege of Bristol, he moved into Wiltshire and Hampshire where he besieged Basing house, a royalist stronghold belonging to the Roman Catholic marquess of Winchester. After the garrison, though hopelessly cut off, had refused to yield, the place was stormed. When a breach had been blown no quarter was given and 300 of the defenders massacred. As a result of this severity another royalist strong point surrendered without a fight. Cromwell, whose discipline throughout the campaign was strict, could no doubt have prevented the violence and plundering at Basing house if he had wished. This was to be the pattern of his later conduct at Drogheda in Ireland. He joined Fairfax at Exeter late in Oct. 1645 and winter quarters were established in the southwest. Cromwell's commission was renewed and he was awarded £2,500 a year secured on confiscated royalist estates. In 1646 he took part in the final stages of the siege of Oxford, which brought the first phase of the Civil War to a close. Then he settled with his family in London and became active in the house of commons.

Quarrels of Army and Parliament.—The problems before the victorious parliamentarians were how to reach a constitutional agreement with the king, how to disband the army, how to suppress the continuing rebellion in Ireland and how to frame a satisfactory religious settlement. Cromwell was anxious to come to an understanding with the king who, once the Scottish army had left England early in 1647, was a prisoner. Cromwell wanted a fair deal for the army which had served parliament so faithfully and successfully. He recognized the importance of restoring order in Ireland and he worked ceaselessly for a religious settlement which, while it abolished the bishops and the Book of Common Prayer, would allow freedom of conscience for all Christians within a general framework of order. Most of the remaining members of the commons wanted to demobilize the army as quickly as possible and to recruit volunteers to serve in Ireland. Moreover, there was in the house a predominant Presbyterian element, antagonistic to the sects, which ignored Cromwell's appeals for liberty of conscience. Cromwell expressed his disgust. He told Fairfax that "never were the spirits of men more embittered than now." Although at the request of parliament he tried to persuade the soldiers to accept a compromise on the terms of their demobilization, he found he could not induce them to volunteer for Ireland. As both sides remained adamant, he decided after prolonged hesitations to throw in his lot with the army. He left London and arrived at the army headquarters at Newmarket at the beginning of June. He expressed his approval of the action of Cornet George Joyce, an officer in Fairfax's life guard, in seizing the person of the king and bringing him to the army, though it is doubtful that he had ordered Joyce to do so and he certainly denied that he had given him instructions to move the king from his previous place of captivity.

The quarrel between parliament and the army thus reached a climax. The army moved from Newmarket toward London and compelled the Presbyterian leaders in parliament to flee, but afterward it withdrew. Meanwhile Cromwell and his son-in-law Henry Ireton met the king and drew up a plan for a constitutional settlement, which they hoped would be acceptable both to him and to parliament. However, the entire political situation deteriorated. A mob invaded the house of commons and forced Cromwell's friends in turn to flee, while the Presbyterian leaders came back. In August Cromwell rode with his cavalry into London and after restoring order there began to busy himself in trying to conciliate the different parties. Now not only were the Presbyterians and Independents at loggerheads, but the army itself was divided between those who wanted a conservative constitutional arrangement with the king and the extremists in the rank and file who advocated a democratic system and the abolition of the monarchy and the house of lords. These latter proposals, put forward by a party known as the Levellers, were debated in the army in Oct.–Nov. 1647. In vain Cromwell, who took the chair at these meetings (held at Putney), strove for unity, concord and compromise. Deep passions were aroused. The king took the opportunity to escape from the control of the army and fled to the Isle of Wight, hoping to regain his throne while his enemies quarreled with one another. Cromwell was bitterly disappointed. He felt it was hopeless to go on bargaining with Charles. On Jan. 3, 1648, he told the commons that the king was "an obstinate man whose heart God had hardened." But all through the winter he struggled to formulate an acceptable settlement. He contemplated replacing Charles I on the throne by his eldest son. The king, meanwhile had reached a secret agreement with a party in Scotland to fight on his behalf, and at the same time he inspired a fresh royalist rising throughout England and Wales.

The Civil War: Second Phase.—Fairfax ordered Cromwell to go to south Wales. He concentrated his force at Gloucester and then marched to Pembroke castle where the governor and garrison had changed sides. The siege lasted nearly seven weeks because the castle was massively fortified and had to be starved into surrender (July 11, 1648). Cromwell then made a forced march north to cut off the Scottish invasion. His infantry covered 260 mi. from Pembroke to Pontefract in Yorkshire in 27 days. On Aug. 16, Cromwell having joined Maj. Gen. John Lambert at Knaresborough, a council of war was held and the decision taken to attack at Preston, even though the parliamentarian army of 9,000 men was known to be inferior in number to the Scots. In fact Cromwell encountered only the northern (English) royalist at Preston and destroyed them in an infantry contest. Then he pursued the Scots toward Warrington. At Winwick pass the Scottish infantry was beaten and 6,000 prisoners taken. Finally the Scottish commander, the duke of Hamilton, and his cavalry were forced to surrender (Aug. 25) to Lambert in Staffordshire. Thus the invasion was crushed and the Scots and northern royalists defeated piecemeal. It was Cromwell's greatest triumph as an independent commander. He now turned to clear the north of England and then, on Sept. 21, crossed into Scotland. He entered Edinburgh on Oct. 4, came to terms with the marquess of Argyl and left behind two regiments to lend him support against Hamilton's party. Berwick and Carlisle surrendered to the English and a fortnight later Cromwell was back in Yorkshire to supervise the siege of Pontefract.

Execution of Charles I.—Meanwhile in the south the fighting came to an end. The king still hoped that dissensions among his enemies would enable him to make good terms for his restoration to the throne and negotiations were continuing between him and parliamentary commissioners in the Isle of Wight. However, the army was angry at the renewal of the war and demands were made for the king's deposition and trial. Cromwell himself thought that the royalists had acted shamefully in breaking their promise not to fight again and in inviting the Scottish invasion. He said that to negotiate further with Charles I was to meddle with "an accursed thing." Both the northern and southern sections of the army demanded that "impartial justice" should be done to "all offenders," and eventually Cromwell informed Fairfax that he agreed with this view. He felt that the army had been chosen by God to oppose and fight the king and that providence now ordained his trial as a criminal. These conclusions he reached slowly and painfully in Yorkshire. On Dec. 7, 1648, having been recalled by Fairfax, he returned to London where he approved the purge of the house of commons by the army. He still seems to have hesitated perhaps hoping against hope for a last-minute compromise with the king. Charles, now brought to Windsor as the prisoner of the army, refused all concessions and was determined on martyrdom. Cromwell, who was one of the 135 commissioners appointed to try the king, had finally made up his mind that Charles must die and according to stories told after the Restoration, was active in promoting the verdict of death and inducing his fellow commissioners

rs to sign the death warrant. Cromwell regarded the execution f the king (Jan. 30, 1649) as an act of justice for his crimes, articularly in engineering the renewal of the war, and there is no olid evidence that he ever repented of it.

Cromwell in Ireland.—Cromwell was chosen the first chair- ıan of the council of state—the organ of the purged parliament hat governed England as a republic. The Levellers were disap- ointed at this oligarchical form of government and John Lilburne, heir leader, incited mutiny and threatened to burn down White- all palace. Lilburne was imprisoned and Fairfax and Cromwell ogether suppressed the mutiny, but a threat to the security of the ew republic arose in Scotland and Ireland. Cromwell agreed ı June 1649 to lead a force to Ireland, provided that adequate unds and equipment were guaranteed, and he landed at Dublin n Aug. 13, as lord lieutenant and commander in chief. The roy- list army had suffered a defeat 11 days earlier and the royalist ord lieutenant retired his remaining best troops to the fortified own of Drogheda, north of Dublin. Cromwell stormed the town n Sept. 10–11, when a large part of the garrison was deliberately ut to the sword because it had refused quarter and had defended he breach in the wall. Cromwell was justified in inflicting this unishment by the current laws of war, but he himself wrote after- ard that "this was a righteous judgment of God upon these bar- arous wretches, who have imbrued their hands in so much nocent blood, and that it will tend to prevent effusion of blood r the future; which are the satisfactory grounds for such actions, hich otherwise cannot but work remorse and regret." The mas- acre struck terror into the Irish, who surrendered several for- esses without fighting. Wexford resisted on Oct. 11, and there as again great slaughter after the first assault had been repulsed, lthough there it was accidental rather than intentional. In No- ember Waterford also resisted strongly. By the end of 1649 uch of the coast of Ireland was in Cromwell's hands. He then oved his army inland and took a number of fortresses in Munster nd the Irish capital of Kilkenny. After the surrender of Clonmel rly in May 1650, he returned to England, having been recalled ecause of a new danger from Scotland.

Cromwell in Scotland.—The Scottish covenanters had de- ared Charles II to be king and refused to recognize the English epublic. The English parliament retorted by sending an army nder Cromwell to invade Scotland. Since Fairfax had refused to ke this command, Cromwell became (June 26, 1650) by act of rliament captain general and commander in chief as well as re- ining the title of lord lieutenant of Ireland. He entered Scotland n July 22 with an army of 10,500 foot and 5,500 horse. He spent month in marching around Edinburgh and in fruitless skirmishes ecause the Scots refused to be drawn into a battle. He lost nearly half of his army through sickness, ran short of supplies and nally led his men back to the port of Dunbar, east of Edinburgh, await reinforcements. The Scots, under Leslie, had, however, utmaneuvered the English and by occupying a position 2 mi. S.W. Dunbar on Doon hill had cut them off from their home bases. herefore, when Leslie brought his men down from Doon hill on ept. 2, Cromwell decided to surprise him by attack at dawn next y. The Scots repulsed the first English assault, but at the criti- l moment Cromwell threw in his reserve of one cavalry and three fantry regiments. The Scots, cramped in the centre and on their ft wing, were almost annihilated. Next day Cromwell's forces cupied Edinburgh (although the castle held out until Christmas ve) and he then confronted the remaining Scots, who were well rtified in a position south of Stirling. In Feb. 1651 Cromwell as taken ill with malaria contracted in Ireland and it was not un- June that active campaigning was resumed. He then sent mbert across the Forth to turn the Scottish position. This ac- mplished, the bulk of the English army followed and threatened e Scots' rear, and the Scots took the obvious course open to them d crossed the border into England.

Cromwell was not surprised by this countermove and felt con- lent of checking and then overtaking the invading army. Leav- g Col. George Monck behind to secure Scotland, Cromwell sent ead his cavalry and followed with the infantry into Yorkshire. hile Charles II was reaching Worcester on Aug. 22, having picked up fewer recruits on his way than he had hoped, Cromwell blocked the king's further advance at Evesham. By dividing his forces he was able to attack Worcester from two sides. A bridge of boats was thrown across the river Severn south of the town and Cromwell in person led the way across. Charles II tried to break out of the city to the east, but Cromwell recrossed the river and rode at the head of a successful counterattack. He described the battle of Worcester (Sept. 3) as a "crowning victory."

LORD PROTECTOR

End of the Rump Parliament.—As commander in chief Cromwell lived, from the end of 1651 onward, in official residences at the Cockpit in Whitehall and at Hampton Court palace. He had been assigned an additional income out of more confiscated royalist estates and became a comparatively wealthy man. In 1652 he pressed for an amnesty to royalists, urged the reform of the law and wanted a new parliament to be elected under a fresh constitution. In Nov. 1651 the house of commons had agreed to have an election three years later, but Cromwell still felt unsatisfied and worked for the reform and strengthening of the republican government. The Anglo-Dutch naval war also disturbed him, as he did not care for fighting against fellow Protestants, but he did his duty as a commander and member of the council of state. Gradually antagonism sprang up between the army leaders and the civilian members of the Rump parliament who were freely accused of feathering their own nests at the republic's expense. In April 1653, after all attempts at a compromise between the two sides had failed, Cromwell took a guard of soldiers and, having accused the members of injustices and corruption, forcibly dissolved the house of commons. In its place the council of the army selected 140 men from a list of names submitted by the congregational churches both to legislate and to direct the government. This assembly became known variously as the Little, Nominated or Barebone's parliament and was afterward described by Cromwell as a tale of his own "wickedness and folly." On Dec. 12 Lambert, after drawing up a new constitution known as the Instrument of Government (*q.v.*), engineered the dissolution of the Little parliament, which delivered up its powers to Cromwell from whom it had first received them.

Lord Protector.—According to the terms of the Instrument of Government, Cromwell became lord protector of the Commonwealth of England, Scotland and Ireland and was assisted in the execution of his duties by a council of state. Legislation was to be initiated or approved by a "freely elected" unicameral parliament which was required to sit for at least five months every three years. On Dec. 16, 1653, Cromwell took the oath as lord protector and on Sept. 3, 1654, addressed his first parliament. The freely elected protectorate parliament at once showed itself unwilling to accept the constitution that had been fastened on the country by the army's leaders. Thereupon Cromwell, insisting that the constitution had received the implicit consent of the nation, told the members of the new parliament that they must accept the "fundamentals" of the new rule if they wished to keep their seats. Apart from 100 convinced republicans the members agreed to do so, but were still more concerned with rewriting the constitution than reforming the laws as desired by the protector. As soon as he could legitimately do so (Jan. 22, 1655), Cromwell dissolved parliament. By this time some royalists hoped to profit from the dissensions between the Cromwellians and the rest by planning an insurrection, which began the following March in Wiltshire. To maintain internal security Cromwell then instituted a system of regional government whereby the country was divided into 11 districts, each governed by a major general commanding police forces of horse militia. The system was financed by a 10% tax, or "decimation," levied upon royalists. Soon afterward, the Dutch war having ended in April 1654, the Commonwealth government became involved in a war with Spain. The lord protector summoned a new parliament, which met in Sept. 1656, in order to raise money for this war.

The second protectorate parliament was, as far as possible, handpicked by Cromwell's officials. About 100 of its members were more or less committed Cromwellians and another 100 of Crom-

well's republican critics were forbidden to take their seats. The remaining members then approved the war with Spain and voted money for its continuation. Nevertheless, even this carefully packed assembly refused to approve the method of government through major generals. In order to try to establish a more permanent and acceptable constitutional system a number of Cromwell's civilian supporters and lawyers then proposed that he should assume the crown and become a constitutional king. In return for this "feather in his cap," as he called it, the protector was asked to agree to the setting up of a second house of parliament and to the commons in the future controlling its own election returns. These proposals were carefully considered by Cromwell, who accepted the arguments for returning to a method of government in tune with tradition and the common law of the land. Most of his friends in the army, however, fiercely objected to his becoming king and to the destruction of the republic. In May 1657 Cromwell finally refused the offer of the crown but agreed to a new constitution, which was known as the Humble Petition and Advice (*q.v.*). When the second protectorate parliament was recalled to approve the constitution, opposition in the commons became violent. On the one hand, the members who had been excluded by the army in 1656 resumed their seats; on the other, many of Cromwell's supporters could not sit because he had already nominated them for membership of the new upper house. The republican leaders in the commons refused to recognize this upper house and expressed their intention of sabotaging the new constitution. Within a fortnight Cromwell lost his temper, and in Feb. 1658 dissolved parliament. For the remainder of his life he ruled without a parliament, although it seems certain that he intended to summon one later in 1658.

ACHIEVEMENTS AND CHARACTER

Cromwell's Foreign Policy.—As the ruler of England Cromwell was more successful in the direction of foreign than of domestic affairs. The Dutch war was brought to an advantageous conclusion, the treaty of Westminster of April 1654 providing for the security of British commerce and respect for British naval supremacy in British waters. The Dutch also promised to abandon support for the royalists. Commercial treaties, all favourable to British trade, were concluded with Sweden, Denmark and Portugal. Once peace was established, so strong was the Commonwealth that its alliance was sought by the rival Catholic powers, France and Spain. Cromwell and his council of state hesitated between them. Eventually religious considerations swayed the decision. It was felt that the French Protestants could best be helped by an alliance with the milder French monarchy while the bigoted Spanish Catholic monarchy might be attacked from the sea as in Elizabethan times and part of the Spanish empire captured in the name of Protestantism as well as of trade. Even before the war was officially declared the protectorate government sent a naval expedition to the Spanish Indies, which secured Jamaica. Another expedition under Gen. Robert Blake advertised British naval power in the Mediterranean. War with Spain began in the autumn of 1655. A mainly commercial treaty was concluded with France at about the same time and was followed in March 1657 by an Anglo-French offensive military alliance. Cromwell promised to send an expeditionary force of 6,000 soldiers, as well as a fleet, to attack the Spaniards in the Low Countries. There the English soldiers fought with distinction and, in accordance with the terms of the alliance, the French reluctantly handed over the conquered ports of Dunkirk and Mardyke to the English Commonwealth. Earlier in April 1657 Blake had defeated a Spanish fleet at the battle of Santa Cruz. In Feb. 1658 Cromwell's ambassador mediated a peace between Sweden and Denmark, although before his death that war broke out again in the Baltic. Relations between the English and Dutch remained uneasy. Cromwell's grand schemes for a European Protestant alliance were never realized, but British prestige was nevertheless high during the protectorate.

Cromwell's Domestic Policy.—Most of Cromwell's domestic legislation was repealed at the Restoration. Nevertheless, important reforms of the law—such as the decision that in the future the language of the common-law courts should be English—were retained. However, attempts to reform the chancery law and to reduce the severity of the criminal code were resisted by lawyers and blunted by the intransigence of the members of Cromwell's parliaments. The policy of the navigation acts introduced to encourage British merchant shipping was confirmed and strengthened by the parliaments of Charles II. The legislative union of England, Scotland and Ireland, which formed part of the constitutional settlement of the protectorate and brought some material benefits to the Scots and Irish, was not continued at the Restoration. In his youth Cromwell had been a fanatical Puritan determined to destroy the bishops. As protector he showed himself increasingly tolerant and even liberal minded in his religious views. Although in 1648 parliament agreed to establish Presbyterianism as the national religion of England, Cromwell saw to it that complete freedom of worship was allowed to all Puritan sects. He tried to protect Quakers and even Unitarians from the full fury of his parliaments and permitted some Anglican and Roman Catholic services to be held in private houses.

Family and Characteristics.—Before he died Oliver Cromwell nominated his eldest surviving son, Richard, to succeed him as protector in accordance with the terms of the Humble Petition and Advice. He was also survived by another son, Henry, who rose to be lord lieutenant of Ireland, and by three daughters—Bridget, who was married first to Henry Ireton and then to Charles Fleetwood; Mary, married to Lord Fauconberg; and Frances, married to Robert Rich, grandson of the 2nd earl of Warwick. Another daughter, Elizabeth (married to John Claypole), who was said to have been Cromwell's favourite, predeceased him by four weeks. His widow lived in retirement until her death in 1672. Oliver Cromwell died of malaria in London on Sept. 3, 1658, and after a big public funeral was buried in Westminster abbey. At the Restoration his bones were hung up at Tyburn gallows and his severed head placed on a pole on top of Westminster hall.

Oliver Cromwell was just under six feet tall with long hair and gray-blue eyes. Though a man of fierce passions, he was, except on the battlefield, slow in reaching decisions. He was a born leader and soldier. His hobbies included hunting, hawking and music, and he liked smoking and an occasional glass of wine. By nature he was neither cruel, tyrannical nor intolerant, but his fatalistic religion and the strictness of his military discipline have given posterity an impression of puritanical severity that is perhaps scarcely justified. *See* CIVIL WAR, ENGLISH; ENGLISH HISTORY. *See* also references under "Cromwell, Oliver" in the Index volume.

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CROMWELL, RALPH (*c.* 1394–1456), 3rd Lord Cromwell, one of the wealthiest men of his time, was treasurer of England from 1433 to 1443. After a military career under Henry V he was appointed in 1422 to the council of regency for Henry VI and became chamberlain of the exchequer soon afterward. An associate of Henry Cardinal Beaufort, he lost his office when Beaufort suffered temporary eclipse in 1432. Both men justified themselves before the lords in parliament and returned to power after the intervention of John, duke of Bedford, in 1433. As treasurer Cromwell attempted reforms but was soon defeated by the impossible tangle of Lancastrian finances. He resigned when Beaufort retired in 1443, and soon joined the inchoate "Yorkist" group, leading the attack in 1449 upon William de la Pole, duke of Suffolk, Beaufort's successor in power. Cromwell was later denounced by Richard Neville, earl of Warwick, as instigator of the first battle of St. Albans (1455). But the Wars of the Roses had not really begun when Cromwell died, childless, on Jan. 4, 1456.

Cromwell's wealth was formidable, amassed through inheritance, through his marriage to Margaret, daughter of John, Lord Deincourt, through the acquisition and improvement of land, the spoils of office and government finance. A conservative modern

stimate, based on his accounts, assesses his net annual income from nd alone at about £1,000 in 1429–30 and at over £2,000 in 1453–4; a less conservative contemporary thought his annual expenses me to £5,000. But he did not hoard. He built castles at Tattershall in Lincolnshire and at Wingfield in Derbyshire; possibly e tower on the moor near Woodhall in Lincolnshire was erected him. He put up new buildings at Colley Weston, Northamptonire, and founded a college at Tattershall. Lawsuits in land inerited or purchased added to his costs, and he was alleged "comonly" to ride to London with 120 horsemen.

See Lord Curzon of Kedleston and H. A. Tipping, *Tattershall Castle* 929).

CROMWELL, RICHARD (1626–1712), lord protector of ngland, eldest surviving son of Oliver Cromwell and Elizabeth ourchier, who unsuccessfully attempted to carry on his father's le as leader of the Commonwealth. Born on Oct. 4, 1626, he rved in the parliamentary army and in 1647 was admitted a mem- r of Lincoln's Inn. In 1649 he married Dorothy, daughter of ichard Mayor or Major, of Hursley in Hampshire. He repreented Hampshire in the parliament of 1654 and Cambridge uniersity in that of 1656, and in Nov. 1655 was appointed one of the uncil of trade. He was not brought forward by his father or epared in any way for his future great position, and lived in the untry occupied with field sports until after the institution of the cond protectorate in 1657 and the recognition of Oliver's right to me his successor. On July 18 he succeeded his father as chancel- r of the University of Oxford; on Dec. 31 he was made a member the council of state and about the same time obtained a regiment d a seat in Cromwell's house of lords. He was received generly as his father's successor and was nominated by him as such on s deathbed. He was proclaimed on Sept. 3, 1658. Richard not ing "general of the army as his father was," his elevation was stasteful to the officers, who desired the appointment of a comander in chief from among themselves, a request refused by ichard. The officers in the council, moreover, showed jealousy the civil members, and to settle these difficulties and to provide oney a parliament was summoned on Jan. 27, 1659, which deared Richard protector, and incurred the hostility of the army by verely criticizing the arbitrary military government of Oliver's lt two years and by impeaching one of the major generals. A uncil of the army accordingly established itself in opposition to e parliament and demanded on April 6 a justification and confirmation of former proceedings, to which the parliament replied forbidding meetings of the army council without the permission the protector and insisting that all officers should take an oath rt to disturb the proceedings in parliament. The army now broke io open rebellion and assembled at St. James's. Richard was mpletely in their power; he identified himself with their cause d the same night dissolved the parliament. The Long parliaent (which reassembled on May 7) and the heads of the army me to an agreement to effect his dismissal and in the subsequent events Richard appears to have played a purely passive part, using to make any attempt to keep his power or to forward a storation of the monarchy. On May 25 his submission was mmunicated to the house. He retired into private life, heavily ndened with debts incurred during his tenure of office and narrly escaping arrest even before he left Whitehall. In the sumer of 1660 he went to France, where he lived in seclusion under e name of John Clarke, subsequently going elsewhere, either (the counts differ) to Spain, to Italy or to Geneva. He was long rearded by the government as a dangerous person, and in 1671 a ecret search was made for him but without avail. He returned to England about 1680 and lived at Cheshunt, in the house of Serjeant Pengelly, where he died on July 12, 1712, being buried at Hursley, Hampshire. According to Mrs. John Hutchinson in her *Life of Colonel Hutchinson* (1885), Richard Cromwell was "gentle and virtuous but a peasant in his nature and became not greatness."

See R. W. Ramsey, *Richard Cromwell, Protector of England* (1935).

(P. C. Y.)

CROMWELL, THOMAS, Earl of Essex (1485?–1540), English statesman, architect of the Reformation and the minister responsible for effecting the dissolution of the monasteries. He was born in Putney, the son (probably) of Walter Cromwell, alias Smyth, a brewer, blacksmith and fuller. His early life is obscure, neither the older legends (preserved in John Foxe's *Book of Martyrs*) nor later researches being very reliable on this point. It appears that he went abroad at an early age and spent some time in Italy, possibly serving there as a soldier in the French army and certainly engaged in getting to know the world. For several years after 1510 he was resident at Middelburg and Antwerp in the Low Countries; he seems to have been closely connected with the London Merchant Adventurers, though there is no evidence that he was ever of their company. By 1520 he had entered Thomas Cardinal Wolsey's service and from that time his career is well documented. In the first place he seems to have added legal training to his commercial experiences. In 1524 he was admitted a member of Gray's Inn and for about eight years he acted as the cardinal's solicitor. His practice was not confined to Wolsey's affairs but included legal services to noblemen, gentlemen and merchants. He continued his trading activities and may have acted as a moneylender. In 1523 he sat in parliament, leaving on record his interest in its business and a speech (which may never have been delivered) attacking Wolsey's foreign policy. Wolsey employed him in 1525 about the dissolution of some lesser monasteries whose property was used to endow the cardinal's colleges at Ipswich and Oxford; in this work he earned a good deal of dislike. However, the cardinal continued to favour him and Cromwell soon occupied something like the position of his man of business and confidential adviser.

Thus, when Wolsey fell into disgrace in 1529, Cromwell was faced with a difficult problem. His enemies were trying to involve him in his master's fate and he, therefore, decided on a characteristic and bold stroke. He determined to bring himself to the king's notice and to do this by entering the parliament that met in Nov. 1529. Utilizing his private connections but also obtaining slight encouragement from Henry VIII, he got a seat at Taunton at the last moment. For nearly three years he worked his way up in the royal favour, entering Henry's service early in 1530, being sworn of the council toward the end of that year and reaching the inner circle of confidential advisers a year later. All the time he was establishing his ascendancy in the house of commons. In 1532 he at last obtained office (that of master of the jewels); to this he added others in the next four years, of which the most important were principal secretary and master of the rolls in 1534 and lord privy seal in 1536. The last office was combined with a peerage, and he took the title of Lord Cromwell of Wimbledon.

Cromwell and the Reformation.—The question of Cromwell's part in the Henrician Reformation has caused much debate. At one time he was credited with supplying Henry with a complete plan as early as 1529; later it became usual to see in him nothing but the king's most competent executive agent. The truth seems to be that he was in no way in charge until early in 1532, taking over when the king's policy of forcing the pope to come to terms by bluster and blackmail had quite clearly proved a failure. It was, to all appearances, Cromwell who then came forward with a clear notion of how to achieve Henry's purpose without the pope. His policy consisted in making a reality of some large and vague claims to supreme power which Henry had uttered at intervals. He proposed to destroy Rome's power in England and to replace it by the royal supremacy in the church. He was behind the first attacks on the papacy (1532), the act against the payment of annates (first-year revenues of benefices and sees that were paid to the pope) and the Supplication Against the Ordinaries, a protest used to secure the submission of the clergy to the king in matters of legislation. The second of these documents was devised by Cromwell on the basis of genuine complaints by the commons against church courts of which he had taken charge as early in 1529. In 1533 he secured the passage of the great Act in Restraint of Appeals to Rome whose preamble embodied his political theory. Thereafter he was in complete control of the government, though he remained careful to pretend to be acting on the king's authority. In 1534 he completed the erection of

the royal supremacy with the passing of the Act of Supremacy; the year after he turned to its exploitation. Political and financial reasons counseling an attack on the monasteries, he was appointed the king's vicar-general with powers to visit and reform all monastic institutions. An earlier survey (1535) established the details of all ecclesiastical property in England in the *Valor Ecclesiasticus*, a remarkable achievement of administrative efficiency. In the second half of 1535 Cromwell's agents visited the monasteries to collect evidence of corruption, worldliness and scandal, and (in theory) to amend these abuses. However, next year this evidence (which was not so much invented as highlighted) was used to justify the dissolution of all the smaller monasteries. Despite such difficulties as serious risings in the north, the task was carried out relentlessly. During 1537–40 the surrender of the greater houses was obtained by pressure and persuasion and by 1540 all monastic institutions had ceased to exist, their property being vested in the crown. Cromwell and other crown officials obtained valuable grants as rewards, but while the minister lived the new wealth was not squandered.

In 1536 Cromwell was also appointed the king's vicegerent in spirituals, that is, his deputy as head of the church. As such he presided in convocation and issued the Injunctions of 1536 and 1538 which began a cautious advance toward a Protestant Reformation by ordering that every parish should possess an English Bible, by attacking some excesses in the practice of pilgrimages and image worship, and by attempting a much-needed reform of the clergy. Cromwell's own religious views have been in much doubt. Certainly the old notion of his Protestant zeal will not stand up to examination but neither will the later view that he had no religion at all. Essentially his was a secular temper. He had had a most unusual training for a king's minister and his early life seems to have equipped him with a healthy amount of disillusionment and skepticism, but his character was essentially positive and he had a faith, even if it was not very ardent and liable to be subordinated to political considerations. As he once told some Lutheran envoys: on the whole he was of their mind in matters of religion, but "as the world now stood he would believe even as his master, the king, believed." Nevertheless, he came to be firmly associated with a radical policy of reform and Reformation. In the main this resulted from difficulties abroad. While hostility between France and Spain had prevented foreign intervention in the critical years 1533–36, there seemed a danger of an alliance against England after that date. Cromwell, whose forthright and clear-sighted temper was less well suited to the conduct of foreign affairs than Henry VIII's skilful opportunism, involved himself in projects of a Lutheran alliance distasteful to the king who wished to stand on Catholic orthodoxy. In 1539 the minister's enemies at home secured a triumph in the passage of the anti-Protestant Act of Six Articles, and though Cromwell recovered his ascendancy he then made the mistake of trying to force the king to his side by compelling him into marriage with Anne of Cleves. The king from the first hated his fourth wife and by Feb. 1540 it was clear that the alliance with the German princes which she represented was unnecessary. Thereafter Cromwell's fall came quickly. He fought back for a few months, being created earl of Essex and lord great chamberlain as late as April 1540, but early in June his enemies persuaded Henry that his vicegerent was a heretic and a traitor. He was arrested on June 10, condemned without a hearing by act of attainder and executed on July 28. His fall did not end the Reformation, but it marked the end of competent government and purposeful policy in Henry's reign; the king soon regretted that he had listened to the lies of Cromwell's foes.

Achievements and Character.—Although he conducted affairs for a bare eight years, Cromwell can lay claim to remarkable achievements. It was his mind and his conception of the state that underlay the revolution known as the Henrician Reformation. The basis of Cromwell's thought was the notion of the sovereign national state which in practice he established by the expulsion of the papacy. He was greatly interested in political theory, being well acquainted with the work of Marsilius of Padua and collecting around himself theorists and thinkers whom he employed to translate ideas into formal plans. It seems improbable that he knew Machiavelli's writings, as was once alleged. As for his conception of the English state and monarchy, the old views which charged him with favouring despotism and wishing only to serve the royal will must be abandoned. His central idea was that of the supremacy and omnipotence of statute, or (as it came to be called) the legislative sovereignty of the king in parliament. In other words, he wished to establish unlimited sovereignty in the hands of a monarchy limited by dependence on consent. His work in parliament—managing elections, drafting statutes, piloting legislation—makes him the first of a long line of English parliamentary statesmen. He also showed himself aware of the need for providing practical management of a new kind. No minister before him, and few after, exercised such pervasive influence over every detail of administration. More, he undertook a complete overhaul of the king's government, and here too he proved that he could seize on a great principle and apply it in detail. The administration which he took over was based on the principles of medieval government which centred upon the king and the men who surrounded him in his household. Cromwell began, and to a large extent carried through, a reconstruction which replaced this sort of "household administration" by a national administration divorced from the person of the king and dependent on civil service departments. This aspect of his work endured, through many reforms, until the great changes of the 19th century. In economic affairs he stood for the encouragement of the English cloth trade (which meant peace with Spain), tried to prevent the uncontrolled private exploitation of land and sponsored the first well-considered attempt to solve the problems of poverty and unemployment.

Cromwell's greatness as a constructive statesman cannot thus be in doubt. Of his character it is harder to speak with such certainty. He was entirely ruthless (though, since he lacked passion, he was not bloodthirsty like Henry VIII), concerned only with carrying through his plans and devastating to opposition. He enriched himself greatly, but it was noticed that he spent as freely as he got. His friends liked him very well, but of necessity a man of such outstanding revolutionary achievements had many more enemies who hated him devotedly. If he had a private life, almost nothing is known of it. His only son, Gregory, who showed no trace of his father's ability or ambition, was restored to his lands in 1541.

Bibliography.—R. B. Merriman, *Life and Letters of Thomas Cromwell* (1902), assembles the better part of the known facts but is heavily marred by a complete lack of understanding. There is a good biography: A. G. Dickens, *Thomas Cromwell and the English Reformation* (1959). Cromwell's work in government is dealt with in G. R. Elton, *Tudor Revolution in Government* (1953). For Cromwell's political theory *see* also W. G. Zeeveld, *Foundations of Tudor Policy* (1948).
(G. R. E.)

CRONACA, IL (Simone del Pollaiuolo) (1457–1508), Italian architect, was not related to Antonio and Piero Pollaiuolo (*q.v.*) and according to Vasari it was his accurate accounts of the marvels of Rome that earned him the nickname of "Il Cronaca" (the chronicler). Born in Florence, he stayed in Rome (*c.* 1475–80) and then returned to Florence. He designed the courtyard and the monumental cornice of the Palazzo Strozzi there, the cornice being a clear result of his study of Roman architecture. His responsibility for the church of S. Francesco al Monte, Florence, is documented and it seems likely that he built the sacristy of S. Spirito in accordance with a design by Giuliano da Sangallo.

See G. Vasari, *Lives of the Most Eminent Painters*, English trans. by G. du C. de Vere (1912–15).
(L. D. Er.)

CRONJE, PIET ARNOLDUS (*c.* 1835–1911), Boer general who played a prominent part in the early stages of the South African War, was born in the Cape Colony but was taken in early life to the Transvaal, during the Great Trek. There, in Nov. 1880, he began the rebellion against British rule, leading resistance to the distraint of goods of a farmer who had refused to pay taxes. In the war that ensued, he was commandant at Potchefstroom and forced the surrender of the British garrison just as a general armistice was being arranged (March 1881). Later he entered the *volksraad* (parliament) of the South African Republic, where he supported Pres. Paul Kruger. He became

superintendent of natives and a member of the executive council. In 1896 he commanded the Boer force which captured the Jameson raiders at Doornkop (Jan. 2). When the South African War broke out in 1899, Cronje, now a general, assumed supreme command in the west and began the siege of Mafeking. After a number of engagements, he repulsed a general attack on his position at Magersfontein (Dec. 11, 1899), thereby checking for two months the northward advance of the British column. In the campaign of Feb. 1900 Cronje, still at Magersfontein, opposed Field Marshal Lord Roberts' army but failed to prevent the relief of Kimberley. Retreating westward, he was surrounded at Paardeberg where, after inflicting very heavy losses on the British, he was forced to surrender with about 4,000 burghers (Feb. 27, 1900). Cronje was a courageous and successful leader of men, but his thinking was slow and inflexible and his strategy faulty. He was, moreover, handicapped by the weak leadership of the commandant general, Piet Joubert, and the poor discipline characteristic of the Boer commandos early in the war. He was a prisoner of war at St. Helena until the end of the war (1902). He retired subsequently to Klerksdorp, Transvaal, dying there on Feb. 4, 1911. *See* SOUTH AFRICAN WAR. (N. G. GA.)

CRONUS, an ancient deity, most likely belonging to the pre-Hellenic population of Greece and not much worshiped by the Greeks themselves. The etymology of the name is unknown but is probably not Greek; the derivation from *chronos,* "time," is impossible. Cronus' functions are connected with agriculture; in Attica his festival, the Kronia, at harvest time, resembled the Saturnalia. In art he is shown as an old man holding an implement, probably originally a sickle but interpreted as a *harpe,* or curved sword.

In mythology he is the son of Uranus (Heaven) and Gaea (Earth). Many of Uranus' children were monsters, so he hid them in the earth as soon as they were born. Gaea at first mourned, then begged her children to help her revenge herself on their father. Cronus alone consented; Gaea gave him the *harpe,* with which he castrated Uranus. In this way Cronus (like similar heroes in Maori, near eastern, Indian and Chinese myth) separated heaven from earth. He now became the lord of his brothers, the Titans and monsters, and shut up the most dangerous of these (the *Hekatoncheires* or Hundredhanded Ones) in Tartarus. He took for consort his sister Rhea; and, warned by his parents that his own child would overthrow him, swallowed Hestia, Demeter, Hera, Hades and Poseidon as soon as they were born. But when Zeus was born, Rhea hid away the infant in Crete and tricked Cronus into swallowing a stone instead. Zeus grew up, made Cronus disgorge his brothers and sisters, waged war on Cronus and was victorious. (The stone, which Cronus had also brought up, later was shown and venerated at Delphi.)

After his defeat by Zeus, different versions of his story make Cronus either a prisoner in Tartarus (or on an island near Britain, guarded by the *Hekatoncheires*) or king of the Golden Age. According to this latter legend, men lived in a state of paradisal innocence under his rule, and the earth bore all its fruits untilled. Cronus in time was rationalized into a great and beneficent western king, hence the late and artificial Italian tale that he was welcomed to the future site of Rome by Janus, the god of beginnings (also rationalized into a king), founded a city there and taught the people navigation, coinage and other skills.

Because of his swallowing of his children, Cronus is frequently identified with foreign gods, notably with the Semitic *baalim* (*e.g.,* Baal Saturnus on numerous Roman inscriptions at Carthage) and with Moloch, to whom human sacrifices, particularly of children, were made.

See H. J. Rose, *A Handbook of Greek Mythology* (1933).
(D. E. W. W.)

CROOK AND WILLINGTON, an urban district in the North-West Durham parliamentary division of Durham, Eng., lying on the western edge of the Durham coal field, Crook being 9¾ mi. and Willington 7½ mi. S.W. of Durham. Pop. (1961) 25,257. Crook is the bigger of the two towns and lies in a valley in the west of the district below the uplands, which there rise to more than 1,000 ft. Willington lies in the eastern part of the district about ½ mi. N. of the Wear river. It is a colliery town and Brancepeth colliery, the largest of the seven in the area, is immediately to its northeast. In the town is a Miners' Welfare hall. Old buildings in the district include the farm of High Woodifield, with a medieval servery; Hunwick hall, dating from the 14th century; and Witton tower, the main tower of which dates from the 16th century. Besides coal mining, the chief industries are the making of machinery for drawing tubes and wires and the manufacture of clothes and firebricks, silica bricks and fireclay.

CROOKES, SIR WILLIAM (1832–1919), English chemist and physicist and discoverer of the element thallium, was born in London on June 17, 1832. He studied chemistry at the Royal College of Chemistry and became an assistant under A. W. von Hofmann (*q.v.*). In 1854 he became assistant in the meteorological department of the Radcliffe observatory, Oxford, and in 1855 he obtained a chemical teaching post at Chester. He inherited a large fortune from his father, who had come to London as a poor tailor. From the time of his marriage in 1856 to Ellen Humphrey he lived in London, devoting himself uninterruptedly to scientific work of various kinds. He founded (1859) and conducted the *Chemical News* until 1906. He had a private laboratory at his house in Kensington Park gardens. He was knighted in 1897 and received the Order of Merit in 1910. He died in London on April 4, 1919.

In 1861 spectroscopic observations on the residue from the manufacture of sulfuric acid led Crookes to the discovery and isolation of thallium, a specimen of which was shown in public for the first time at the exhibition of 1862. In the course of investigations on the properties of thallium he observed the curious behaviour of the hot element while it was being weighed in a vacuum. This led Crookes to construct the radiometer (*q.v.*).

His researches on the electrical discharge through a rarefied gas led to the observation of the dark space which bears his name, and he developed his theory of "radiant matter" or matter in a "fourth state." He invented numerous devices to study the behaviour of cathode rays. On the discovery of radium he took up the study of its properties. He invented the spinthariscope which shows the presence of traces of radium salt by the production of phosphorescence on a zinc sulfide screen.

Crookes was constantly consulted by the government on chemical questions, and one of his many practical contributions to the public welfare was his production of a glass which would effectively shield the eyes of workers from the deleterious heat rays and ultraviolet light emitted from molten glass. Crookes wrote or edited various books on chemistry, including *Select Methods of Chemical Analysis,* which went through a number of editions.
(R. E. O.; X.)

CROOKES' TUBE: *see* X-RAYS: *Basic Theory.*

CROP DRYING AND PROCESSING. Farm crops are perishable by nature and except for those used immediately all require some attention to keep them in suitable condition until used. Treatments for this purpose can be classed as crop processing, as distinct from food processing or product processing, which are for the purpose of making a product more suitable for food or other use.

The simplest crop-processing methods are those which rely almost entirely on the climate or the property some crops have of tending to condition themselves against fast spoilage. For example, grains in many climates, if left in the field, will become dry enough to last for a long time. Some fruits and vegetables such as potatoes, with suitable exposure, will cure to a condition that protects them against rapid deterioration.

Crop processing, even when most of the treatment is left to nature, is mostly a matter of control of moisture or temperature or both. There are processing methods in which other factors are controlled, such as making silage, in which the composition of the air is important, but for the most part safe preservation of crops depends on cooling or drying. *See* also CROP-PROCESSING MACHINERY.

REFRIGERATION

Fresh fruits and vegetables are particularly responsive to cool-

ing. These products continue to live after harvest and in the process of living gradually consume themselves to the point where they become useless. The rate of self-consumption depends largely on the temperature. Refrigeration is therefore one of the important crop-preserving processes. In addition to slowing the life processes of the product itself, cooling tends to prevent the activity of microorganisms. In most cases it is desirable to reduce the temperature to just above the product's freezing point. However, some products will not tolerate cooling below certain levels. For example, bananas are damaged by temperatures below about 50° F. Most fresh fruits are damaged by temperatures below their freezing points, which are usually between 28° and 32° F.

Cooling is accomplished by ventilating with cool night air, by evaporative cooling, by cold water or by mechanical refrigeration. Mechanical refrigeration provides the most positive control of the process. Precooling, or cooling prior to storage or transit, is usually done in conjunction with storage or transit refrigeration. For some products it is common practice to precool them in refrigerator cars before shipment. For further discussion of refrigeration *see* Food Preservation; Refrigeration: *Applications of Refrigeration.*

DRYING

For many crops, drying is even more necessary than cooling. Forages and grains are in this category. Methods for aiding natural drying are as old as agriculture. Hay may be left in the field after cutting, spread on the ground for exposure to the sun and wind. In some climates this can be done with very little hazard. In northern Europe hay is often stacked over poles standing in the fields to allow exposure to the wind and protection against rain. In South and Central America coffee beans, which are harvested in a moist condition, are spread in thin layers on huge trays that can be exposed to the sun in the daytime and slid into sheds at night. In North America corn is harvested with the kernels still on the ears and stored in cribs. These are relatively narrow buildings having slatted sides, with the slats close enough together to hold the ears, but open enough to permit the wind to blow through the stored corn. (W. V. Hl.)

Artificial Drying.—Special handling of crops or use of machines to dry the crops sufficiently to prevent spoilage in climates where natural drying is precarious has a long history. The earliest account of artificial crop drying is probably Jethro Tull's description of an Oxfordshire farmer's success in drying grain in a malt kiln about 1700 (*Horse-Hoeing Husbandry,* 1733). In 1866 George Dyson patented a stack drier consisting of a hollow vertical cylinder through which air was blown or from which it was removed by a fan. Both James Paxman and W. A. Gibbs exhibited driers at the Royal Agricultural society's show in 1869, and Gibbs also invented a haymaking machine that agitated the unstacked hay while hot air was driven through it.

In 1919 Charles Tinker of Kilmartin patented a stack drier consisting of a cone-shaped coil of steam-heated pipes around which the crop was stacked, the drying being done in a Dutch barn. The Institute of Agricultural Engineering at Oxford experimented with stack drying from 1923 to 1925. By 1938 there were 96 centres for drying in Great Britain.

In the United States experimentation with artificial drying did not begin until 1910. The design of the first drier for forage crops was inspired by lumber kilns. By 1915 several commercial companies had produced driers, but interest lagged until 1925, when emphasis began to be placed on hay and forage crops as substitutes for cotton in the southern states. Independently, Arthur J. Mason, an engineer interested in preserving alfalfa, built an experimental plant at West Point, Miss., in 1911, patented a conveyer drier in 1916 and by 1926 made installations at Plainsboro, N.J.

The artificial drying of grass and alfalfa was also tried in the Netherlands and Switzerland. Germany and Scandinavia experimented chiefly with factory-size plants capable of drying both root and forage crops. However, before World War II the process had not advanced far in commercial farming on the continent. (R. O. W.)

Hay Driers.—High moisture in stored hay not only causes rapid deterioration of the value of the hay as feed, but frequently results in spontaneous combustion. The hazard of loss of the hay crop as well as of buildings and other property from spontaneous combustion has made many farmers conscious of the necessity of storing only dry hay. Since about 1930 the practice of barn curing hay or drying in the mow with mechanical ventilation has become common in some areas. When hay is first cut it usually has 70% or more of moisture. It wilts very quickly and dries to a moisture content of about 40%. At this stage it can be put in the mow and dried to a satisfactory condition, about 20% moisture, by blowing air through it. It may be put in the mow as loose hay just as it comes from the field; chopped and blown into the mow; or first baled in loosely bound bales. In any of these forms air can be blown through it for drying. Before the hay is put in, the mow is prepared by placing an air-duct system on the floor. There are many different arrangements of duct systems but perhaps the most common is one in which a central main duct is laid full length on the floor along the centre of the mow and smaller ducts are connected along each side and perpendicular to it. These ducts have frequent or continuous openings along their length so that when hay is put on them air forced into the duct moves upward through the hay and dries it. The fan at one end of the main duct to supply the air is usually driven by an electric motor, although a tractor or other motor can be used.

Hay drying is usually done with unheated air but sometimes the air is heated to increase the speed of drying. In this case the air is passed through an oil or gas furnace before being forced into the duct system. The air is seldom heated to more than 10° or 15° F. above atmospheric temperature, which is sufficient to assure that drying will be continuous even during the most humid weather. Higher temperatures tend to overdry the hay nearest to the ducts. The hazard of fire must be considered and is one reason that heated air is not used more widely for hay drying.

Grain Driers.—Even in the 19th century heated-air grain driers were used to some extent in terminal elevators and mills. About 1930, when the development of hybrid seed corn changed the production of corn seed to a specialty, the relatively high value of the seed made it economical to dry it mechanically. Shortly after World War II mechanical drying of grains on the farm came into general use. As with hay driers, grain driers may use either heated or unheated air. When heated air is used the drying is usually done in special drying compartments through which the grain flows or in which it is held for the relatively short time required for drying. One exception is ear corn, which is sometimes dried in cribs with heated air. Drying with unheated air is usually done in storage bins and the grain may remain in the same compartment for storage after drying is completed.

The advantages of heated air in grain drying are: (1) drying of each batch is completed in a few hours so the drying operation can be part of a continuous-flow harvesting-drying-storing or sale process; (2) the progress of drying is independent of the atmospheric temperature or humidity; (3) with limited power available more grain can be dried in a harvesting season. The advantages of unheated air are: (1) less first cost for the drying equipment; (2) less supervision of the operation is required; (3) there is no expense for fuel and no fire hazard.

The capacity of a heated-air drying system depends greatly on the initial moisture content of the grain. With such grains as wheat and oats it is seldom necessary or economical to have an initial moisture content of more than about 20%. With corn it is frequently desirable to harvest the crop with as much as 30% moisture. Initial moisture for rice is frequently between 20% and 25%. The rapidity with which moisture can be extracted from grain depends on the drying temperature. For this reason the capacity of a given drying compartment can be increased substantially by raising the drying temperature. Temperatures up to about 200° F. are used for feed grains. With some grains, however, it is necessary to hold the temperature down even though this decreases the drying capacity and therefore increases the per bushel cost. Seed grains are reduced in germinating power if temperatures over about 110° F. are used. Rice is subject to

damage during milling if it has been dried at temperatures above about 130° F. Such damage is less if the rice is dried in several passes, that is, if only a part of the excess moisture is removed during one pass through the drier. The rice is then allowed to temper in a bin for several hours after which it is again put through the drier. Sometimes several such passes are made. The wet-milling processors find that corn dried at temperatures over about 130° F. cannot be processed satisfactorily. The effect of drying temperature on livestock feed is not well understood. There is evidence that the feeding value is somewhat lowered by temperatures over about 150° F.

Fuel oil and gas are usually used to heat the air. For most purposes the products of combustion of these fuels do not harm the grain, so many driers are used in which the burned gases are included with the air that passes through the grain. Appropriate safety devices are essential parts of heated-air driers. These include a device for limiting the temperature of the drying air, provision for stopping the burner if the fan fails and provision for stopping the fuel supply and fan if the flame fails.

Grain drying with unheated air is usually done in storage bins. Several weeks may be needed to complete drying. This method is most practical in relatively dry climates but it can be used successfully in humid areas where, however, the rate of air supply must be greater. If too little air volume is used the grain in the upper layers in the bin will mold before drying is completed. Economical application of unheated-air grain drying is achieved by designing the system so that the rate of air supply is appropriate to the quantity of grain, its initial moisture content and the climate. If too much air volume is used the operation is uneconomical in use of power. If too little air is used drying does not prevent spoilage of at least part of the grain.

AERATION

Another process, not to be confused with grain drying, is that of aeration for the prevention of damage to stored grain that is already dry. In the absence of aeration there is a tendency for moisture in stored grain to move from one part of the bulk to another. This results from temperature differences in different parts of the bin. The moisture content of some of the grain in the bin may rise to a serious level if the temperature differences are not eliminated. This is done by ventilating the grain with a low volume of air, much lower than is required for grain drying. Since about 1950 the practice of aerating grain stored for more than a few weeks has become almost universal in large storages and it is used to some extent in small farm-type bins.

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CROP INSURANCE: *see* Casualty Insurance.

CROP-PROCESSING MACHINERY. The machinery described under this heading is for preparing crops for market, storage, food and feed, and for handling feed for livestock. The machines for the most part are belt driven by an internal-combustion engine, tractor or electric motor, and occasionally by a steam engine. Crop-drying and processing methods are discussed in the article Crop Drying and Processing. For information on corn pickers, cotton pickers, etc., and for further discussion of combines and other harvesting machinery *see* Harvesting Machinery.

See also Farm Buildings; Farm Machinery; Rural Electrification.

Threshers.—When small grain is harvested with a header, binder or reaper it must be threshed before it is ready for market. This is the purpose of the thresher which performs three main functions—threshing or flailing the grain out of the heads, separating the grain from the straw and cleaning the grain. Threshing is accomplished by the cylinder (tooth, rasp, sometimes called fluted or rub bar, or flail type) and concaves, which knock the grain out of the heads, part of it falling through the grates underneath the rear portion of the cylinder. The remainder passes with the straw which is directed onto the oscillating or vibrating straw racks or strawwalker by a beater, where separation takes place. A grain pan underneath catches the grain from the cylinder and straw rack and passes it on to the chaffer, sieves and screens. This, aided by a fan, is the cleaning mechanism which removes the weed seeds, dirt and chaff.

The grain then gravitates to the grain auger, thence successively to a vertical conveyer, weigher and bagging or wagon spout. Another auger directs any unthreshed heads or tailings to an elevator which delivers them back into the cylinder. A wind stacker mounted at the rear of the machine blows the chaff and straw through a pipe onto a stack. Self-feeders and conveyers are used for carrying the bundles or sheaves to the cylinder. Volume governors for effecting uniform feeding, bandcutters for cutting the bands and various other features are available according to the make of machine. For threshing soybeans, peas, beans and similar crops low cylinder speeds (400 to 600 r.p.m. in place of the normal 1,000 to 1,200 r.p.m.) are required to avoid excessive cracking of the seed. The size of the thresher is determined by the width of the cylinder and the width of the machine at the rear. The smallest thresher is about 20 × 28 in. (20-in. cylinder and 28-in. width of machine) and the largest machines are about 40 × 62 in. The foregoing applies to the machines used mainly in the United States and Canada.

In England and continental Europe more care is taken of the straw, both in threshing and afterward. Often the bands are cut by hand and the bundles are hand-fed into the cylinder. The fluted-bar cylinder which does not break the straw as badly as the spike cylinder is more commonly used. What light material there is, however, such as chaff and short straws (cavings), is discharged from the thresher and not allowed to get into the straw. This leaves clean straw which is usually delivered directly into a press or trusser which bundles and ties it and passes the bundles up a chute into the mow or for loading onto a wagon. However, balers patterned after the United States type of construction are used to some extent in place of the presses. The standard-size thresher in England is 54 in., which is the width of the cylinder and also the approximate width of the machine. Although in the main the work accomplished by U.S. and British machines is more or less the same, a few features occur in the British that do not appear in the American, such as the awner and chobber to remove the bristles or beards and any broken spikes, the second cleaning fan, the rotating screen and the extra grain spouts. The awner and chobber, which are enclosed in a housing with an adjustable opening at one end, consist of a shaft upon which are mounted in succession two or three turns of an auger, a series of spirally arranged knives (the awner) and two disks of different diameters fitted with several bar elements with projecting teeth giving the appearance of a cone. When threshing barley, the grain is conveyed to the awner by an elevator and an auger for removing the bristles or beards and then is passed to the chobber for further rubbing.

Silo Fillers (Ensilage Cutters).—Silage or ensilage (*q.v.*) is herbage stored in a green, moist state. Silage possesses certain advantages as a feedstuff, and the practice of growing succulent fodder crops such as corn (maize), alfalfa, oats, grass, etc., for making it, particularly in humid regions, is common. Silage may be stored in trenches or pits, picket silos or tower silos.

For making silage the crop is mowed green and usually cut up into short lengths by a portable combined silage cutter and blower. The material to be cut is deposited on a conveyer which carries it to a pair of feeding rolls, the lower one fixed, the upper one floating, thence to the knives of flywheel or lawn-mower type. From the knife housing, the chopped material is generally blown into the silo through a vertical sheet-metal pipe leading into the top of the silo, often 50 to 60 ft. high and frequently higher.

Sometimes, however, an endless belt or chain conveyer is used for grass silage. Some machines are provided with a molasses pump and distributing system for adding molasses or other preservative to crops deficient in sugar.

Hay and Straw Cutters (Chaffcutters).—The chaffing or chopping of hay and straw into short lengths is done to facilitate drying or mixing with other feeds and to assist in the feeding of livestock. In a chaffcutter the hay or straw is fed into a long chopper or a trough, at the bottom of which is a moving belt for conveying the uncut fodder to toothed rollers. These rollers hold the stalks while the knives descend and cut the fodder. The knives, which may be curved or straight, are usually attached to the spokes of the flywheel and so set that they cut the fodder as it is pushed forward by the feeding rollers against the mouth or shear plate of the machine. The length of cut is varied by adjusting the speed of the conveyer.

Baler or Baling Press.—Where hay or straw is baled from the stack a portable baler is used. As a charge of hay is placed on the platform and pushed into the hopper it is forced into the baling chamber by a feeder head. The plunger then moves forward and compresses this charge and returns momentarily to its initial position while another charge is being placed in readiness. Grooved blocks inserted at intervals by the operator determine the length of the bale. Baling wires or ties are pushed through the grooves to secure the bale and then tied. As the bales are forced from the press the blocks drop to the ground ready for use again. The tightness of the bale may be controlled by hand screws at the discharge end of the baling chamber. Power may be supplied through sweeps drawn by work animals or by an internal-combustion engine.

In the United States the more common sizes of the baling chamber are 14 × 18 in., 16 × 18 in. and 17 × 22 in. The baler is pulled through the field and picks up the hay or straw from the windrow or swath by means of a revolving cylinder with wire fingers on the outside. The operation of the baler is automatic. An apron feeds the hay into the compressor chamber where a knife on the side of the plunger cuts each bunch of hay loose so the bundles will be cleanly separated. The bales are tied with either twine or wire by means of two needles and a knotter head. This is the same tying process as performed by the grain-binder knotter head.

Husker-Shredder.—In regions of the United States where corn is harvested for the stover (stalks) as well as the grain, frequent use is made of the husker-shredder (fig. 1). As in the case

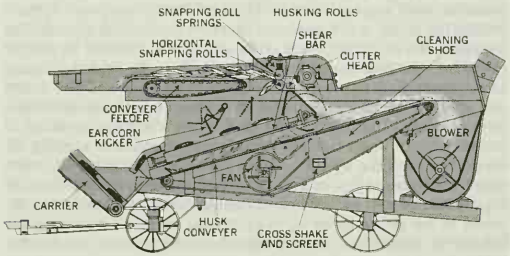


FIG. 1.—HUSKER-SHREDDER

of the mechanical corn picker the cornstalks with ears attached go through the snapping and husking rolls (these may be combination rolls, the lower or forward end snapping and the upper end husking) where the ears are snapped off and husked. The ears are then delivered by an elevator into a wagon or the crib and any shelled corn passes through a cleaning unit similar to a thresher and thence to a discharge spout for sacking or other disposal. The husks and stalks pass through the shredder head where they are shredded and then disposed of through a blower. This material is used for feed or bedding.

Mills (for Crushing, Grinding, Kibbling).—These machines, often known as feed grinders or feed mills, are used principally for milling cereals, corn, soybeans, etc., before feeding to

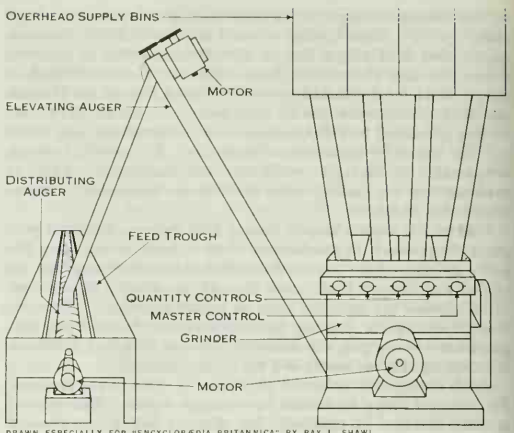


FIG. 2.—AN AUTOMATIC ELECTRIC MILL FOR MIXING, GRINDING AND DISTRIBUTING GROUND FEED TO THE FEED TROUGH. THE MILL MEASURES EACH FEED TO BE GROUND PROPORTIONATELY

livestock, so as to aid digestion, as, for example, in the case of crushed oats, or to facilitate mixing with other fodder; *e.g.*, ground ear corn or chaffed hay or straw. The degree of grinding is very coarse compared with flour, though some mills used by farmers can grind wheat sufficiently fine for making whole-meal bread.

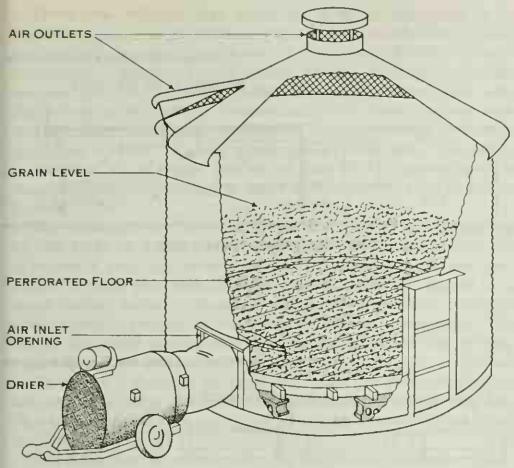
Crushers or kibblers are used mainly for oats, corn and linseed, which are bruised, broken or flattened without being ground into a meal. The essential components are two roughened or fluted rollers which crush the material as it passes between them. One roller is fixed and the other adjustable so that different grains can be crushed or the fineness of crushing varied. A crusher may be hand or power driven.

Grist or grinding mills are invariably power driven and utilize small disks (smooth, rough or fluted) revolving at a high speed in a vertical plane for grinding grain fed from a hopper. Stone was originally used for the grinding disks, but chilled metal and artificial stones are now commonly employed. The disks may be flat or conical and provision is made for adjusting them to vary the fineness of grinding. Where a farmer desires to grind whole-meal flour the mill may be provided with a meal sifter. Combined crushing and grinding mills are also made; the essential components resemble those described above.

Hammer Mills.—The hammer mill to a considerable extent replaced the burr or gristmill for grinding small grains including wheat, oats, barley and shelled corn, as well as ear corn and dry roughages. The grain is fed by gravity from a hopper or by a conveyer into rapidly revolving hammers which pulverize the material and force it through grinding liners or screens encircling the revolving hammers. The size of the holes in the screen determines the degree of fineness of the meal. As the material passes through the screen a blower carries it into a cyclone (separator) where the dust settles. From there it gravitates into sacks or is conveyed to a bin. For grinding roughage, such as cornstalks, auxiliary knives are provided to chop it into short lengths before it falls on the hammers.

In the second half of the 20th century, combine harvesters that would reap, thresh and grind grain for feed in one operation were introduced, tending to make hammer mills, gristmills and crushers obsolete.

Automatic Livestock and Poultry Feeders.—The scarcity and high cost of farm labour in the United States has caused both grain and livestock farmers to increase the size of their farms in order to make the most economical use of the larger labour-saving machines. This change was well under way in the second half of the 20th century. At the same time the availability of electricity on many farms made it possible for livestock and poultry farmers



DRAWN ESPECIALLY FOR "ENCYCLOPÆDIA BRITANNICA" BY RAY I. SHAWL; FROM A U.S. DEPARTMENT OF AGRICULTURE LEAFLET

FIG. 3.—DRYING GRAIN IN AN ENCLOSED STORAGE BIN WITH A PERFORATED METAL BOTTOM. HEATED AIR BLOWN UNDER THE FLOOR RISES THROUGH THE GRAIN, DRYING IT SLOWLY

to install the new automatic feed-grinding, mixing and distribution systems for feeding. Fig. 2 shows an installation of this type. The grains and supplements are placed in overhead or ground-level storage bins from which they are delivered to the grinding mill by gravity or by small-diameter augers. The drawing shows an arrangement for four different ingredients being fed into the mill to be ground, mixed and delivered to the feeding storage or trough. It is possible to deliver the feed directly to the feeding troughs by an auger as shown or the feed can be delivered several hundred feet through a small auger also operated by an electric motor. In the drawing a second auger above the feed trough delivers the feed down the trough, allowing it to fall through holes until the trough is full. The grinding equipment can be set to operate by a time clock for a definite length of time or it can be equipped with a switch at the far end of the auger which will automatically shut off the mechanism when the trough is full. It is also possible to blow the feed through plastic pipe mounted overhead or buried in the ground. The plastic pipe can be bent around corners which makes it easy to install.

The proportion of the various ingredients fed to the mill is controlled by a small ratchet-driven auger in each compartment at the top of the mill. The quantity of each ingredient is controlled by a separate dial and the rate at which the material is fed to the mill is controlled by a master dial. Other methods of controlling the quantity of each ingredient are the electric-vibrator type and the belt- or chain-driven volumetric type. Equipment is also available for delivering ear corn from a crib to the grinder. A mill of the type described, when driven by a three-horsepower electric motor, can grind 1,000 to 2,000 lb. of feed an hour. Ensilage can also be automatically delivered from the silo to the feed troughs.

Corn Shellers.—For shelling corn in the ear, use is made of the corn sheller—the cylinder type for large capacity and the spring type for small capacity. In the cylinder type the ears are fed into the sheller by a conveyer and feeding spiral where the conical-shaped lugged cylinder revolving within the shelling cage causes the kernels to be rubbed off the cob. The shelled corn falls onto a cleaning screen, exposed to an air blast, and then is discharged into bags or a wagon.

The spring-type sheller may be of the one-, two-, four- or six-hole size. The one- or two-hole type may be operated by a hand crank or a small electric motor, but the larger ones require more power. The shelling is effected by a shelling wheel fitted with projections. The corn is fed into the hole or holes as the wheel revolves and, with the aid of a rag iron or weight under spring pressure for holding the ears against the wheel, the kernels are rubbed off.

Cake Breakers.—These machines, for hand and power operation, consist of a feeding slot and one or two pairs of toothed or spiked metal rollers which break linseed cake, soybean cake or similar feed material as it passes between them. The distance between the rollers can be varied to alter the size of the broken pieces, called nuts; these are passed over a riddle or coarse sieve in order to separate the meal and fine particles from the nuts.

Root Cleaners, Cutters and Pulpers.—These machines are used mainly to chop up swede turnips or rutabagas which are hard. Mangels and white or soft turnips are usually fed whole, though they may occasionally be sliced. Cleaners consist of a number of iron bars joined together in the form of an open cylinder which

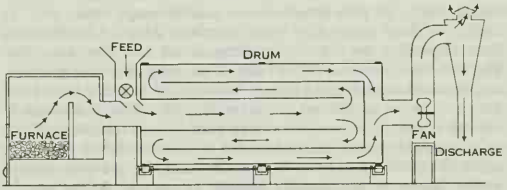


FIG. 5.—REVOLVING-DRUM TYPE OF FORAGE DRIER, TRIPLE-DRUM DESIGN

can rotate in an inclined plane. The roots are fed into a hopper at one end and pass by gravitation as it rotates along the cleaner into the cutter or pulper, any loose soil falling through the iron bars in the process. The rate of cleaning is regulated by altering the inclination of the cylinder to the horizontal. Cutters or pulpers are of various types and may be operated by hand or power. The commonest types work on the rotary principle and have a hollow barrel or drum carrying cutting devices of various shapes on the periphery. The roots are fed from a hopper, and the barrel, which is mounted on a frame, can rotate in either direction so that the roots can be sliced by one set of knives and cut into fingers by the other. It is usual to slice roots for cattle and cut them into fingers for sheep.

Drying Agricultural Products.—Grain with high moisture content at harvest time should be dried to the proper moisture per cent for sale or storage. It is practical to dry grain with a 30% moisture content but the grain should be allowed to field dry as much as possible. Grain should be dried down to 11% or 12% for storage in tight bins or to 15½% for immediate sale. In the United States the blower supplying hot or cold air for drying is usually of the type shown in fig. 3. The drier fan is driven by a 3- to 7½-h.p. electric motor or by a tractor

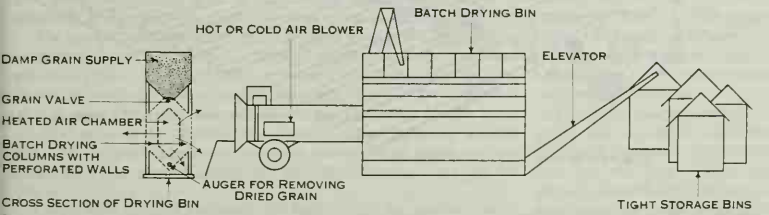


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FIG. 4.—COMPLETE BATCH DRYING SYSTEM (RIGHT) FROM HOT-AIR BLOWER TO STORAGE BINS. THE CROSS-SECTION DRAWING (LEFT) SHOWS THE HOLDING BIN ABOVE TWO DRYING COLUMNS. HEATED AIR BLOWN INTO THE CENTRE SPACE PASSES THROUGH THE LAYERS OF GRAIN

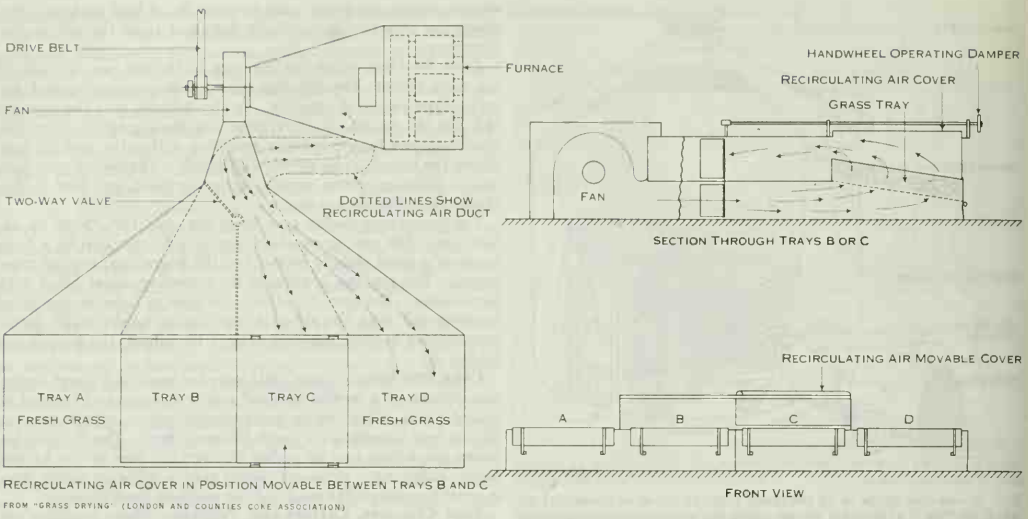

FIG. 6.—TRAY DRIER

power take-off shaft. The large horsepower of the tractor engine allows the fan to be stepped up to a higher speed, thus delivering much more air. The electric-motor-driven driers deliver from 15,000 to 30,000 cu.ft. of air per minute depending upon the size of the unit. Drying temperatures usually range from 140° to 180° F. These driers may burn from 3 to 25 gal. of fuel oil an hour depending on the drying temperature and the drier size. Fig. 3 shows a low-cost type of drier consisting of an airtight storage bin with a perforated floor. The hot air is blown under the floor and passes up through the layer of grain. The blower can be started as soon as a foot or more of grain covers the floor. Grain to a thickness of six feet can be dried in about 70 hours depending upon the moisture content at the start and the per cent desired at the finish. A considerable amount of corn is shelled as it is harvested in the field and the moisture content is usually high enough to require drying before storing in tight bins.

The most popular type of grain drier is the batch drier shown in fig. 4. The drying bin holds from 200 to 300 bu. depending on the size of the drier. There is a storage bin for damp grain above the drying area. The cross section of the drying bin at the left shows a double column of grain about 16 in. thick. Hot air is blown into the centre and passes out through the layers of grain. When the batch is dry it is augered out at the bottom and delivered to the permanent storage bins. The blower is the same as that described before.

Another type of machine can be set for a certain number of hours of drying after which it empties out the dried grain and refills itself from the storage bin above. Still another type is known as the continuous drier. In this machine a thinner layer of grain flows through the drying area at a slow enough rate to be dry by the time it passes out the bottom.

From three to seven hours will be required to dry the grain in the batch type, depending on the amount and its moisture content. From 3 to 25 gal. of fuel oil per hour will be burned to dry a batch of grain.

The Rotating-Drum Type.—A stationary type of drier for alfalfa and grasses consists of a large rotating drum (fig. 5) into which the shredded or cut material to be dried is fed. The material is subjected to rather high temperatures for quick drying as it passes through the machine. The dried material is cooled and fed into a hammer mill where it is ground into a meal and packaged in cloth or paper bags for shipment. The tray drier (fig. 6) may be of various designs, one of which is quite popular in England for drying hay. Coke is used for fuel and the hot gases from the furnace are blown under two sections containing mats of hay. The section with green hay is arranged so the hot gases pass up through the mat and into the open until the hay is half dry, when it is pitched by hand into a second compartment with a cover. Here the gas passes through the half-dry hay and back to the furnace to be reheated. There are two additional compartments symmetrical with the first two which are being prepared while drying is taking place in the others. In the duct-type or mow drier (fig. 7) a series of ducts open on the underside and raised an inch off the floor cause the air to pass through the surrounding hay under pressure produced by a blower. These ducts are about six feet apart and green hay may be piled on them to a depth of about five feet until dry, when an additional five feet may be added and so on up to the height of the mow. Depending upon atmospheric conditions, a five-foot depth is usually dried in from 10 to 25 days if no heat is used.

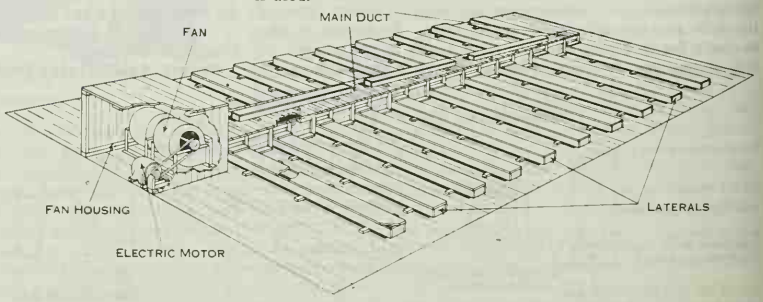

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FIG. 7.—MOW DRIER FOR LONG OR CHOPPED HAY. COLD AIR IS USED, AND THE SIZE AND PLACEMENT OF THE DUCTS IS SUCH THAT AIR IS DISTRIBUTED EQUALLY OVER THE ENTIRE DRYING AREA. A FIVE-FOOT LAYER OF HAY TAKES 10 TO 25 DAYS TO DRY, DEPENDING UPON MOISTURE CONDITIONS

Elevators.—Where large quantities of hay or straw are to be stacked or placed in the mow, or grain in bins or cribs for storage, much labour is saved by the use of elevators. A common type consists of a hopper, a long trough, usually rectangular in section and open on top, and an endless belt or chain fitted with forks for conveying hay, flights (cross-pieces) for conveying ear corn and sometimes small grain and flights of special design for working inside a spout for small grain, shelled corn, etc. The whole is mounted on a frame carried on wheels for convenience in transport and the machine is made in sections so that it can be folded.

The material is fed into the hopper from which it is picked up by the forks or flights and conveyed up the trough to the top of the stack, grain bin, mow or silo. A second type of elevator consists of a metal pipe with an auger turning inside and driven by a small electric motor or gasoline engine. This elevator comes in various lengths and can be easily handled by one or two men. The end of the auger pipe is inserted into the grain and the turning auger moves the grain at a rapid rate. A third type of elevator is the blower. Grain is dropped into a hopper from which it is fed into an air blast and carried through a pipe to the storage bin. This type of elevator is quite heavy but can be moved from place to place.

Elevators may be operated by animal power, internal-combustion engine, electric motor or, when used for stacking straw, direct from the threshing machine.

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CROPS. Crops are plants and their products usually grown with special care or for a special purpose, and in most instances harvested to yield a product for which there is a market demand. Emphasis is placed on the ability to produce a harvest. The Germans use the word *Ernten* synonymously for crops and harvests. The harvesting or gathering of the product may involve the entire above-ground portion of the plant, as in the case of green vegetables or of forage crops cut for either hay or silage. It may be limited to the harvesting of underground tubers, as in the case of potatoes. In the cereals the entire plant may be cut or harvested but generally only the seeds are marketed. The stems and leaves, that is, the straw, of the cereals are of value for returning organic matter to the soil, for bedding and, more recently, together with cornstalks, for the manufacturing of paper. In parts of the world, notably in Asia, the straw of the cereals and stalks of other plants are valued sources of fuel.

Not all crops are harvested in the accepted manner. Pasture crops are grazed by animals and are thus converted into milk, beef, mutton or pork, and the term crop is used by livestock producers who refer to their pig, lamb or calf crops; nevertheless its use is generally reserved for the designation of plant products.

The production of a marketable product may yield its place to crop production for special purposes, as where cover crops are grown to protect land from wind or water erosion and from nutrient losses by leaching. Bare unprotected soil is subject to physical and chemical losses in that particles may be removed by the force of wind or water or soluble elements may be lost by being washed out. Plants used for cover crops may also serve as green manure crops by being plowed under for soil improvement (*see* CATCH CROP).

Crops may be used for food, for feed or for the production of special products. Fruits and leafy vegetables are used for direct human consumption. Wheat kernels are processed to produce flour. The by-products of the milling industry, the germs and bran separations, are used largely in animal feeds. Sugar is extracted from either the stems of sugar cane or the roots of sugar beets. Fatty oils, used either for food or in industry, are extracted from the seeds of such crop plants as corn, soybeans, cotton, peanuts and flax, or from the fruits of the olive, the dried meat of the coconut or from the kernels or the fibrous pulp of the oil palm. Essential oils used in the flavouring of foods are distilled from such plants as spearmint and peppermint. In addition there are the drug crops, such as belladonna, aconite and castor beans, to name only a few, and the stimulants such as tobacco, coffee and tea.

The designation of plants as food and feed crops varies in different parts of the world. It is associated with the economic status of various countries. Around 90% of the corn produced in the United States is fed to livestock, only about 8% being processed for human consumption. Most of the corn crop grown in southern Europe, Mexico, Asia and Africa is used for direct human consumption. In the United States barley is produced for feed and malting; it is used as a food crop in northern Africa and in Asia. Population pressure in southeastern Asia forces the soybean into the food-crop class, in that it provides a cheap source of protein, fat and oil. In the United States the crop is grown primarily for oil, for industrial uses and as a forage crop.

Many crops are of importance not only for their primary use but also for their by-products. Oil-producing crops yield not only oil but also high-protein feeds. Cotton is a fibre crop, yet an average ton of cottonseed (*q.v.*) produces 311 lb. of crude oil, 906 lb. of meal, 520 lb. of hulls and 143 lb. of linters or short fibres that remain on the seed after ginning. It is difficult to justify the continuance of the sugar-beet industry on the basis of the sugar produced without consideration of the value of the by-products of this industry, namely, molasses, beet pulp and the tops and leaves of the beet plant.

The area of production, or the distribution of crop plants, is determined by a multitude of factors. Not only must the climatic and soil conditions be favourable but there must also be an economic justification for the crop. Technological, social, historical and even political forces enter into the original establishment and continued cultivation of a crop in a given area.

The origin, development and continuance of the sugar-beet industry in Europe and in the United States provides a good example of the operation of these factors. It took the technological know-how of Franz Carl Archard to apply the discovery made by his teacher, A. S. Margraff, in 1747 that sugar crystal could be separated from the white beet. Archard built the first practical sugar-beet factory in Lower Silesia in 1802. In this venture he received the material assistance first of Frederick the Great and subsequently of Frederick William III of Prussia. Napoleon I encouraged and subsidized early beet production in France in 1811, with the double objective of producing sugar on the continent of Europe and countering the British blockade. These actions set the pattern of providing governmental assistance to the young industry in the European countries and later in the United States where the sugar-beet acreage is set by the federal sugar program. Plant breeders made their contributions to sugar-beet production by the development of beets with a high sugar content and the breeding of varieties with disease resistance.

To this must be added the development of single-germ seed, containing only one seed per seed ball. The availability of this seed makes possible precision planting, which facilitates field thinning. Other technological advances were the development of equipment making possible the mechanization of production and harvesting of the crop, and improvement of sugar through new extraction methods in factories.

Temperature relationships determine the limits within which crops may expand into the higher latitudes. Cotton ceases to be a crop of economic importance in areas with growing seasons of less than 185 days. Barley, on the other hand, being able to complete its growth cycle in a much shorter period, is adapted to areas with short and cool growing seasons. This accounts for the occurrence of this crop in high latitudes and at high elevations.

The availability and seasonal distribution of moisture establish other limits to crop expansion. Timothy and Kentucky bluegrass

occur in humid regions while crested and Siberian wheat grass survive and produce forage in extremely dry areas. Corn yields its place to the sorghums in the southern Great Plains area because of its more exacting moisture and temperature requirements; the sorghums will produce a crop under greater moisture stress than will corn.

Climatic and soil conditions determine not only the distribution of crops but also their characteristics in relation to special uses. Wheat produced in humid woodland climates, as in the eastern part of the United States and in western Europe, is soft and low in protein. It is suitable for the cookie and pastry trade. The winter and spring wheats produced in the areas of the drier grassland climates of the Great Plains and the Crimean section of the U.S.S.R. are hard, vitreous and high in protein, and for that reason are in demand by the bread trade. These variations in kernel characteristics are accounted for mainly by climatic differences in the two areas. The nature of the soil and the choice of varieties also contribute to the differences indicated. *See* AGRICULTURE and articles on specific crops.

See also references under "Crops" in the Index volume.

(K. H. K.)

CROQUET AND ROQUE, an outdoor game which may be played on the lawn or on a smooth hard-surface court with mallets with which the players manipulate balls through a series of wire wickets, hoops or arches.

The game evolved, according to some writers, from the *paille-maille* which was played in Languedoc at least as early as the 13th century. It was a popular game of the royal families of France in the 17th century before it crossed the channel to England and became the game of the kings and queens. By 1850 it had become one of the most popular outdoor sports in England and by 1870 it was being played in almost every section of the United States, but not as an organized sport.

In Great Britain the first all-comers' meeting was held at Moreton-in-the-Marsh, Gloucestershire, in 1867. In 1870 the All England Croquet club was formed, the annual contest for the championship taking place on the grounds of that club at Wimbledon. After being for ten years or so the most popular game for the country house and garden party, croquet was practically ousted by lawn tennis, until, with improved implements and a more scientific form of play, it was revived about 1894–95. In 1896–97 was formed the United All England Croquet association, now known as the Croquet association. The chief events of the year are played on the club croquet lawns at Hurlingham and Roehampton, and the tournaments at Parkstone, Eastbourne, Brighton, Cheltenham and Budleigh Salterton are specially popular.

Croquet flourishes in many parts of the Commonwealth of Nations, with affiliated associations in Australia, Tasmania, New Zealand, etc. Some of these associations have as many as 300 clubs affiliated to them. A team from Australia visited England in 1925 and the test matches were won by the home country. Further test matches were played in 1928 and 1935 (won by Australia) and in 1937 (won by England). In 1950 the international trophy was played for in New Zealand and won by the New Zealand team, but England recovered the trophy when a New Zealand team visited England in 1956.

The game is also popular in the U.S. where a National Croquet association was organized in 1882, and regulations and rules were established for an organized sport. In 1889, at a tournament meeting in New York city, Samuel Crosby suggested that the letters "c" and "t" be dropped from the word croquet making it roque. The organization later became known as the National Roque association (see *Roque*, below). Lawn croquet continued to be played throughout the country, but organized croquet was lost sight of for a number of years. Then in 1950 at Oklahoma City, Okla., a National Croquet association was organized to promote croquet as an organized sport in the United States.

There are several versions of croquet and the rules and court dimensions differ in Great Britain and the United States. Croquet terms, shots, strokes, styles of play and methods of scoring are identified in *British Croquet*, below.

British Croquet.—In Great Britain the official game of croquet is association croquet. It is played between two sides, playing alternate turns, each side consisting of either one or two players. Four balls are used, one side playing blue and black and the other side red and yellow. Each side has 26 points to score, 13 with each ball.

A game is won by the number of points which the loser has still to make when his opponent has hit the peg with both balls. Any ordinary turn may be played with either ball of the side, provided that no ordinary turn may be played with the same ball again until all the balls are in play. However, when a side consists of two players, one partner plays throughout with one ball of the side, and the other partner with the other.

The court is rectangular, 35 yd. long by 28 yd. wide, within a boundary defined by a continuous line (*see* fig. 1). Corners I, II, III and IV are marked by coloured flags. Portions of the yard line, 13 yd. long measured from the corner spots at corners I and III toward corners IV and II, respectively, are called balk lines. Eight white pegs, not exceeding $\frac{3}{4}$ in. in diameter or 3 in. in height above the ground, are placed on the boundary, at distances of 3 ft. from the corners of the boundary. The square yard formed at each corner by the two corner pegs, the corner spot and the corner flag is called a corner square. The six arches, or hoops, are of round iron, $\frac{5}{8}$ in. in diameter and of uniform thickness. They stand 12 in. in height above the ground, vertical and firmly fixed. The crowns of the hoops are straight and at right angles to the uprights, which should be $3\frac{3}{4}$ in. apart, inside measurement ($3\frac{1}{16}$ in. for certain competitions between experts), from the ground upward. The winning (centre) peg is of wood and of uniform diameter above the ground of $1\frac{1}{2}$ in. The setting of the hoops and peg is as shown in fig. 1, the order of making the points being indicated by the arrows. Each hoop is run twice and the peg is hit once, and may be so from any direction. (The game is still occasionally played with two pegs, one near each end of the court on the centre line, each being struck when six hoops have been run and this is the official game in the U.S., as described in *Lawn Croquet, Pro-*

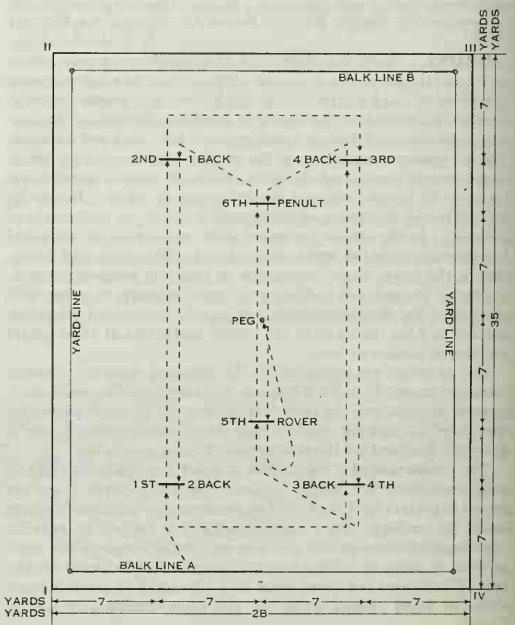

FIG. 1.—PLAN OF BRITISH CROQUET COURT SHOWING SETTING OF HOOPS AND PEGS, AND ORDER OF PLAY IN ACCORDANCE WITH THE OFFICIAL LAWS (1928) OF THE CROQUET ASSOCIATION

Only those portions in heavy outline need be marked on the ground. The order of making the points is indicated by the arrows

fessional Croquet and *Roque*, below, but this setting is no longer authorized by the British Croquet association.)

Like most other games croquet is subject to alteration and amendment in its rules and laws, but finality seems to have been reached in regard to the setting, which has been in general use since 1922. Mallets may be of any size and weight, but the head must be made of wood only, except that metal may be used for weighting or strengthening it. The two end faces must be parallel, of wood only, and identical in every respect, and each face may have a rounded edge which shall not be considered part of the face. A player may not change his mallet during a turn, except in the case of bona fide damage. The balls must be $3\frac{5}{8}$ in. in diameter and of even weight, not less than $15\frac{3}{4}$ oz. nor more than $16\frac{1}{4}$ oz. The hoop or peg next in order for every ball at the commencement of a turn is distinguished by a clip the colour of the ball.

The object of the player is to score the points of the game by striking his ball through each of the hoops and against the peg in the proper order, and the side wins which first succeeds in scoring all the points with both the balls of the side. Each player starts in turn from either of the balk lines. If he fails either to make a point or to roquet (*i.e.*, drive his ball against) another ball in play, his turn is at an end, and the next player in order takes his turn.

If he succeeds in scoring a point, he is entitled to another stroke; he may then either attempt to score another point, or he may roquet a ball. Having roqueted a ball (provided he has not already roqueted the same ball in the same turn without having scored a point in the interval) he is entitled to two further strokes: first he must take croquet; *i.e.*, he places his own ball—which from the moment of the roquet is dead or in hand—in contact with the roqueted ball on any side of it, and then strikes his own ball with his mallet, being bound to move or shake both balls perceptibly. (If at the beginning of a turn the striker's ball is in contact with another ball, a roquet is held to have been made and croquet must be taken at once. If when taking croquet either ball should cross the boundary it must be replaced on the yard line opposite the point at which it did so; but balls passing the boundary at a point within the corner square must be replaced on the corner spot.)

After taking croquet the striker is entitled to another stroke, with which he may score another point, or roquet another ball not previously roqueted in the same turn since a point was scored; or he may play for safety. Thus, by skillful alternation of making points and roqueting balls, a break may be made in which point after point and even all the points in the game (for the ball in play) may be scored in a single turn, in addition in a peeling break to three or four points for the partner ball. (Peeling is a term used when the striker causes a ball, other than his own, to run a hoop in order; that ball is then said to have been peeled.) The chief skill in the game perhaps consists in playing the stroke called taking croquet (but *see* below on the rush). Care must be taken that both balls are moved or perceptibly shaken and that neither of them is driven over the boundary line, for in either event the player's next stroke is forfeited and his turn brought summarily to an end.

There are two main styles in playing croquet and the essential feature of each, whether to make a roquet or run a hoop, is that the eye, the ball and the object aimed at should form a vertical right angle. The upright style is played with a long mallet of about 39 in. The player faces the object to be hit, holding the top of the mallet with his left hand, the arm being close to the side. The right hand grasps the shaft lower down and is solely responsible for the necessary power of the strike, the left hand merely acting as the fulcrum of the swing.

Either the right or the left foot may be in advance, and should be parallel to the line of aim, the player's weight being mainly on the front foot. For the other style, commonly known as centre play, a shorter mallet of about 33 in. is used. The mallet is swung between the feet, the hands being close together and often overlapping. The centre style is undoubtedly more tiring and the strain on wrists greater, whereas the upright method, because it is less fatiguing, is far easier to maintain, especially on a slow lawn.

In making a shot the ball should be hit in the centre and as low down as possible with the exact middle of the mallet. The eyes must be concentrated on the spot and the head of the mallet drawn back slowly. This is the secret of all successful shots, either for roquets or hoop running; the more difficult the angle of the hoop, the slower the back swing—any jerking is fatal. The rush stroke is a roquet and is used to drive the pilot ball some distance; the ball must be hit full in the face for a straight rush. The hands and mallet should be kept down and should follow well through. True hitting should be aimed at, not force. The roll is a croquet stroke in which both balls are rolled along the same distance and is attained by standing well forward with the hands in front of the head of the mallet. The stroke is not a hit, but a sweep.

The pass roll is the most difficult of all, as unless it is played firmly and with deliberation the mallet will hit the ball twice and the stroke will be a foul. The stance is similar to that for the roll, but the ball is hit higher up and the curtailed back swing is more vertical, resulting, if the stroke is smooth, in the player's ball's passing the other ball. The split shot is utilized when two balls are to be driven in opposite directions. The player lines the balls so that they point in the direction that the croqueted ball is to travel, then plays the stroke facing the midway between that point and where his ball is being directed. The angles are the same as in billiards, though it is impossible to obtain an absolute right angle. The stop shot is also analogous to billiards, the object being to drive the croqueted ball a long distance and to keep the striker's ball back. The striker stands farther behind than usual, hitting the ball very near the bottom of the face of the mallet with a short, sharp hit. Taking off is a croquet shot and consists in taking off from a ball which is to be left behind and merely shaken to another ball or given spot on the lawn.

A first-class croquet lawn should be as level as possible with a true and consistent surface; no obstacle to an all-round break is therefore present other than the player's lack of skill. If games were won by all-round breaks alone, however, much of the interest would be missing. The picking up and assembling of the balls and the laying of a break at the conclusion of a turn generally require infinitely more skill and thought than the somewhat automatic execution of a three- or four-ball break. The main principle in either three- or four-ball breaks is always to keep the balls in a straight line and sweep them, as it were, along the path of direction. The chief secret of break making is correctly rushing the pilot ball with the aid of which the hoop has been made to the right spot after running it; by doing so the next shot is made easy, and the approach to the following hoop will become a short straight stop shot, ensuring a good position for hoop running. This positioning is the hallmark of first-class players. During a three-ball break the player must keep in mind the earliest and safest opportunity for bringing the fourth ball into play, for though it may be relatively simple to continue with only three balls it is impossible to finish the break satisfactorily unless all four balls are in command.

Tactics play an important part in the game. They must be based upon the player's knowledge of his own skill and what he knows of his opponent's strength or weakness. Broadly speaking, two points must be considered before shooting: what will be gained if the roquet is successful and how it will affect the opponent's next turn if unsuccessful. Although either ball of a side may be played, much can be done to compel the opponent to shoot with his forward ball. It can be left near the hoop of the player's backward ball, and in many other ways it is possible to influence the progress of the adversary.

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(H. J. W.; P. G. Ds.; M. B. R.)

Lawn Croquet.—The layout of the field for lawn croquet is determined by the available space. The playing field consists of nine wire hoops, or wickets, and two wooden stakes (*see* fig. 2). No layout should be more than 40 ft. wide and 75 ft. long (smaller than the British 28 by 35 yd. or 84 by 105 ft.). The

boundary line is usually 7 ft. from the end wickets and 5 ft. from the side wickets. In placing the wickets in the playing field, the first wicket is placed a mallet-handle length from the starting stake and the same distance is measured from the first wicket to the second wicket.

The same measurements are used at the other end of the playing field in placing wickets 6 and 7. The other five wickets are placed in accordance with the space available. The centre wicket (4), is placed in the centre of the playing field. The side wickets, 3, 5, 8 and 9, are placed at right angles from wickets 2, 6 and 4, and five feet within the boundary of the playing field. Each side has 32 points to make, 16 with each ball. The balls are of hardwood, $3\frac{3}{8}$ in. in diameter, and are made in multicolours with stripes or in solid colours. The mallets are of hardwood, with heads 6 in. to 8 in. long, and with handles approximately 30 in. long.

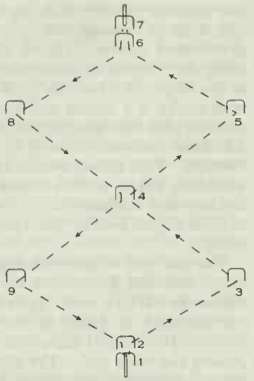


FIG. 2.—UNITED STATES LAWN CROQUET COURT LAYOUT, SHOWING PLACEMENT OF WICKETS AND DIRECTION OF PLAY

The object of the game is for a player to make all or as many wickets as possible before giving his turn of play to his opponent. When a player has hit any other ball with his own he may take one more shot from where his ball lies; he may place his ball a mallet head's distance in any direction from the ball he has hit and take two shots; he may place his ball against the other, step on his ball with one foot and strike his ball firmly to drive the other away, and then take one additional shot; or he may place his ball against the other and drive both balls in the same direction or at any angle. A rule book is included in each set of croquet equipment. However, ground rules are established by the local players of each court, since the courts are largely based on the available space.

Official Regulation Croquet.—A more technical game of skill than lawn croquet, official regulation croquet has been developed by the organized croquet associations. It is played on a smooth hard-surface court with short mallets (approximately 15-in. handle) and hard rubber balls. An official, regulation-size court is 40 by 75 ft. with ten steel wickets, $3\frac{3}{8}$ in. wide and 9 in. above the ground surface and two steel stakes, and is surrounded by a concrete boundary wall (*see* fig. 3). The two centre wickets, 4 and 12, are placed 18 in. apart, which makes the centre wicket more difficult to make than the other wickets. The hard-rubber balls are $3\frac{1}{4}$ in. in diameter, weigh 12 oz. and are made in sets of four, red, white, blue and black.

The mallet heads are of hardwood or aluminum tubing, with a rubber tip on one end and a hard laminated plastic or aluminum tip on the other end. The size and weight of the mallets vary according to the desire of the players.

The object of the game is for a player to make all or as many wickets as possible before giving his turn of play to his opponent. A player has a hit, a roquet (a drive or hit against an opponent's ball) and a free shot to make a wicket before giving his turn of play to his opponent. A player's ball may hit another ball or all three balls before making a wicket or knocking his opponent's ball behind the wicket or out of position. A player is dead on a ball after a hit, until he makes a wicket or point, that is, he cannot hit the ball in successive hits, even upon his next turn of play, until he has made a wicket, or point. Professional players may use pool or billiard strategy in making carom shots, in which a player's ball hits the wall, rebounds, and hits another ball, balls or wickets. A carom shot is also known as a wall or bank shot. It is used by a player to knock an opponent's ball out of position when he is dead on the ball. It is also frequently used to get in position or to hit an opponent's ball when the latter's ball is behind a wicket, stake or another ball. The wall or bank shot is used at all times when the player is unable to make a direct shot against his opponent's ball or through a wicket.

The game, which is played by two players (singles) or four (partners or doubles), is started by the players lagging, or shooting, from the centre of the court to the playing line. The player whose ball stops nearest the playing line has the first shot. The balls are then placed on the four corners of the court (*see* fig. 3). Partner's balls are placed diagonally opposite each other. The player who wins the lag for first play, places his ball at the starting end of the court and he has a choice of the sides of the court. All shots must be fair and distinct blows from the mallet. It is not permissible to push the ball with the mallet. The side or corner wickets are made in the direction of the centre wickets. The other wickets are made in the direction of play on the court. Coloured clip pins of red, white, blue and black are used for markers.

At the completion of a player's turn, he places a marker at the wicket for which he will aim at his next turn. Such markers are not absolutely necessary, since the player's ball designates the wicket for his next turn of play; the use of markers, however, prevents arguments and friction among the players. Games are decided by completed games, by a designated time limit or by a designated number of innings (a complete round of play by all players before their next turn of play).

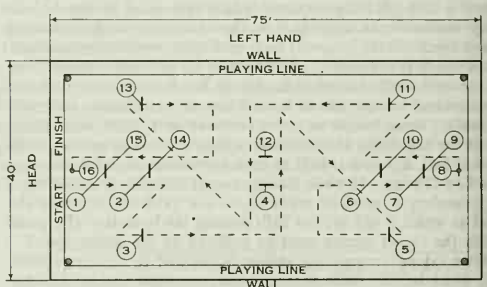


FIG. 3.—PROFESSIONAL CROQUET COURT LAYOUT AND DIAGRAM OF PLAY
Starting position of balls shown by filled circles

If the game is being decided by a completed game, the player who makes all the wickets and hits the two posts, or makes a possible score of 32 points first, is the winner. If a game is being decided by a designated time limit or innings, the length of time for the game (one to two hours) or the number of innings (9 to 15) is designated before the start of the game.

Roque.—This is a scientific version of croquet. The object of the game is the same as that of croquet.

An official regulation size roque court is 30 by 60 ft. and is octagon shaped (*see* fig. 4). The court has a hard surface and a solid concrete boundary wall. The court has ten $\frac{5}{8}$-in. diameter steel wire arches. The space between the arches is $3\frac{3}{8}$ in. The arches are set rigidly in the ground and extend 8 in. above the surface of the court. There are two steel stakes, $\frac{3}{4}$ in. in diameter, set rigidly in the ground at both ends of the court.

The balls are of hard rubber, $3\frac{1}{4}$ in. in diameter, one red, one white, one blue and one black. The mallets have a solid head with a smooth face of laminated plastic or aluminum on one end and rubber on the other end, for hard and easy shots. The standard handles are 15 in. long; there is, however, no restriction as to the size or weight of the mallets. Court markers are of the same colour as the balls, red, white, blue and black.

Much scientific thought is given to the maneuvering of the balls through the arches and keeping the opponent's ball out of playing position by direct, roquet and carom shots.

A game is started by lagging as in croquet. All four balls are placed on the corners nearest the centre of the playing line (*see* fig. 4), with the partner's balls diagonally opposite each other.

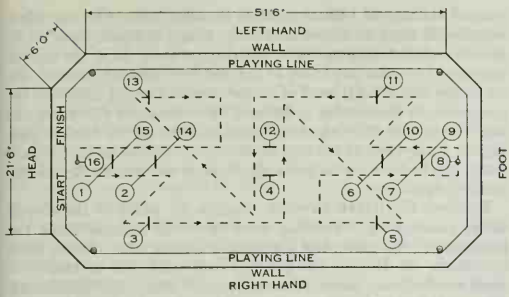


FIG. 4.—ROQUE COURT LAYOUT AND DIAGRAM OF PLAY

Starting position of balls shown by filled circles

The playing ball and the next in sequence are placed at the head of the court. The player who has won first, attempts to hit a ball down the line and to maneuver the balls in position for making the arches. If he is successful, he may make one arch, a number of arches, or all 32 points before giving his turn of play to his opponent. A player making 32 points in one turn of play before giving the balls to his opponent is known as a rover. Games are decided by completed games, by a designated time limit, or by a designated number of innings. The player making all arches and hitting the two posts or making all 32 points first is the winner of a completed game. If playing innings, the player having the greatest number of points at the close of a designated number of innings (usually 15), is the winner. If playing time limit (usually two hours), the player having the greatest number of points at the designated time is the winner. A player may become a winner at any inning or at any time limit if he makes the complete 32 points before the designated number of innings or designated time limit. (M. T. Y.)

CROSBY, FANNY (1820–1915), originally Frances Jane Crosby, U.S. writer of hymns widely sung in her day, was born at Southeast, Putnam County, N.Y., on March 24, 1820. She lost her sight at the age of six weeks as the result of negligence on the part of a doctor. In 1835 she entered the Institution for the Blind in New York city and was teacher of English there from 1847 to 1858. In her youth she published several volumes of poetry. In 1858 she married her pupil, the blind musician, Alexander Van Alstyne, and six years later began writing hymns. From then until her death on Feb. 12, 1915, at Bridgeport, Conn., she composed about 6,000 hymns. "Safe in the Arms of Jesus" was her best-known hymn. Several became known in England and were translated into foreign languages. She wrote her memoirs in 1903 and 1906.

CROSBY, a residential town and municipal borough of Lancashire, Eng., 7 mi. N.W. of Liverpool. The name is of Norse origin. The borough was formed in 1937 from the former urban districts of Great Crosby and Waterloo with Seaforth. Pop. (1961) 59,707. Area 11 sq.mi. (including 3¼ sq.mi. of seashore). Crosby hall has been the home of the Blundell family for many centuries. At Seaforth house (1813), now demolished, lived Sir John Gladstone, father of the prime minister William Ewart Gladstone.

The borough is the home of the Merchant Taylors' schools (the boys' founded in 1620 and the girls' in 1888), and of the Waterloo rugby football club (1882). Coursing (Waterloo cup) takes place at Altcar, a few miles northeast of the borough.

CROSIER, sometimes called PASTORAL STAFF, a crook-shaped staff, a liturgical symbol of a bishop's or abbot's office, used in solemn pontifical functions of the Eastern Orthodox, Roman Catholic and Anglican churches. Some abbesses also have the right to use it, and, exceptionally, other ecclesiastical dignitaries have been granted the privilege. It is conferred by the consecrating bishop on bishops at their consecration and on abbots at their blessing, and may normally be used only in the territory or in the churches under their jurisdiction.

In the west the crosier was originally a staff surmounted by a cross, a sphere or a horizontal crossbar representing a tau cross; in the 13th century the present spiral or curved top came into general use. In the Eastern Church the staff usually terminates in a tau cross or two curved serpents. There is evidence that abbots in Ireland used a pastoral staff as early as the 5th century. As an insignia of a bishop's power of ruling, first mention of it is made at the fourth Council of Toledo in 633. It was adopted by the bishops of France in the late 8th century, and thence its use became general. Not until after the 10th century, however, did the crosier become a true liturgical insignia, to be solemnly blessed and to be employed primarily in services of worship: at first only in processions and the consecration of churches, and later in all pontifical rites except on Good Friday and at funeral services. (G. L. D.)

CROSS, HARDY (1885–1959), U.S. professor of civil and structural engineering, who revolutionized the calculation of moments in a continuous framework, was born at Farmers Delight plantation, Nansemond county, Va., on Feb. 10, 1885. After some years of teaching, interspersed with periods spent gaining engineering experience, he was appointed professor of structural engineering at the University of Illinois in 1921. In 1937 he was appointed professor of civil engineering at Yale, becoming professor emeritus on his retirement in 1951. He died at Virginia Beach, Va., on Feb. 11, 1959.

Cross's outstanding contribution to the theory and practice of structural engineering lay in his method of calculating moments in the members of a continuous framework. By its use, calculation can be carried to any required degree of accuracy by successive approximations, thus avoiding the immense labour of solving simultaneous equations that contain as many variables as there are rigid joints in the frame. The method, first announced in 1930 in a paper to the American Society of Civil Engineers, is known as the moment distribution method, or simply the Hardy Cross method.

Cross also successfully applied his mathematical methods to the solution of pipe network problems that arise in municipal water supply design; these methods have been extended to other pipe networks such as gas pipeline systems.

Cross was awarded honorary doctorates by several U.S. universities, and medals by a number of U.S. professional bodies. In 1958, as a recognition of the world-wide significance of his work, the (British) Institution of Structural Engineers awarded him its gold medal. (S. B. HN.)

CROSS, RICHARD ASSHETON CROSS, 1ST VISCOUNT (1823–1914), English statesman, the greatest home secretary of the 19th century, was born at Red Scar, near Preston in Lancashire, on May 30, 1823. He was educated at Rugby, where one of his school friends was Edward Stanley, afterward 15th earl of Derby and a future cabinet colleague, and at Trinity college, Cambridge. He was called to the bar by the Inner Temple in 1849 and quickly built up a large practice in Lancashire. He sat in the house of commons as Conservative member for Preston from 1857 to 1862, when business commitments forced him to give up his seat. He returned to parliament in 1868, defeating Gladstone for South-West Lancashire. During the whole of this time he was very active in local government.

In 1874 Disraeli brought Cross into his cabinet as home secretary despite his complete lack of ministerial experience, describing this action to Queen Victoria as an "almost unexampled mark of confidence." It was a key position, for the whole success of Disraeli's policy of social reform depended upon it. In 1875 Cross carried the Artisans' Dwelling act, which empowered municipal authorities to acquire and demolish slums and to build, own and let their own housing; the Public Health act; two acts reinterpreting Gladstone's trade union legislation of 1871 in a sense more favourable to the unions; and a Factory act. Other measures brought in by Cross codified existing legislation governing factories and the sale of food and drugs, and provided for the transfer of prison management from local to central government and for the preservation of open spaces near large towns. If this legislation, showing that "Tory democracy" was no mere phrase, was inspired by Disraeli, it is nonetheless true that Cross was more than a mere

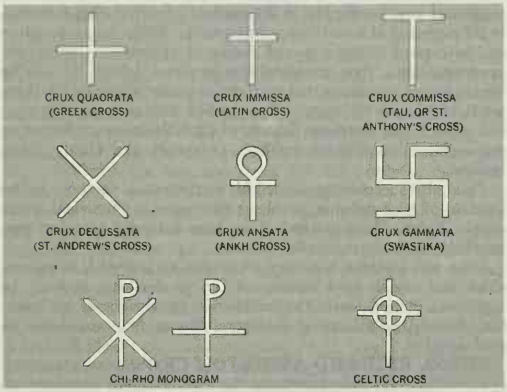
executor of detail. He shaped policy too.

Between 1880 and 1885 Cross's star began to wane. He was on bad terms with Lord Randolph Churchill and, although he was home secretary in Lord Salisbury's fleeting government of 1885, he was sidetracked to the India office from 1886 to 1892 and elevated to the peerage. He was lord privy seal from 1895 to 1900. He died near Broughton-in-Furness, Lancashire, on Jan. 8, 1914.

There was nothing brilliant about Cross, but he was efficient and shrewd, essentially a man of business rather than a debater or orator, and he achieved more than many people with far greater superficial talents. (R. N. W. B.)

CROSS, the principal symbol of the Christian religion, recalling the crucifixion (*q.v.*) of Jesus Christ and the redeeming benefits of his passion and death. The cross is thus both a sign of Christ himself and of the faith of Christians. In ceremonial usage, marking a sign of the cross may be, according to the context, an act of profession of faith, a prayer, a dedication or a benediction.

There are four basic types of iconographic representations of the cross: (1) the *crux quadrata,* or Greek cross, with four equal arms; (2) *crux immissa,* or Latin cross, whose base stem is longer than the other three arms; (3) *crux commissa,* in form of the Greek letter tau, sometimes called St. Anthony's cross; and (4) *crux decussata,* named from the Roman *decussis* or symbol of the



TYPES OF CROSSES

numeral 10, also known as St. Andrew's cross. Tradition favours the *crux immissa* as that on which Christ died (*cf.* Matt. xxvii, 37), but some believe that it was a *crux commissa.* The manifold variations and ornamentations of processional, altar and heraldic crosses, of carved and painted crosses in churches and graveyards, etc., are developments of these four types.

Pre-Christian Crosses.—Cross forms were used as symbols, religious or otherwise, long before the Christian era in almost every part of the world, though it is not always clear to what degree they may be simply marks of identification or possession or may bear significance for belief and worship. Two pre-Christian cross forms have had some vogue in Christian usage. The ancient Egyptian hieroglyphic symbol of life—the *'ankh,* a tau cross surmounted by a loop and known as *crux ansata*—was adopted and extensively used on Coptic Christian monuments. The swastika—called *crux gammata,* its form being composed of four Greek capitals of the letter gamma—is marked on many early Christian tombs as a veiled symbol of the cross. This symbol had a wide diffusion before the Christian era in Europe, Asia and America, and is commonly thought to have been an emblem of the sun or fire, and hence of life. (As revived in Nazi Germany, from the mistaken fancy that it was a Nordic symbol, it was intended as both a substitute for and a caricature of the Christian cross.)

Many Jewish ossuaries dating from the 1st century A.D. have been discovered in Palestine bearing tau crosses, either carved or marked in charcoal. Some scholars consider these to be the oldest identifiable signs of Christian burial; others consider them to be Jewish eschatological symbols, based upon Ezek. ix, 4, the sign of the letter *taw* (the last letter of the Hebrew alphabet, corresponding to the Greek tau), marked on the forehead of the righteous for protection in the coming judgment. But the early Christians, as both Tertullian and Origen indicate, understood the Ezekiel passage as a prophecy of the sign of the cross. It may be that the ossuary marks have no religious significance and are merely identification signs.

Earliest Christian Crosses.—Before the peace of the church under Constantine, Christians were extremely reticent about the portrayal of the cross, lest too open a display of it expose them to ridicule or danger. In general, they preferred to employ a cryptic substitute (*crux dissimulata*), of which the commonest examples on burial slabs are the anchor, ax, trident and swastika. Christian writers also saw the "sign of the cross" hidden in many natural phenomena and objects: shipmasts, plows and other tools, military standards (*vexilla*), birds on the wing and the human body standing with arms extended at prayer (the *orans*). In contrast, however, to their caution about pictorial images of the cross, the Christians frequently used the ceremonial gesture of signing the cross to fend off demonic spirits. Tertullian said:

> At every forward step and movement, at every going in and out, when we put on our clothes and shoes, when we bathe, or sit at table, or light the lamps, or go to bed or sit down, and in all the ordinary actions of daily life, we trace upon the forehead the sign of the cross.

Hippolytus reminded Christians that this signing against the devil was a reminder of the "seal" of their baptism, when the bishop laid his hands upon them, anointed them with chrism and signed their foreheads after they had come out of the baptismal water.

The zealous sect of Montanists frequently inscribed crosses on their funerary monuments in Phrygia, but elsewhere examples of indisputably Christian crosses on tombs or objects are very rare. In the Roman catacombs, a Greek cross embellishes an inscription in the Lucina crypt of St. Calixtus, a tau cross is inscribed on a graffito in the subterranean mausoleum of the "Innocents" at St. Sebastian, and a Latin cross appears in a fresco of the (probably Gnostic) Hypogeum of the Aurelii on the Viale Manzoni. None of these crosses is earlier than the end of the 2nd century.

Much debated is the significance of a T-shaped cross marked in the plaster of a house at Herculaneum (destroyed in A.D. 79), whether it indicates the private oratory of a Christian or is merely the trace of a wall bracket or shelf. Equally enigmatic are the origin and meaning of the Sator-Rotas magic square, of which the earliest examples have been found at Pompeii. In any case, it is certain that Christians had much to do with the wide diffusion of the square, discerning in it among other things a cryptogram of the cross:

R	O	T	A	S
O	P	E	R	A
T	E	N	E	T
A	R	E	P	O
S	A	T	O	R

The Cross After Constantine.—Constantine's conversion to Christianity, on the eve of his victory over Maxentius in 312, was related to his vision of the "heavenly sign" of the cross which he believed to be a divine pledge of his triumph. Though the accounts of his vision as recorded by Lactantius and Eusebius differ in details, there is no question that Constantine promoted, as symbols of the Christian faith, both the cross and the chi-rho monogram of the name of Christ. He exhibited them, both separately and in combination, upon his military standards and armour, his statues and his coins, and in the decorations of his palaces. In

particular, the remodeling of the standard of the troops, the so-called *labarum*, in the form of a cross surmounted by the chi-rho, was symbolic of his aim to place the empire under the protection of the saving sign of Christ. The symbols became immensely popular on Christian *objets d'art* and funerary monuments, notably the so-called "passion sarcophagi" that date from *c.* 350 onward (a celebrated one is the Lateran museum sarcophagus no. 171); and impressive mosaics of the monogram set in a starry sky adorned a wall niche in Santa Costanza at Rome, of the early 4th century, and ceilings in the baptisteries of Naples and Albenga, of the 5th century.

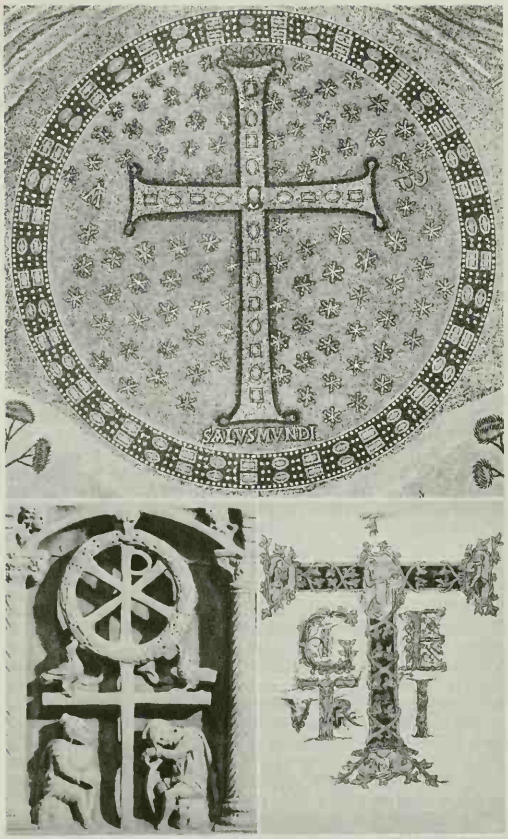
A primary stimulus for devotion to the triumphal trophy of the cross was the erection at Constantine's initiative of the basilica and rotunda at Jerusalem over the supposed sites of the crucifixion and resurrection. Eusebius described the discovery of the Holy Sepulchre and the layout and adornment of these buildings. No reference to any finding of the true cross, however, is made by Eusebius or by the pilgrim of Bordeaux (A.D. 333). But Cyril of Jerusalem, in lectures to catechumens about 350, mentioned the existence of the wood of the true cross, pieces of which had been "distributed all over the world," and a letter of Cyril to the emperor Constantius II related the apparition of "a gigantic cross of light in the sky above holy Golgotha" on May 7, 351.

By the end of the 4th century, Ambrose, Rufinus and others knew the tradition of the "invention" or finding of the true cross by Constantine's mother, Helena, on her visit to the holy places in 326. According to the legend, three crosses had been found deep in the ground, together with the superscription placed over Christ's head and the nails with which he was crucified. A miraculous cure had identified the true cross. Helena sent her son two of the nails, one in a diadem, the other in a bridle. The basilica of Santa Croce in Rome, built in a palace of Helena, exhibits to this day a piece of the cross and the superscription plaque, and one of the nails is said to be preserved in the iron crown of Lombardy, venerated at Monza.

On a rocky mound of the open court between the basilica and rotunda of the Holy Sepulchre, a large commemorative metal cross was erected, which Theodosius II in 417 encased with gold and precious jewels. A representation of this cross, as it appeared *c.* 400 with the buildings around it, may be seen in the apse mosaic of Santa Pudenziana in Rome. (The cross, however, may be later than most of the mosaic, a restoration having been carried out late in the 8th century.) This cross inspired many artistic representations of a jeweled or flowering cross, among which may be named the cupola mosaics of the mausoleum of Galla Placidia at Ravenna, and the church at Casaranello, and the apse mosaic of S. Apollinare in Classe at Ravenna; and among smaller objects, a 5th-century ivory cover of the Gospels-book in the Milan cathedral.

Many representations occur on the little bottles (ampullae) which pilgrims to the Holy Land brought home filled with consecrated oil from the lamps of the sacred places; a famous collection of them is in the cathedral treasury at Monza. Persons fortunate enough to obtain filings from the true cross kept them in caskets (*staurothecae*) of precious metal, ivory or enamel, often of a cross shape and hung from a chain around the neck, thus originating the pectoral cross (*encolpion*), which in modern times has become a distinguishing insigne of prelates. (Other relics, of course, were deposited in these crosses and caskets, and pectoral crosses were not always reliquaries.) The Museo Sacro of the Vatican possesses several precious examples of these crosses, as does also the Victoria and Albert museum in London, ranging in date from the 6th to the 9th centuries. Among the treasures of Durham cathedral is the pectoral cross buried with St. Cuthbert in 687, a gold cross with cloisonné work inset with garnets, generally considered to be English work of the 7th century.

Two festivals of the cross commemorate the Jerusalem traditions. The more ancient one, a major feast of the Eastern Churches, is the Exaltation of the Holy Cross (Holy Cross day) on Sept. 14, which goes back to the dedication of the Church of the Holy Sepulchre in 335. The feast was introduced in the west in the 7th century, when it had become doubly famous by the emperor Heraclius' recovery and restoration of the true cross in 629, which the Persians had taken when they captured Jerusalem in 614. In the same century a feast of the Invention of the Holy Cross on May 3 appears in calendars of Gallican service books; this feast was added to the Roman calendar in the 9th century.



(TOP) AND (BOTTOM LEFT) ALINARI; (BOTTOM RIGHT) BY COURTESY OF THE BIBLIOTHEQUE NATIONALE, PARIS

(TOP) CRUX IMMISSA, DETAIL OF THE MOSAIC VAULT OF S. APOLLINARE IN CLASSE, RAVENNA, ITALY, 6TH CENTURY; (BOTTOM LEFT) CHI-RHO CROSS FROM THE PASSION SARCOPHAGUS #171 IN THE LATERAN MUSEUM, ROME, 3RD–4TH CENTURY; (BOTTOM RIGHT) CRUX COMMISSA, ILLUMINATED INITIAL FROM THE DROGO SACRAMENTARY, 9TH CENTURY, IN THE BIBLIOTHÈQUE NATIONALE, PARIS

Of the services developed at Jerusalem around the holy places, those of Holy Week deeply affected the pilgrims. One of these, the veneration of the relic of the cross on Good Friday, was widely disseminated, and survives today in the Good Friday rites of the Roman Catholic Church, as the Veneration of (or Creeping to) the Cross. This devotion is mentioned in the late 4th century in the account of the pilgrim Etheria and by the poet Prudentius. A gift of a relic of the true cross made by Justin II to the Abbey of the Holy Cross in Poitiers in 569 inspired the famous hymns of the cross by Venantius Fortunatus, the *Vexilla regis* and *Pange lingua gloriosi*, used in the Roman liturgy. During the iconoclastic controversy of the 8th–9th centuries, the propriety of the veneration of the cross, as of other religious images, was debated in both the Eastern and Western churches.

Crucifix.—For several centuries after Constantine, Christian devotion to the cross centred in its indication of the victory of Christ over the powers of evil and death. Indeed, the Fathers of

the Church often explained the cross as a cosmic sign of Christ's universal dominion—its four projections reaching out to embrace and bring under his subjection "the breadth and length and height and depth" (*cf.* Eph. iii, 18) of all creation. Realistic portrayal of his suffering was avoided. The earliest "crucifixion" scenes known depict Christ alive, with eyes open, standing rigid against the cross with his arms straight out, his Godhead manifest, even though he is pierced and dead in his manhood. Two types may be distinguished: an "Eastern," in which Christ wears a long sleeveless tunic (the *colobium*), and a "Western," in which he is nude except for a loin girdle. The Eastern type, created in Palestine, is best represented in the late 6th-century miniature of the Rabula Codex of the Gospels, now in Florence; a mural in Santa Maria Antiqua at Rome; and a painted wooden reliquary from the Lateran *Sancta Sanctorum*, now in the Museo Sacro of the Vatican. Two early examples of the Western type are an ivory casket in the British museum and a wooden panel on the doors of Santa Sabina at Rome. The date of these is disputed, but they cannot be earlier than the 5th century. The eastern type is found in Irish miniatures, but the other type prevailed in the west from the Carolingian period.

By the 9th century, artists began to stress more and more the realistic aspects of Christ's suffering and death. In the east, the struggle with iconoclasm led to acceptance of an iconographic portrayal of a nude, dead Christ, in reaction to the monophysite tendencies of the iconoclasts to overstress the Godhead of the Son of God and hence to reject the propriety of figured representations of his humanity. But the Eastern Church has nonetheless maintained, since the iconoclastic controversy, a strong aversion to sculptured portrayals in the round. The churches of the west have never shown such caution.

The Western approach to the cross, stemming particularly from St. Augustine, has been less concerned with the cosmic and creedal connotations than has the Eastern. It has been more subjective, personal and mystical, emphasizing the cross as the supreme expression of the divine charity, and—during the medieval period in particular—finding in the suffering of the Redeemer remedy for sin and consolation for the tragedy of life. Western portrayals of the crucifixion, whether painted or carved, exhibited an increasing finesse in the suggestion of pain and agony. Romanesque crucifixes, with all their stark simplicity, show often a royal crown upon the head of Christ; but the later Gothic type replaced it with a crown of thorns. The ultimate horror of Christ's agony is perhaps brought to a climax in Mathias Grünewald's Isenheim altar paintings (completed *c.* 1515–16), in the Colmar museum. Renaissance artists tended to soften and humanize the Gothic realism of the crucifixion; baroque artists gave the scene great drama.

A new iconography inspired by ancient models emerged in the 20th century, especially for crucifixes in liturgical settings: the *Christus Rex*, in which Christ on the cross is crowned and vested as a king and priest, and the marks of his suffering are much less prominent.

Other Medieval Crosses.—The custom of carrying a cross before church processions, which can be traced back to the 6th century, may have been borrowed from the court ceremonial of the Roman emperors. An ivory from Constantinople, now in the cathedral of Trier, shows a procession for the translation of relics led by the emperor and empress, the latter carrying a cross. Bede relates that when Augustine and his fellow monks entered Canterbury in 597 a silver cross and a banner with an icon of Christ were borne in their procession. Seven silver processional crosses, one for each region of the city, are mentioned in the 7th-century *Ordines* that describe the processions before the papal stational masses at Rome. In medieval times the processional cross was placed near or behind the altar during the celebration of mass; and from the 13th century onward, the cross itself came to be detached from its staff and placed directly on the altar. Not until the missal of Pius V, however, was the placing of a cross or crucifix on the altar a requirement. From the 13th century also dates the privilege of archbishops to have a cross carried before them within the bounds of their province. In such processions, the image of the crucified Christ is customarily turned backward to face those who follow it. In the conventions of medieval iconography, an archbishop is distinguished from a bishop by a cross staff which he holds instead of the bishop's crosier.

From the earliest period of Christianity in Ireland, crosses were engraved on standing stone slabs—a means of Christianizing an ancient pagan cult of the standing stone. It was also the custom of Irish missionaries to erect crosses of wood (later of stone) to mark preaching stations, and similar crosses were set up beside their monasteries. From these traditions evolved the impressively carved free-standing crosses of stone that are such a distinctive feature of Celtic-Christian culture. These crosses have a circle about the intersection of the two beams—possibly suggested by the chi-rho monogram in a circle—and the carvings display not only the crucifixion, but scenes from the Old and New Testaments and the lives of the saints. The oldest ones in Ireland date from the 9th century, among the most famous being those of Muiredach, Monasterboice, Kells, Durrow and Clonmacnoise. From Iona the Celtic stone crosses were introduced to Scotland and Northumbria and thence to other parts of Britain. Those at Bewcastle and Ruthwell (near Dumfries), commonly dated to the late 7th century, are the most celebrated. Their carvings show marked stylistic influence from the art of the Mediterranean world. The Ruthwell cross bears a runic inscription with lines from the Anglo-Saxon poem *The Dream of the Rood*. Crosses such as these probably provided the inspiration in later medieval times for the erection of stone crosses in market places, churchyards and memorial sites, marking the stages of funeral processions of eminent personages.

The crusaders received the sign of the cross as a symbol of their vow to recover the true cross at Jerusalem from the infidel, and the crusading movement thus gave impetus to the use of the cross as a heraldic emblem. Best known is the Maltese cross of the Hospitallers, a white cross of eight points on a black ground. Heraldic crosses also appear on the ensigns of Christian countries: the English cross of St. George is a plain red cross on a white ground; the Scottish cross of St. Andrew is a plain diagonal white cross (a saltire) on a blue ground; and the Irish cross of St. Patrick is a plain diagonal red cross on a white ground. (*See* also FLAG: *The Use of the Cross;* HERALDRY.)

The Cross in Reformed Churches.—The Lutherans have generally retained the ornamental and ceremonial use of the cross and crucifix. The Calvinistic churches on the other hand consistently refused them until the 20th century, when ornamental crosses on church buildings, and even on communion tables, began to make an appearance. The Church of England would probably have followed the Lutheran example but for the determined opposition of Puritan prejudice. The English Church, however, stubbornly retained the ceremonial signing with the cross in the rite of baptism, and canon 30 (1604) presents a vigorous defense of the custom. Since the Tractarian movement of the mid-19th century, Anglican churches throughout the world have witnessed a revival of the use of the cross, and there are few parishes today without at least altar and processional crosses. Likewise the ceremonial use of the sign of the cross in giving absolution and benediction is common. The crucifix, however, is almost entirely confined to private devotional use.

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(M. H. SH.)

CROSSBILL, the common name for three species of northern finches of the genus *Loxia*, remarkable because the tips of the bill are crossed. This adaptation enables them to pry up the scales of the cones of evergreens and to extract the seeds with the tongue. In appearance, and as they climb about among the twigs, they resemble diminutive parrots. In North America the

red crossbill (*L. curvirostra*), often known simply as crossbill, ranges from northern evergreen forests southward in the mountains to North Carolina and western Mexico; it occurs also throughout Europe and across northern Asia.

The adult male is brick red with dusky wings and tail; the females and young are dull yellowish green. It is a sociable bird even when nesting.

Crossbills, which wander widely and erratically in search of pine cones, may stop to nest even in winter where food is abundant. The crudely built nest of twigs holds three or four pale greenish eggs spotted with olive and brown at the larger end. The male feeds the female as she incubates the eggs. The crossbill's sweet song is seldom heard; but its call note, given when the birds are flocking, is distinctive.

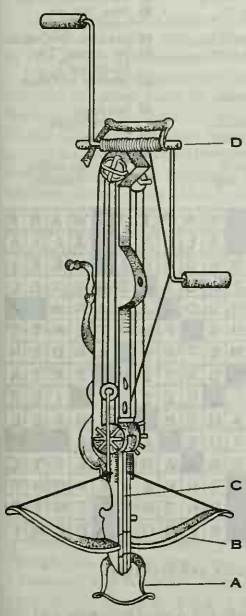
BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

RED CROSSBILL (LOXIA CURVIROSTRA)

The white-winged, or two-barred, crossbill (*L. leucoptera*), also found in both hemispheres, is somewhat more northern in range; it has an isolated race in the mountains of Hispaniola, West Indies. The parrot crossbill (*L. pityopsittacus*) is found in Scandinavia.

(Dn. A.)

CROSSBOW, or arbalest, the leading hand missile weapon of the middle ages prior to the introduction of firearms. Consisting of a short bow fixed transversely on a wooden stock, it had a groove to guide the missile and a trigger to release it. The wooden crossbow could be drawn by hand, but the most effective type had a steel bow so stiff as to require a small winch. The stock terminated in a stirrup that enabled the soldier to hold the weapon in position with his foot while operating the winch with both hands. A square-headed bolt known as a "quarrel" was the standard ammunition. About ten inches long, its maximum range was 300 yd. It could be fired with considerable accuracy and could pierce all but the stoutest body armour.



PARTS OF THE CROSSBOW

(A) stirrup for reloading; (B) steel bow; (C) slot for guiding missile; (D) winch for retracting steel bow

Not much is known about the origins of the crossbow but it probably evolved in Italy early in the middle ages. At any rate, the Italian city states were among the first to adopt the weapon, and Genoese crossbowmen hired out to all the armies of Europe. As the name "arbalest" implies (from the Latin *arcu,* "bow," and *ballista,* "engine of war"), it was simply a small ballista bearing the same relation to that engine of war as the musket to the cannon.

Such was its effectiveness, as compared to conventional bows of the age, that several popes interdicted the crossbow (except against infidels) on the ground that its use constituted an atrocity. Nevertheless, it proved to be the most effective hand missile weapon of the crusaders in their battles with the Saracens. Richard the Lionhearted won the battle of Arsuf (1191) largely because of the havoc wrought among Saladin's forces by Christian crossbows.

When the relative merits of crossbow and English longbow were tested on the field of Crécy (1346) the longbow appeared to advantage. But the poor showing of the Genoese crossbowmen may be charged chiefly to the inept tactics of their employers, the French knights. Actually the crossbow had several points in its favour: its ammunition was cheaper and less bulky; it could be fired from a reclining position; and its compactness made it better suited to firing from behind a wall or parapet. On the debit side, the crossbow was slower and less accurate, though it must be remembered that the English archers had no equals in Europe.

Even after the advent of firearms the crossbow held its own until the introduction of the arquebus (*q.v.*) in the late 15th century. Its merits have been demonstrated in the 20th century by sportsmen who have used it successfully for hunting large game. Enough interest was shown in the United States during the 1950s so that the crossbow was manufactured and sold commercially on a small scale.

See Sir Ralph Payne-Gallwey, *The Cross-bow* (1903). (Ln. Ms.)

CROSSETTE, in architecture, a projection at the upper corners of the architrave of an opening, when the top or lintel projects on either side beyond the width of the architrave below. In this sense it is synonymous with "ancon." The form developed through primitive construction in which the lintel stone was much wider than the opening, but remained commonly in use in all the classic styles. The term also applies to a projection on a voussoir which fits into a corresponding space in the adjoining voussoir.

CROSSOPTERYGIAN, the name of a major group (Crossopterygii) of bony fishes, prominent in Upper Paleozoic (120,000,000-year period initiated 320,000,000 years ago) freshwater deposits and important as the group from which land vertebrates appear to have been derived. The group, except for a single aberrant survivor, *Latimeria,* has been long extinct (*see* Coelacanth).

The typical crossopterygians, the Rhipidistia, flourished in the Devonian but then declined in importance and disappeared shortly after the opening of the Permian. The skull roof has a complex pattern of bones, most of which can be compared with those present in early land animals; similar comparisons can be made in jaw and palate structure. The brain case is distinctive in that it is completely divided into front and back halves and has a large canal, housing an anterior prolongation of the notochord, beneath the posterior segment—features not present in typical land animals (or, indeed, in other fishes) and once thought to debar crossopterygians from the ancestry of higher vertebrates; however, very ancient fishlike amphibians (*q.v.;* Ichthyostegalia), described from the late Devonian of Greenland, have the notochordal canal and traces of a brain-case division.

The paired fins, where known, have a skeleton showing a single element in the proximal segment (closest to the body), two in the second and an irregularly branching arrangement beyond—a pattern from which the vertebrate land limb can be readily derived. Lungs and internal nostrils were presumably present. Although no specific form can be identified as actually ancestral, it is reasonable to believe that the rhipidistian crossopterygians included the forebears of the amphibians and hence of all land vertebrates.

In the Late Devonian appeared the Coelacanthini, a specialized side branch of the crossopterygians, various members of which took to the sea and have been identified in the fossil record as late as the Cretaceous period. The *Latimeria* belongs to this group.

(A. S. Rr.)

CROSS RIVER, in Nigeria, rises in the mountains of southern Cameroon and flows in a great arc northward round the Oban hills before reaching its estuary. Its total length is about 300 mi., and during the rains it forms an important routeway. River steamers can reach Itu at all seasons, Ikom from June to November and Mamfe during August and September. The lower stretches of the river are bordered by mangrove swamp, but the upper reaches flow through high forest, which includes mahogany and the ubiquitous oil palm.

The estuary of the Cross river is really the drowned lower part

of its valley. It has been suggested that the Benue originally reached the sea at this point, an explanation which would help to account for the broad plains of the lower Cross basin and the low northern watershed. The estuary is the only major break in the Nigerian coast line which is not impeded by a sand bar across its mouth, and this fact, coupled with a moderate tidal range (9 ft. at Calabar), makes the Cross river the finest natural port approach in Nigeria. Unfortunately the remote position of Calabar and the absence of railway connection with the rest of Nigeria have neutralized these advantages. (J. C. PH.)

CROSSWORD PUZZLE, the most popular form of word puzzle. A crossword puzzle consists of a diagram, usually rectangular, divided into blank (white) and canceled (black, shaded or crosshatched) squares. This is accompanied by two lists of numbered definitions, one for the horizontal and the other for the vertical words, the numbers corresponding to identical numbers on the diagram. Into each of the blank squares of the diagram a certain letter of the alphabet is to be inserted, forming the words fitting the numbered definitions. In properly keyed puzzles most of the letters form a part of two interlocking words, one running down and one across, and when the proper solution is fitted all the words cross each other, or interlock, which fact gives the puzzle its name.

The first crosswords appeared in England during the 19th century. They were of an elementary kind apparently derived from the word square, a group of words arranged so the letters read alike vertically and horizontally, and printed in children's puzzle books and various periodicals. However, it was in the United States that the puzzle developed into a serious adult pastime. The first modern crossword puzzle was published on Dec. 21, 1913 in the *New York World's* Sunday supplement, *Fun*. It appeared as only one of a varied group of mental exercises, but it struck the fancy of the public so favourably that the desire for crosswords spread immediately. By 1923 they were being published in most of the leading newspapers and were the most talked of form of entertainment in the United States. Within a few months the craze reached England to take it by storm. In the United States and England the impetus supplied by the initial surge of popularity made the puzzles first a national fad and then a well-entrenched habit. Almost all daily newspapers in the United States and Great Britain have a crossword feature of some kind.

Crosswords in multiple forms are found in almost every country and language. Scholars have even gone so far as to adapt them into Latin. Advocates claim the puzzles are both a pastime and an interesting means of improving the vocabulary. Though the majority of puzzles are confined to symmetrical patterns of shaded or blacked-out squares (*see* fig.) within a rectangle, there are many variations. These include (*a*) an asymmetrical scattering of squares; (*b*) a plain diagram with no squares canceled and the ends of words marked simply by a thick line; (*c*) isolated but quite successful examples of pictorial designs, either in outline containing the diagram, or in line inside the diagram, or a combination of both; (*d*) diagramless puzzles with no clue given to the position or length of the words.

The general type of crossword has also been subject to variation. Some puzzles employ abstruse definitions, puns and anagrams. A number of words in one puzzle may bear upon some announced theme such as music, sports, literature or geography. Many of the puzzles in this category are difficult and serve as the medium for a generally recondite examination of the theme. Again, some clues will be omitted altogether, but a direction be given that the words thus neglected belong to a particular class: jewels, for example, or the words in a quotation. Sometimes every word will have some given prefix, suffix, or part in common, and only the rest of the word will actually fill the spaces in the diagram; (cat)alepsy, (Cat)hay, etc.; unc(tion), cap(tion), etc.; qu(it)e, cr(it)ic, etc.

Among well-known series of collections have been the *Cross Word Puzzle Books* and *Crossword Puzzle Omnibuses*, edited by Margaret Petherbridge Farrar; the *Giant Crossword Puzzle Books*, edited by A. M. Lownsbery; *Double-crostics*, edited by E. S. Kingsley and Doris Nash Wortman; and collections of puzzles that have appeared in the *New York Times*, the *London Daily Telegraph*, the *Manchester Guardian*, the *New Statesman* and the *Edinborough Scotsman*.

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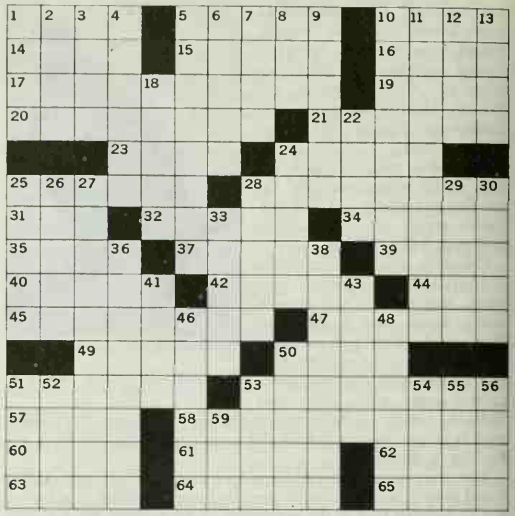

ACROSS

1 Incarcerate.
5 Royal name in France.
10 Distort.
14 Melville work.
15 Solo.
16 Inter ——.
17 Louisiana city.
19 Military cap.
20 Clean, as a dust mop.
21 Philadelphia Institute.
23 Dull sound.
24 Tia ——.
25 Winy.
28 Camping gear.
31 Role for Richard Boone.
32 Tin or copper.
34 Scene of "As You Like It."
35 London stables.
37 Office machine.
39 Portuguese Miss.
40 Sneak about.
42 Adjust, as a clock.
44 Noun suffix of agency.
45 Pennant.
47 Make lower in quality.
49 "—— pray."
50 Osprey's cousin.
51 Mountain ridges.
53 Sweet liqueur.
57 Tibetan sheep.
58 Louisiana city.
60 Common: Comb. form.
61 Tidal bore.
62 Put into circulation.
63 Fastener.
64 Track of the lion.
65 Attican township.

DOWN

1 Positions.
2 Oriental nurse.
3 Jot.
4 Take care of.
5 Painted the town red.
6 Audible.
7 Sulk.
8 Language: Abbr.
9 Got ready to drive.
10 Bugles, bells, etc.
11 Louisiana city.
12 Mature.
13 Container.
18 Biblical name.
22 Pro ——.
24 Author Verne.
25 Parts of boots.
26 French composer of "Escales."
27 Louisiana city.
28 19th cen. stylist.
29 Heads: Fr.
30 Attractive but risky thing.
33 Weight deductions.
36 Tropical American tree.
38 Valley of western song.
41 It's better than never.
43 All wound up.
46 Rumples.
48 Blew the car horn: Slang.
50 January, in Cadiz.
51 He wrote "The Nazarene."
52 Mother of Greek gods.
53 Southern constellation.
54 Volume.
55 Clip.
56 Feminine suffix.
59 Luck: Archaic.

J	A	I	L	■	C	A	P	E	T	■	W	A	R	P
O	M	O	O	■	A	L	O	N	E	■	A	L	I	A
B	A	T	O	N	R	O	U	G	E	■	K	E	P	I
S	H	A	K	E	O	U	T	■	D	R	E	X	E	L
■	■	■	T	H	U	D	■	J	U	A	N	A	■	■
V	I	N	O	U	S	■	P	U	P	T	E	N	T	S
A	B	E	■	M	E	T	A	L	■	A	R	D	E	N
M	E	W	S	■	D	A	T	E	R	■	S	R	T	A
P	R	O	W	L	■	R	E	S	E	T	■	I	E	R
S	T	R	E	A	M	E	R	■	D	E	B	A	S	E
■	■	L	E	T	U	S	■	E	R	N	E	■	■	■
A	R	E	T	E	S	■	A	N	I	S	E	T	T	E
S	H	A	S	■	S	H	R	E	V	E	P	O	R	T
C	E	N	O	■	E	A	G	R	E	■	E	M	I	T
H	A	S	P	■	S	P	O	O	R	■	D	E	M	I

THE NEW YORK TIMES

SAMPLE CROSSWORD PUZZLE AND SOLUTION

Solvers and Setters (1956); E. M. Lane, *Rapid Crossword Solver* (1958). (G. E. Lr.; M. Dl.)

CROTCHET: *see* Musical Notation.

CROTHERS, RACHEL (1878–1958), U.S. playwright and one of the few women directors in the history of the American stage, was born in Bloomington, Ill. She died at Danbury, Conn., on July 5, 1958. Her professional career began in 1906 with the success of her first full length play, *The Three of Us*. For the next three decades, until *Susan and God* (1937), Broadway saw an average of one new Crothers play each year, the majority of them popular and critical successes, an achievement unequaled by any other American woman playwright. Her plays accurately reflected, better than those of any other dramatist during this period, the position of women in American society.

Miss Crothers chronicled, sometimes seriously, more often humorously, such timely problems as the double standard (*A Man's World,* 1910), trial marriage (*Young Wisdom,* 1914), flaming youth and the problem of the younger generation (*Nice People,* 1921; *Mary the Third,* 1923), Freudianism (*Expressing Willie,* 1924) and divorce (*Let Us Be Gay,* 1929; *As Husbands Go,* 1931; *When Ladies Meet,* 1932). These and other successes, such as *Old Lady 31* (1916), *A Little Journey* (1918) and *39 East* (1919), were marked by simplicity of plot, the happy ending and expert dialogue, which shrewdly combined instruction and amusement, sentimentality and humour, tears and laughter. Her comedies always advocated the classic ideals—sanity, moderation and the balanced view of life. Most of the plays were published.

Miss Crothers took full responsibility for the entire production of almost all her plays, casting and directing such stars as Carlotta Nillson, Maxine Elliott, Emma Dunn, Francine Larrimore, Christal Herne, Lily Cahill, Frieda Inescort, Tallulah Bankhead, Katharine Cornell and Gertrude Lawrence. Never an ivory tower dramatist, during World War I she was founder and president of Stage Women's War Relief; during the depression of the 1930s she was founder and president of the Stage Relief fund, which aided needy theatre folk; and during World War II she helped organize and directed the American Theatre Wing, famous for the Stage Door Canteens.

The best and most instructive statement of her dramatic theory is to be found in her essay, "The Construction of a Play," collected in *The Art of Playwriting* (1928). (I. An.)

CROTONA (Croto or Croton; mod. Crotone), a Greek town in southern Italy on the east coast of the territory of the Bruttii (mod. Calabria), 7 mi. N.W. of the Lacinian promontory (Capo Colonne). It was founded by Achaeans led by Myscellus *c.* 710 B.C. Like Sybaris (*q.v.*), it soon became a city of power and wealth. It was especially celebrated for its successes in the Olympic games from 588 B.C. onward, Milo (*q.v.*) being the most famous of its athletes. The philosopher Pythagoras established himself there *c.* 530 B.C. and formed a society of 300 disciples sympathetic toward aristocracies. In 510 B.C. Crotona was strong enough for its people to defeat the Sybarites and raze their city to the ground. At this time many smaller cities were allied to Crotona. Shortly after the sack of Sybaris the disciples of Pythagoras were driven out and a democracy was established. In the 4th and 3rd centuries it suffered from the attacks of Dionysius I of Syracuse, who became its master for 12 years, of the Bruttii and of Agathocles of Syracuse, and even more from the two invasions of Pyrrhus, king of Epirus, in 280–278 and 275, between which in 277 the Romans obtained possession of it. Livy states that the walls had a length of 12 mi. but that after the wars with Pyrrhus about half the area between them had ceased to be inhabited.

During the Second Punic War, Crotona revolted from Rome after the battle of Cannae in 216 B.C.

The importance of the city was mainly due to its harbour, which, though not a good one, was the only port between Tarentum (Taranto) and Rhegium (Reggio). The original settlement occupied the hill above it (143 ft.) and later became the acropolis. Its healthy situation was famous in antiquity, and to this was ascribed its superiority in athletics; it was the seat also of a famous medical school mentioned by Herodotus. On the Lacinian promontory was the famous temple of Hera Lacinia of which only one column is standing. It was approached by a processional way from Crotona, which, in front of the gate into the enclosure wall, was about 20 yd. wide. The full uncovering of the sanctuary was begun about 1955.

The ancient site was occupied by the medieval Cotrone. There ensued a long period of obscurity, terminated about 1921 by a commercial and industrial revival; the ancient name, in Italian *Crotone,* was resumed in 1928. Pop. (1957 est.) 39,118 (commune).

CROTON OIL (Oleum Tiglii), an oil prepared from the seeds of *Croton tiglium* (family Euphorbiaceae), a tree native or cultivated in India and the Indonesian archipelago. Its use as a drug apparently originated in China; it was unknown to the ancient Hindus. In the 16th century the Dutch introduced it into Europe, where it had alternate periods of favour and disfavour as a medicinal agent. The seeds resemble those of the castor-oil plant but do not have a polished or mottled appearance. The kernels contain from 50% to 60% of oil, which is obtained by bruising them to a pulp and expressing between hot plates. The oil is a brownish or pale yellow transparent and viscous liquid with an acrid persistent taste and a disagreeable odour. The active component of the oil is not known with certainty but appears to be associated with a solid fraction known as croton resin.

Applied to the skin, croton oil acts as a powerful irritant, inducing so much inflammation that definite pustules are formed. Taken internally, even in minute doses, it soon causes colic and a fluid diarrhea; larger doses produce severe inflammation of stomach and bowels. These effects may follow absorption of the oil by the skin. Croton oil was formerly employed as a purgative or as a counter-irritant, but it is now considered too dangerous for medicinal use. It is sometimes used in veterinary medicine as a purgative.

(V. E.)

CROTUS RUBIANUS (Johannes Jäger) (*c.* 1480–*c.* 1539), German humanist, was born at Dornheim and educated at Erfurt, later becoming professor of theology at Cologne. In 1515 he contributed to the collection *Epistolae Obscurorum Virorum,* his satirical letters on scholasticism and monasticism. After four years in Italy, he became rector of Erfurt university (1520) and there entertained Martin Luther. Three years later he went to Fulda, but finally settled in Halle, where he reverted to his old religion (*c.* 1530) and became a canon. His *Apologia* appeared at Leipzig 1531.

CROUP is an acute affliction of children characterized by harsh cough, hoarseness and laboured breathing. These symptoms result from inflammation of the membranes of the larynx and spasm of the laryngeal muscles. Allergy or physical irritation (such as cold air) occasionally cause this reaction, but it is usually caused by infection of the area. Croup occurs most commonly during early childhood because of the greater susceptibility of young children to respiratory infections and because of the size and structure of the larynx at that time of life.

In treatment, steam inhalations may afford considerable relief. The effectiveness of antibiotics depends upon the sensitivity of the microorganism causing the particular infection. (M. O. B.)

CROUSAZ, JEAN PIERRE DE (1663–1750), Swiss theologian, philosopher and controversialist whose letters to a wide range of correspondents reveal the intellectual climate of his time. Born at Lausanne, April 13, 1663, he was professor there from 1700 to 1724 (being twice rector of the university), and again from 1738 to 1749. In the interval, having left Switzerland as a result of theological disagreement, he held a chair at Groningen for two years, and from 1726 to 1732 was tutor to Prince Frederick of Hesse-Cassel. He died in Lausanne, Feb. 22, 1750. Crousaz published numerous mathematical and philosophical works. His *Traité du beau* (1714) was an attempt to explain subjective differences in aesthetic outlooks. With the encouragement of Cardinal Fleury, he sought to refute the doctrines both of Pierre Bayle and of Leibniz. His critique of Pope's *Essay on Man* was translated into English by Samuel Johnson (1742). His greatest importance lies in his correspondence, which was still unpublished in the early 1960s, although about 2,000 letters had been located.

It brought him into touch with many leading figures in intellectual life: Ferchault de Réaumur, Antonio Conti, Fontenelle, Noel Antoine Pluche, Dortous de Mairan, Jean Bernoulli, Jean Paul Bignon, Jean Alphonse Turrettini, Jean Barbeyrac, Pierre Des Maizeaux, Louis Racine, J. B. Rousseau, Voltaire, Henri François D'Aguesseau and William Wake, archbishop of Canterbury.

See J. de la Harpe, *Jean-Pierre de Crousaz* (1955). (RT. S.)

CROW, a Siouan-speaking Plains Indian tribe known also as the Absaroka and linguistically and historically affiliated with the Hidatsa (*q.v.*) of the upper Missouri river. Probably lured by the trade in horses, the Crow broke with the Hidatsa and moved westward early in the 18th century. By 1740 the Crow had emerged as middlemen engaged in the trading of horses, bows, shirts and featherwork to the village Indians in return for guns and metal goods which they carried to the Shoshone in Idaho.

The Crow roamed the Yellowstone river and its tributaries, especially the Bighorn river, into Wyoming. They were divided into three bands known as the Mountain, River and Kicked-in-Their-Bellies. In 1868 they accepted reservation lands and in the early 1960s were situated on 2,282,764 ac. of former tribal lands in southeastern Montana. All but 14% of the reserve was owned by the Crow.

The majority of the Crow on the reserve had a sixth-grade education or more, and most of the families received an income of more than $2,000 per year. In population the Crow, at one time, may have numbered between 4,000 and 5,000. In 1955, 3,530 were enumerated for a per capita payment.

Much of Crow life revolved around the buffalo and the horse. The former provided them with food, clothing, robes, tepee covers, sinew thread, containers and shields. The Crow used the "surround" method of hunting and killed buffalo with sinew-backed and compound elkhorn bows. The processing and preparation of food, housing and clothing were tasks for the women. The meat was dried and stored in rawhide envelopes (parfleches). Clothing of both sexes was tailored of deer, elk and buffalo hide. Men commonly wore the two-piece soled moccasin, breechclout, hip-length leggings, shirt and buffalo robe. The war bonnet of eagle feathers was worn on ceremonial occasions by renowned warriors. Women covered themselves with a long sleeveless skin dress and almost knee-length moccasins.

The Crow traced their descent matrilineally. They were organized into 13 exogamous sibs which in turn were united into six unnamed phratries. Each sib had an outstanding warrior who acted as its chief. The kinship system was of the "Crow" type (*see* KINSHIP TERMINOLOGY). Paternal relatives were treated with respect and were feasted, but especially strong avoidances, including a taboo on conversation, characterized the son-in-law and parent-in-law relationship. Brothers and sisters were taught, out of respect, to avoid speech and bodily contact. However, a man could be familiar with potential spouses and with the wives of his own and sib brothers. These, together with a man's "joking relatives," commonly ridiculed him for his social errors.

The quest for a supernatural guardian who adopted his "child" was basic to Crow religious belief and practice. Fasting in isolation, wailing, and tormenting of the body with skewers passed through the chest and back tissues were usual practices to induce a vision. Mementos of this experience were gathered into a "medicine bundle." Among the Crow the most notable bundles were those associated with the sun dance, medicine arrows and tobacco. Tobacco, according to myth, was given to the Crow to overcome their enemies, and they cultivated it with ceremonial rite.

Warfare was largely a matter of raiding for horses, and victorious warriors were expected to dispose generously of their booty. The stylized coups which had to be completed before recognition as a chief reflect the psychology of the raid; as in (1) wresting a weapon from an enemy, (2) striking an enemy with a coupstick, (3) taking a horse tethered within the enemy camp and (4) leading a war party without loss of life. The bow and arrow, lance, shield and medicine bundle constituted the usual armament of the Crow warrior.

The recitation of war exploits was introduced into every religious and social occasion, and the sun dance (*q.v.*), the most important rite, was performed to attain vengeance. *See* also PLAINS INDIANS.

See Robert H. Lowie, *The Crow Indians* (1935). (F. W. V.)

CROW, a common name for several species of *Corvus*, family Corvidae, the largest of the perching birds. In the U.S. the common crow is *Corvus brachyrhynchos*, a deep-glossy-black bird from 17 to 21 in. long, with black bill and feet. The crows of England and the continent are the all-black carrion crow (*C. corone*) and the grayish-bodied hooded crow (*C. cornix*); both are large, chunky birds averaging 18 in. in length.

JOHN H. GERARD

COMMON CROW (CORVUS BRACHYRHYNCHOS)

Although the American common crow feeds largely on grain (a habit that makes it very unpopular with farmers), it also destroys quantities of harmful insects. In the central portions of Canada and the northern U.S., the crow is very destructive to nesting waterfowl as it is much addicted to eating their eggs. It is gregarious and at times forms large roosts, but does not nest in colonies. Each mating pair has its own nest of sticks and twigs, usually high up in a tree, in which are laid five to six, sometimes eight, greenish to olive eggs with darker speckles. Four races, or varieties, are recognized.

The carrion crow is resident in Britain and in much of southwestern Europe. It shares its range with the hooded crow. Both forms migrate south in winter, a line from the Firth of Clyde to the head of the Adriatic roughly dividing their summer homes; the carrion crow occurs to the southwest of this line, the hooded crow to the northeast. Where the ranges overlap, the two species appear to interbreed freely, sometimes producing intermediate types. The European crows feed on carrion, small birds, eggs, etc.; they build isolated nests and reproduce much the same as the American species.

Several other species of *Corvus* are common: the American northwestern crow (*C. caurinus*) occurs from Kodiak Island to Puget sound; the fish crow (*C. ossifragus*), along the Atlantic coast of North America; and the house crow of India (*C. splendens*), which is very tame and useful as a scavenger. The so-called carrion crow of the U.S. is the black vulture (*see* VULTURE). (HT. FN.)

CROWBERRY (CRAKEBERRY), a common name for a low-growing heathlike shrub (*Empetrum nigrum*) belonging to the family Empetraceae (*q.v.*), found in alpine situations throughout the northern hemisphere and also in the Andes. It has slender, wiry, spreading branches covered with short, narrow, stiff leaves, the margins of which are recurved to form a hollow cylinder concealing the hairy under surface. The minute flowers are succeeded by black, edible berrylike fruits, one-fourth to one-third inch in diameter, which are much eaten by birds. Crowberry finds limited use as an ornamental in the cool rock garden.

CROWDER, ENOCH HERBERT (1859–1932), U.S. army officer who administered the Selective Service act during World War I and later served as ambassador to Cuba. He was born in Edinburg, Mo., on April 11, 1859, and attended local public schools. He graduated from the U.S. military academy at West Point in 1881. After four years of Indian warfare (1881–85) in the cavalry, he was detailed as professor of military science at the University of Missouri, where he studied law and received a law degree. In 1891 he entered the judge advocate general's corps. During the Spanish-American War he was judge advocate of troops in the Philippines, where he served also as associate justice of the supreme court (1899–1901). He headed the first division (administrative affairs) of the U.S. army general staff in 1903 and was military observer with the Japanese army during the Russo-Japanese War (1904–05). He then went to Cuba (1906–08) as

secretary of state and justice and divised Cuba's first electoral laws. After attending the fourth Pan-American congress in Argentina, he became judge advocate general of the U.S. army in 1911.

When the U.S. entered World War I in 1917, Crowder's office drafted the Selective Service act (*see* CONSCRIPTION). At first Crowder doubted its practicality, but when the law was enacted in May 1917 he was appointed to administer it as provost marshal general. During earlier wars, dependence on state militia and volunteer regiments had greatly confused military mobilization. The draft was democratic in spirit and practice, and its administration was decentralized to local communities. Crowder presided over the registration of some 24,000,000 men and an increase in the armed forces from about 213,000 to more than 3,600,000 men, of whom 2,800,000 were inducted through selective service. This experience provided valuable precedents for World War II when selective service was re-instituted. Crowder described his contributions in *The Spirit of Selective Service* (1920).

After the war Crowder helped revise Cuba's electoral laws and served there as personal representative of President Wilson and President Harding until March 5, 1923, when he was named U.S. ambassador to Cuba. He retired on Sept. 1, 1927, upon completing 50 years of government service. He died in Washington, D.C., on May 7, 1932.

See David A. Lockmiller, *Enoch H. Crowder: Soldier, Lawyer and Statesman* (1955). (D. F. TR.)

CROWE, SIR EYRE (1864–1925), British diplomat who was a vigilant critic of German foreign policy in the years preceding World War I, was born at Leipzig on July 30, 1864, the third son of Sir Joseph Crowe, the art historian, and of Asta von Barby. He was educated in Germany and France and when he entered the British foreign service in 1885 could claim to be trilingual. His subsequent career was spent almost entirely at Whitehall and he never held a diplomatic post abroad, his ambition being to become head of the foreign office. Crowe was a prodigious worker and mastered the history and principles of British foreign policy with great thoroughness. In 1903 he married one of his German cousins, Clema Gerhardt, widow of Eberhardt von Bonin.

Crowe took an important part in reorganizing the foreign office in 1904 and 1905. In Jan. 1907 he wrote the memorandum, with which his name is historically associated, "on the present state of British relations with France and Germany." It had great influence on the foreign secretary, Sir Edward Grey. Crowe warned him that Germany aimed at the domination of Europe, that concessions would only feed its appetite and that the entente with France must not be abandoned. Crowe, who was knighted in 1911, became assistant undersecretary of state for foreign affairs in 1912. In 1914 he strongly pressed the case for British intervention against Germany and in 1919 he was one of the British plenipotentiaries at Versailles. He became permanent undersecretary at the foreign office in 1920. His health, which had never been good, broke down under the self-imposed strain of ceaseless work and he died at Swanage, Dorset, on April 28, 1925.

Crowe's great services were fully recognized by successive prime ministers and foreign secretaries, and the verdict of Stanley Baldwin—"We have lost the ablest servant of the crown"—was one that few would have cared to challenge. (R. N. W. B.)

CROWE, SIR JOSEPH ARCHER (1825–1896), English art historian who is best known for his collaboration with G. B. Cavalcaselle (*q.v.*), was also a foreign service official and journalist. He was born in London, Oct. 20, 1825, and passed his boyhood mainly in Paris, where his father, Eyre Evans Crowe, was *Morning Chronicle* (London) correspondent. After 1843 he became correspondent in London to his father's paper and correspondent and foreign editor to the *Daily News* (London). He represented the *Illustrated London News* during the Crimean War and the *Times* (London) during the Indian mutiny. His work impressed the foreign secretary, Lord John Russell, who appointed him consul general at Leipzig in 1860. He thereafter held various diplomatic posts in Europe. In 1890 he was appointed knight commander of St. Michael and St. George. He died at Gamburg-on-the-Tauber, Bavaria, Sept. 6, 1896.

In 1847 Crowe had encountered Cavalcaselle. The two joined forces to produce *The Early Flemish Painters* (1856), which Crowe had already begun; *A New History of Painting in Italy, From the Second to the Sixteenth Century* (3 vol., 1864–68); *A History of Painting in North Italy* (2 vol., 1871); and other works. The two Italian histories were revolutionary in English art literature in the way in which they combined stylistic and documentary evidence; and they remained in the mid-20th century the standard general histories of Italian art in English.

In addition to those works already mentioned Crowe also wrote *Reminiscences of Thirty-Five Years of My Life* . . . (1895) and, with G. B. Cavalcaselle, *A History of Painting in Italy* . . . (ed. by L. Douglas) (1903), the preface of which contains an excellent biographical sketch. (P. J. MV.)

CROWFOOT, the name applied to several species of *Ranunculus,* most of which are better known as buttercups (*q.v.*). They usually have leaves divided into five to seven sections, bearing some resemblance to birds' feet, hence Crowfoot. *See* also RANUNCULACEAE; RANUNCULUS.

CROWLAND (CROYLAND), a civil parish in the Parts of Holland, Lincolnshire, Eng., lying in a low but fertile fen district near the Welland river, 9 mi. N.N.E. of Peterborough by road. Pop. (1951) 2,835. The origin of the monastery which existed in the Anglo-Saxon period is somewhat obscure. The documents in the *Historia Crowlandensis,* supposedly by Abbot Ingulf, are forgeries of about 1182–1450. Matthew Paris, using the chronicle of the monk Felix (*c.* 751), describes the coming of the hermit St. Guthlac to Croyland, then an island, on St. Bartholomew's day 699. Guthlac died in 714. The first abbey (716–860), built by King Aethelbald over Guthlac's cell, was destroyed by the Danes and rebuilt in stone, 948–975. Crowland abbey was in possession of most of its lands before the compiling of Domesday Book. Of Abbot Joffrid's church of 1100–70 parts survive. There was later damage by fire and earthquake, but then came a great period (1392–1469) under Abbots Overton, Upton and Lytlington, who transformed the building into the Perpendicular style. The north aisle of the abbey has been restored and is used as the parish church; the remainder forms a striking ruin. The church has a 15th-century carved wooden screen and a Norman immersion font. The west front of the abbey nave, dating to the great period, retains many canopied statues of patrons spiritual and temporal and the tympanum over the doorway contains scenes from the life of St. Guthlac. Oliver Cromwell besieged it in 1643, and the 18th and 19th centuries saw the south aisle and wall of the nave reduced to ruins.

The triangular footbridge in the market place once spanned three streams which are now covered over; it is a 14th-century structure which replaced an earlier one. Crowland's annual St. Bartholomew fair, first mentioned in a charter of Henry III (1226), is still held early in September. The spelling Crowland appears only after the Dissolution.

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CROWLEY, ROBERT (*c.* 1518–1588), English Puritan and social reformer, who played a prominent part in the vestiarian disputes of Elizabeth I's reign, was educated at Magdalen college, Oxford, of which he became a fellow. He set up a printing office in Holborn, London, and from there published many of his own tracts. Typographically his most notable production was an edition of *Pierce Plowman* in 1550. His *An informacion and Peticion agaynst the oppressours of the pore Commons of this Realme* (1548) is remarkable for its attack on the "more than Turkish tyranny" of the landlords and capitalists of that day. A Christian socialist, Crowley approved the efforts of the protector Somerset to stop enclosures.

In the most important of his writings, the *Way to Wealth* (1550), he attributes the failure of the protector's policy to the organized resistance of the wealthier classes. Three works written in verse were the *Voyce of the laste trumpet* (1550), *One and thyrtye Epigrammes* (1550) and *Pleasure and Payne* (1551). Crowley gave up printing when he was ordained in 1551. During

Mary's reign he was in exile at Frankfurt. On Elizabeth I's accession he became archdeacon of Hereford in 1559 and prebendary of St. Paul's in 1563. He was incumbent of St. Peter le Poer in London, and then of St. Giles, Cripplegate. His objection to surplices, which he called "porters' coats," led in 1566 to his deprivation and imprisonment, when he refused to allow his choir to wear them. In the same year he published a tract entitled *A briefe discourse against the outwarde apparell and Ministring garmentes of the popishe church.* In 1576 he accepted the living of St. Lawrence Jewry, but resigned two years later. He died on June 18, 1588.

See J. W. Allen, *History of Political Thought in the Sixteenth Century* (1928); A. Peel, "Robert Crowley: Puritan, Printer, Poet," in *Journal of the Presbyterian Historical Society of England* (May 1938). (G. Hu.)

CROWN, an English silver coin of the value of five shillings; hence used to express the sum of five shillings. It was originally of gold and was first coined in 1526, in imitation of the French "crown of the sun." In 1551 Edward VI introduced silver crowns and half-crowns, and down to the reign of Charles II crowns and half-crowns were struck in gold and silver, double crowns in gold alone. Edward VI also introduced the practice of dating coins and marking them with their current value.

The "Oxford crown," struck at Oxford in 1644, was designed by Thomas Rawlins and included a view of that city on the obverse. After the reign of Charles II the crown was struck in silver only. At one time during the 19th century it was proposed to abandon the issue of the crown, and from 1847 until 1887 no crowns were struck. From the latter year until 1902 the coin was in limited circulation.

From 1902 to 1927 no crowns were minted, but small quantities were struck in the years 1928–37, the largest number coined being 714,769 in 1935 on the occasion of King George V's jubilee. The half-crown continued to be minted in large quantities.

The figure of St. George by Benedetto Pistrucci first appeared on the reverse of the crown in 1818. The design of the reverse was altered in 1927, 1935 and 1937, after which it showed a crowned shield with supporters. Pistrucci's design was revived for the Festival of Britain in 1951. The Coronation crown of 1953 (struck to a total of nearly 6,000,000) showed, on the obverse, the queen mounted. A new issue of crowns was made in 1960, though on a limited and experimental scale: the obverse bore the queen's profile portrait while the reverse was a repetition of that of the coronation crown. *See* also Numismatics: *Coins of the British Isles, Colonies and Commonwealth.* (W. D. C.; C. H. V. S.)

CROWN AND REGALIA. Regalia, or crown jewels, are the visible emblems or insignia of royalty that pertain to a monarch. They vary greatly in different countries, both in significance and value, but in European countries a crown, generally richly jeweled, is the chief insigne.

Crowns.—The crown (Lat. *corona*) or diadem and coronet (O.F. *coronete,* diminutive of *corone,* "crown") are ornaments, worn on or round the head, which have been used in nearly all civilizations and epochs. In ancient times wreaths of the most varied kinds were in use, made from flowers, ivy, rushes, vine leaves, etc., or from durable materials. They were used in family life, at symposia, in weddings and in the cult of the dead, but were also officially conferred. The Roman emperors wore golden imitations of the victor's laurel wreath, and after the emperor cult had made them the sun god's earthly image they were depicted with the aureole. The highest sign of imperial dignity, the diadem, Hellenistic in origin and a symbol of monarchy, consisted of a band of material with a precious stone fastened to it above the brow. Caesar rejected the diadem and wore the golden wreath of the Etruscan kings. Succeeding generations accepted the monarchy and with it the diadem, and its band was studded with precious stones and edged with pearls so that it became a fixed circlet. In addition the emperor of later times as commander of the army wore a helmet more splendid than that of his officers, made of gold and set with gems.

In the Byzantine era diadem and helmet were united in a golden crown, half spherical in form, set with pearls and precious stones,

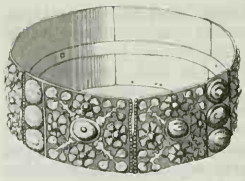

FIG. 1.—IRON CROWN OF LOMBARDY

called *kamelaukion* because of its likeness to the priest's headdress of that name. The Norman rulers of south Italy and Sicily took over this type of crown when they were raised to the rank of king (1130). The emperor Frederick II (d. 1250) followed their example. In his wife's grave was found a crown (preserved at Palermo) that must have been made for the last of the Hohenstaufen emperors; it shows the *pendilia,* of golden wire and precious stones, which hung down on both sides and which derive from the ribbons that once floated from the diadem band.

Crowns played a great part in the church from ancient times; the martyrs were represented with the "crown of eternal life," and churches, especially altars, were embellished with votive crowns suspended on chains. From the 11th century, Christ and the Virgin were depicted with royal crowns, while in the late middle ages God the Father was represented with an emperor's crown.

Germanic tradition also affected medieval crowns. In the time of the migrations tribal kings were distinguished from the warriors by their long, flowing hair or by their splendid helmets, sometimes gilded. However, it is recorded that Clovis, king of the Franks (d. 511), wore a crown as a symbol of *regnum,* "royal authority." The oldest extant crown is that belonging to Theodelinda, queen of the Lombards (d. 627), in the cathedral treasury in Monza (*q.v.*); it is a simple circle set with 180 stones in five rows. West Gothic sacred crowns with small chains that were discovered in the 19th century near Fuente de Guarrazar, in Spain, also date from the 7th century; although they served as church ornaments they must have resembled the crowns worn at the time. The hooped crown, with two hoops crossing over the crown, can be traced to 850 and may perhaps have been worn by Charlemagne; technically it is a simplified helmet with the intermediary plates omitted, and was occasioned by the Carolingian attempt not to fall behind the Byzantine emperors with their *kamelaukion.* However, simple circlets were also worn in the 9th century, as is shown by the "iron crown" in Monza, which probably comes from the legacy of a Carolingian princess. At this time it became usual, following Old Testament tradition, to give the ornaments that surmounted the circlet the form of lilies. The oldest extant lily crown rests on the head of the Madonna of Essen (*c.* 980). There is perhaps an example of a narrowed-down Carolingian hooped crown with lilies in the one worn by the golden statue of St. Foy in Conques (near Rodez, in Aveyron *département*).

The most magnificent medieval crown is that made *c.* 960 for the Holy Roman emperor Otto the Great, which has been known as the *Reichskrone* ("crown imperial") at least since the 12th century and is the most treasured piece of the secular treasury in Vienna. It consists of eight plates, four of them adorned with enamels, the details being derived from Byzantine art. In the setting of the stones the proportions of the numbers were taken into account, but numbers with biblical significance took the place of those beloved by the Germans. In addition the various kinds of precious stones enumerated in Rev. xxi, 19–20 were used. The hidden meaning of the crown (on the analogy of the allegorical interpretation usual at the time) can be interpreted thus: the left side with the enameled pictures of David and Solomon refers to the

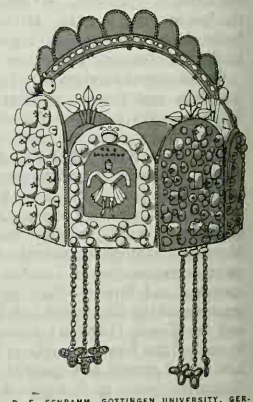

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FIG. 2.—RECONSTRUCTION OF THE CROWN IMPERIAL

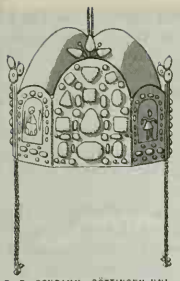

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FIG. 3.—RECONSTRUCTION OF THE CROWN IMPERIAL, WITH MITRE

kingly office, the right side to the priestly office; the part above the brow with the 12 different gems refers to the New Testament (*i.e.*, the 12 apostles), while the similarly decorated part above the neck refers to the Old Testament (*i.e.*, the 12 tribes). It is noticeable that this crown possesses only a single, vertical hoop; the reason for this is that, as the high priest had worn *corona aurea super mitram*, so the emperor wore a mitre beneath the crown. In the time of the Holy Roman emperor Conrad II (d. 1039) the original hoop was replaced by a new one and the cross, originally worn on the breast, was fastened to the crown above the brow. The pendants and ornaments which originally belonged to the sides have been lost. According to its description, William the Conqueror's crown must have been similarly made up.

In the middle and late middle ages hooped, circlet and lily crowns were all worn and new forms were added, such as the conical. A whole series of the crowns worn by the German emperors and kings and their wives has been preserved; their designs have been used in part as embellishments for relics, book covers and crucifixes. The *Hauskrone* ("family crown") which the Holy Roman emperor Rudolf II had made for himself in 1603 and which later was used as the Austrian crown had only one hoop like the imperial crown; the belly-shaped excrescences right and left of the hoop must be interpreted as the corners of the mitre which had been given a hard form, being set with pearls, in the late middle ages. The shape of this crown is the basis of the Russian crown.

The English and French medieval crowns have perished. The medieval kings attached importance to the possession of more than one crown and Edward II of England had at least ten. In times of need some would be pawned or sold, and when the fashion changed old crowns would be remodeled. In the late middle ages there was a saying—though it was disputed—that the hoops on the crown were the prerogative of the emperor, and since the king of England did not want to seem inferior to the emperor, Henry VII's crown exhibits a double hoop. This made the kings of France and Scotland do the same in order to show their equality, and thus the hooped crown became the typical king's crown. Hence the circlet or coronet could become the symbol of nobility, and as early as the 9th century a *corona ducalis* ("ducal crown") was mentioned. But even in the 12th century a pointed cap was the sign of aristocracy, and the German electoral princes always contented themselves with a fur-edged hat.

From the 13th century artistically worked wreaths included the golden coronet decorated with precious stones (*circulum, garlanda*) which was set on the head of a bride, and with which princesses adorned themselves. From the 14th century princes and counts and finally barons wore such coronets, and from the end of the 15th century even the lower nobility took over this right. In England there was a peculiar development: the nobility were not content with adorning their coats of arms with such coronets but actually wore them at coronations, which they continue to do. Gradually, in England as in the rest of Europe, the splendour and number of points were fixed for the crowns of each rank of the nobility.

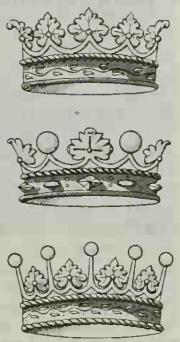

FIG. 4.—CORONETS OF DUKES, MARQUESSES AND EARLS

The triple crown of the pope has a unique history. (*See* TIARA.)

Other Regalia.—*Sceptre.*—The primeval symbol of the staff was familiar to the Greeks and Romans and also to the Germanic tribes in various forms (*baculus,* "long staff"; *sceptrum,* "short staff") and had various significances. The staff of command belonged to God as well as to the earthly ruler; there was the old man's staff, the messenger's wand, the shepherd's crook and, derived from it, the bishop's (*see* CROSIER); and so on. The Carolingians first used a long staff but also imitated the short Roman one. Consequently from the 10th century two staffs were used in the consecration of a king. In most countries the second was displaced by the orb (*see* below). The only country to retain two staffs was England, where the two became alike in length but were distinguished in being surmounted respectively by a cross and by a dove. The sceptre with the cross was interpreted as being the symbol of the ruler's might; the sceptre with the dove was the symbol of the king's office as the head of justice and equity.

FIG. 5.—PAPAL TIARA (WITHOUT THE INFULAE)

Orb.—The orb was also borrowed from the Romans. It was originally a representation of the *sphaira* ("cosmos"), conceived as a ball; the king of the gods, Jupiter, and hence the emperor, as his earthly representative, was depicted with it. Although this significance became outdated Christians were able to use the symbol by setting a cross above the ball. The Byzantines kept it in this form until the late middle ages, but only in visual representations of their emperor. The western emperors also had themselves depicted with a similar ball in the 9th and 10th centuries. The first actually to take an orb in his hand was Henry II at his coronation as emperor (1014). From that time the "imperial apple" belonged to the emperor's insignia, but as early as the 11th century other European rulers wanted to be painted with, and then to possess, an imperial apple as well. Only the king of France attached no importance to the emblem. On the English seal the dove of the Holy Ghost was also set upon the ball's cross. In the 14th century one of the sceptres and the orb were temporarily combined to form one symbol, but since the 16th century a separate orb has been a part of the English coronation. In every country the memory of the original significance has been revived from time to time, or the ball has been referred back to the earth or globe, but the essential motive in the preservation of the orb was that it belonged by general consent to a true king.

Sword.—The sword with which the kings were girded as knights must be reckoned among the regalia, for it was used for investiture or was carried in front of the ruler as a sign of his power. Many such swords survive. The oldest is the Essen sword (in Münster) which perhaps belonged to Otto III and which has a scabbard of pure gold (10th century). In the emperor's treasures in Vienna there are two 11th–12th-century swords of state. The "sword of Charlemagne" (Louvre) is in fact north European work and no older than the 12th century. In England there are five swords connected with the regalia. (*See* also SWORD: *Presentation and State Swords.*)

Others.—Other emblems of royalty belonging to the regalia are the ring, and in some countries the lance and a helmet with a crown reversed upon it. Charles I's ring, bequeathed to George III by Cardinal York, is in the Tower of London. The armillae (bracelets) of the medieval kings, which still retain their place in the English coronation ceremony, took their justification from the example of the Jewish kings but actually derive from the *baugae* ("bracelets") of the Germans.

Existing Regalia.—Since the gold of which they were made and the gems which adorned them were often needed for other purposes, many regalia have perished. The ancient regalia that exist are therefore very unequally distributed over Europe.

France.—The French insignia and coronation robes were kept in the Benedictine abbey of St. Denis, north of Paris. Nearly all of them were destroyed during the Revolution but they are known through inventories and old prints. What has been preserved is exhibited in the Galerie d'Apollon in the Louvre.

Spain.—Spain also has almost no royal emblems left. The crown discovered in Sancho IV's tomb at Toledo probably had be-

longed to King Alfonso VIII of Castile (1158–1214). A crown which Beatrice (d. 1235), the wife of Ferdinand III of Castile-León, brought with her from her German homeland was stolen in 1873, but a photograph of it exists. A conical crown, dating from King Martin I of Aragon, is preserved in Barcelona, and in Granada there is a circlet ornamented with garnets which tradition associates with Queen Isabella (d. 1504).

Italy.—In Monza the crown of Theodelinda, queen of the Lombards, and the Carolingian "iron crown" are preserved, and in Palermo is a closed crown which belonged to the emperor Frederick II *(see* above, *Crowns).*

Hungary.—The crown of St. Stephen is a Byzantine circlet of 1071–74 which was altered in Hungary in the 12th century into an emperor's crown by the addition of two crossed hoops. It has therefore nothing to do with King Stephen (997–1038). There is, however, in existence his coronation mantle, cap and sword. Possibly even older is the Hungarian sceptre in the form of a crystal ball on a short stem.

Poland.—Three crowns, Hohenstaufen in origin, which were used by the 14th-century Polish kings were preserved as ornament for a cross in Cracow (late 15th century) and for the Sigismund relic in Plock (1370). In addition the replica of the "holy spear," which Emperor Otto III gave to the Polish king Boleslaw I in 1000, is preserved in Cracow. All the other objects are from the 16th, 17th or 18th centuries.

Russia.—The oldest of the existing royal emblems is the Great Monomach cap, with which the emperors were crowned until the 18th century, and a cone of gold pieces (14th century) with a conical point and a fur edging (17th century). Similar in form are other caps for the other realms of the empire. The series of orbs begins with the "Monomach's apple," made in 1627. Catherine sought to have royal emblems that were similar in form to those of the west but she tried to surpass them in splendour. The treasures that survived the Revolution are exhibited in the Kremlin, Moscow.

Sweden.—Regalia, no longer used at the coronation, are shown at the opening of the *Riksdag.* The king's crown was made in 1561 for Eric XIV and the crown prince's coronet, which was placed over a great velvet hat, was made for Charles X Gustavus (1650). The series of orbs begins with one which Eric XIV commissioned.

Denmark.—The Danish regalia are exhibited in Rosenborg castle, Copenhagen, the chief being the crown made for Christian IV (1588–1648). At the coronations (up to 1848), however, the crown made about 1665–70 for Frederick III was used. The orb was also made for him.

Germany.—Germany is the richest of all countries in regalia. The most important royal emblems were preserved in the imperial castle of Trifels in the middle ages. In 1423 they were entrusted to the free imperial city of Nürnberg and in 1796 were safely carried to Vienna in face of the revolutionary arm (now Hofburg, secular treasury). The central feature of the crown jewels is the imperial crown made for Otto I. The "holy spear," acquired by Henry I, was the most important imperial relic. "Attila's sabre" is a Hungarian ceremonial weapon of about 900.

The imperial treasury acquired a great many robes from the treasury of the kings of Sicily on Henry VI's marriage to Constance in 1186. Some important regalia are preserved in the treasury of Aachen cathedral, others in the church at Bamberg which was endowed by Henry II. Some crowns went abroad, to Stockholm, Poland, etc. In addition there are the regalia which the German princes, striving toward royal dignity, had made: the Bavarian regalia are in the treasury in Munich, the Prussian in Hohenzollern castle, Sigmaringen.

England.—England's regalia were all sold during the Commonwealth, but the inventories which were made for the sale and earlier records give an idea of what once existed. After the Restoration new crown jewels were made and almost every succeeding generation has augmented them.

The king of England has three crowns. St. Edward's crown, made for the coronation of Charles II in 1661 after the pattern of the ancient King Edward the Confessor's crown destroyed by the Commonwealth, is used at the coronation ceremony. The imperial state crown, made for Queen Victoria in 1838, contains the Black Prince's ruby, which was worn by Henry V at the battle of Agincourt; the great sapphire from the crown of Charles II; Elizabeth I's pearl eardrops; the sapphire from the coronation ring of Edward the Confessor; and a 309-carat diamond, one of those cut from the Cullinan.

The imperial crown of India owes its origin to a law that prevents the crown of England from being taken out of the country; when, therefore, George V was crowned in Delhi (1911) as emperor of India, a new crown had to be made.

Next in importance are the queen's crowns or diadems. The crown of Queen Mary of Modena, wife of James II, is of the usual formal shape and contains no coloured stones. The crown made in 1937 for the coronation of Queen Elizabeth, consort of George VI, contains the Koh-i-Nor diamond, which was presented by the army of the Punjab to Queen Victoria.

The prince of Wales's crown is of gold without jewels and is distinguished from a coronet by one arch, introduced by Charles II.

The other regalia consist of the king's two sceptres (the royal sceptre adorned with the 516½-carat Star of Africa diamond cut from the Cullinan) and St. Edward's staff; the queen's two sceptres and ivory rod; the king's orb and the queen's orb; coronation bracelets, St. George's spurs, and the ampulla and anointing spoon. Besides the regalia proper there are many pieces of royal plate.

Scotland.—The "honours of Scotland," preserved in Edinburgh castle, were used for the last time in 1651. The hoops of the crown date from James IV (1488–1513) and the circlet itself (which replaced an older one) only from James V (1513–42). James V also had the sceptre lengthened; its shaft came to Scotland in 1492 as the gift of Pope Alexander VI. The sword was a gift of Pope Julius II in 1507.

Ireland.—The Irish crown jewels were stolen from Dublin castle and have never been recovered. There was nothing of historic or of great intrinsic value among them.

See also THRONE; ROBES; CORONATION.

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(P. E. SM.)

CROWNE, JOHN (*c.* 1640–*c.* 1703), English dramatist popular at courts of Charles II and James II, was born about 1640 in Nova Scotia. His father had emigrated there but was dispossessed by the French government. John Crowne arrived in England soon after the Restoration, and his first literary work was a romance *Pandion and Amphigenia* (1665). The earl of Rochester gained him the commission for a masque for performance at court, *Calisto* (1675), and this brought him into favour with Charles II. *The Countrey Wit* (1675), based on Molière's *Le Sicilien* and also admired by the king, was followed by many other plays: comedies, heroic dramas and historical tragedies all dedicated to prominent figures at court and acted with great success. *City Politiques* (1683), which satirized the Whig party and contained characters readily recognizable as portraits of Titus Oates and others, was one of his best comedies but made him many enemies. Crowne petitioned the king for a small place that would release him from the necessity of playwriting, and Charles agreed to grant this request on condition that Crowne would write one further play, and suggested he base it on Mureto y Cavaña's *No puede ser guardar una mujer.* The result was the lively *Sir Courtly Nice* (1685), which remained a stock piece for nearly a century. Of his

St. Edward's crown, or the crown of England, fashioned in 1661 for the coronation of Charles II and now used at coronation ceremonies

The imperial state crown made for Queen Victoria's coronation in 1838 and now used on such state occasions as the opening of parliament

The Great Monomach cap. The oldest extant Russian crown, perhaps first used at the coronation of Ivan IV, 1547, though Russian tradition dates it earlier. According to that tradition, the crown was given to St. Vladimir in 988 by the Byzantine emperor. It is ornamented with diamonds, rubies, pearls and emeralds; the base is bordered with sable fur

British regalia. (Left) Head of the royal sceptre, adorned with the Star of Africa, cut from the Cullinan diamond. (Top right) Ampulla, the vase holding the holy oil with which the sovereign is anointed. (Lower right) The sovereign's orb, a golden ball surmounted by a jeweled cross

BY PERMISSION OF (TOP LEFT, TOP RIGHT, BOTTOM CENTRE, BOTTOM RIGHT UPPER, BOTTOM RIGHT LOWER) THE LORD CHAMBERLAIN, HER MAJESTY'S STATIONERY OFFICE, CROWN COPYRIGHT RESERVED. (BOTTOM LEFT) DAVID DOUGLAS DUNCAN

CROWN AND REGALIA

"Imperial Crown," made in the 10th century for Otto the Great, and used at coronations of Holy Roman emperors. The cross is an 11th-century addition; the arch was renewed about 1030

Turkish vassal crown. Originally the crown of King László II of Hungary, it was captured by the Turks in 1526 and presented by them to their vassal, the prince of Transylvania, in 1605. Ornamentation includes silver plates decorated in niello and set with pearls and precious stones surmounted by an emerald

Cloak of Roger II, king of Sicily 1130–54. Decorated with a scene in duplicate showing a lion attacking a camel. The cloak was taken over in 1194 by the Hohenstaufens and used as a coronation robe of the Holy Roman emperors

Crown of Louis XV of France, 1745. A typical Bourbon crown with a band of jewels and eight arches rising from fleurs-de-lis to support a large double fleur-de-lis at the top

Austrian imperial crown, made for Rudolf II in 1602. It is ornamented with diamonds, rubies, pearls and a large sapphire. Behind the crown is Rudolf's tabard with coat of arms. Orb in left foreground and sceptre at right were made for the emperor Matthias who succeeded Rudolf II

PHOTOGRAPHS, (BOTTOM LEFT) RAPHO GUILLUMETTE, (OTHERS) ERICH LESSING—MAGNUM

other plays the most notable is *The English Frier* (1690), which owed a debt to Molière's *Tartuffe* and satirized the Catholic priests who had been powerful at the court of James II. Although his plays enjoyed great popularity, partly because of their topical wit, they lack literary distinction, and it is only for his creation of the "type" character of Sir Courtly Nice that Crowne is remembered. D. E. Baker in his *Companion to the Playhouse* (1764) states that Crowne was alive in 1703; but nothing is known of his later life.

The *Dramatic Works of John Crowne* were edited by J. Maidment and W. H. Logan in four volumes (1873–77).

See A. F. White, *John Crowne: His Life and Dramatic Works* (1922); G. P. Winship, *A Bibliography of . . . John Crowne* (1922).

CROWN LAND, in Great Britain, land belonging to the crown, the hereditary revenues of which were surrendered to parliament in the reign of George III.

In Anglo-Saxon times the property of the king consisted of (1) his private estate, (2) the demesne of the crown, comprising palaces, etc., and (3) rights in the folkland of the kingdom. By the time of the Norman conquest the three became merged into the estate of the crown, that is, land annexed to the crown, held by the king as king. He also ceased to hold as a private owner, but had full power of disposal by grant of the crown lands, which were increased from time to time by confiscation, escheat, forfeiture, etc. The history of the crown lands of the reign of William III was one of continuous alienation to favourites. Their wholesale distribution by William III necessitated the intervention of parliament, and in the reign of Queen Anne an act was passed precluding the alienation of crown lands. The income from certain crown lands was also made to constitute part of the civil list funds. At the beginning of his reign, George III surrendered to parliament the hereditary revenues of the crown, including the income from the crown lands, in return for a fixed "civil list" (*q.v.*), and the sovereign was also relieved by parliament of the cost of government and of the armed forces, etc. This course has been followed by all succeeding sovereigns. It is the income only which is surrendered to parliament, the ownership of the crown lands remaining vested in the sovereign. The control and management of the crown lands is regulated by the Crown Lands act, 1829, and various amending acts. Under the acts management is entrusted to the commissioners of crown lands (formerly the commissioners of woods, forests and land revenues) who have certain statutory powers as to leasing, selling, exchanging, etc.

CROWN POINT, a town of Essex county, N.Y., U.S., about 90 mi. N.E. of Albany and about 9 mi. N. of Ticonderoga, on the west shore of Lake Champlain. Putnam's creek, named for Israel Putnam of Revolutionary War fame, flows through the town. In 1609 Samuel de Champlain fought the Iroquois Indians there and began the enmity between the Five (later Six) Nations and the French. Subsequently Dutch and English traders traveled in the vicinity. In 1731 the French constructed a stone fort on the peninsula which they called *Point a la Couronne* ("Crown Point"). The fort was named Ft. St. Frédéric in honour of Jean Frédéric Maurepas. Despite English and colonial expeditions sent against it, Crown Point remained in French hands until 1759 when it was occupied by Lord Jeffrey Amherst who began construction near old Ft. Frédéric of a larger fort which was garrisoned but never completed.

At the outbreak of the American Revolution the fort was captured by Col. Seth Warner and a force of Green Mountain Boys; it remained in American hands except for a brief period in 1777 when it was occupied by a detachment of Burgoyne's invading army.

The permanent population of about 1,700 is swelled by summer residents and tourists. The chief occupation is farming; manufactures include lumber and woodenware. (G. L. F.)

CROWN VETCH (*Coronilla varia*), a spreading, long-lived, drought-tolerant legume, with attractive pinkish-white flowers, used principally for erosion control, as a cover crop and for soil improvement. Its perennial habit, associated with its habit of producing a dense surface cover and a deep, heavy root system on poor soils, makes it especially valuable for use on raw steep slopes along highways and similar places. It may be established either from seeds or from crowns. It has a broad adaptation to soils and climate. (F. V. G.; J. M. Bl.)

CROWTHER, SAMUEL ADJAI (1809?–1891), African missionary bishop, was born in Oshogbo in the Yoruba country, West Africa, and was sold into slavery in 1821. The next year he was rescued, with many other captives, by H.M. ship "Myrmidon" and was landed at Sierra Leone. Educated there in a missionary school, he became a teacher and afterward missionary on the Niger. In 1842 he entered the Church Missionary college in London, and in June 1843 was ordained.

Returning to Africa, he worked among his own people and afterward at Abeokuta. There he devoted himself to the preparation of schoolbooks, and the translation of the Bible and Prayerbook into Yoruba and other dialects. In 1864 he was consecrated first bishop of the Niger territories. Crowther died in Lagos on Dec. 31, 1891.

See J. McKay, *The Life of Bishop Crowther* (1932).

CROYDON, a county borough of Surrey, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with Coulsdon and Purley to form the new London borough of Croydon (*see* London). Croydon county borough, which includes Addington, Addiscombe, Upper Norwood, South Norwood, Norbury, Shirley, Thornton Heath, Woodside, and Waddon, lies 10 mi. S of London Bridge. Pop. (1961) 252,387. Area 20 sq.mi. The town centre was being extensively redeveloped in the mid-1960s. New civic buildings included Fairfield Halls, comprising concert and banqueting halls, an art gallery and the Ashcroft Theatre (named after Dame Peggy Ashcroft). The parish church of St. John the Baptist is of ancient foundation, but the present structure was built, after a fire in 1867, by Sir George Gilbert Scott. It contains the tombs of six archbishops of Canterbury, including that of John Whitgift (*q.v.*), who founded the hospital or almshouse (1597–99) which bears his name. Croydon is a bishopric suffragan in the diocese of Canterbury. Educational facilities include two boys' schools of the Whitgift foundation, a technical college and college of art, and an outstanding public library. There are 2,278 ac. of parks and open spaces. Though largely residential, Croydon has more than 1,000 factories and workshops, and products include scientific instruments, internal-combustion engines, radio and television receivers.

Croydon was originally farther west than the present town and was mentioned in 9th-century charters and in Domesday Book. Still earlier settlement is indicated by the prehistoric remains near Addington Park. There are a number of springs in the neighbourhood, which are important determinants of settlement in chalk country. The manor of Croydon was presented by William I to Archbishop Lanfranc, founder of the archiepiscopal palace, now part of a girls' school. The palace was a favourite summer residence of the archbishops of Canterbury from 1086 to 1758; the main buildings date from the late 14th to the late 15th century. From 1808 to 1896 the archbishops had a residence at Addington Palace, now the Royal School of Church Music. The Surrey iron railway (1801), the first public goods railway in the world, ran between Croydon and Wandsworth. Croydon airport, west of (and largely outside) the borough, was established in 1915 and made a government civil customs aerodrome in 1926. It played a leading part in the history of civil aviation in Great Britain, but after World War II its primacy passed to London airport at Heathrow, and it was closed in 1959. The parliamentary constituencies are Croydon North West, Croydon North East, and Croydon South.

CROZIER, WILLIAM (1855–1942). U.S. army officer and inventor, was born at Carrollton, O., Feb. 19, 1855. He graduated from West Point in 1876 and served on the western frontier for three years thereafter against the Sioux and Bannock Indians. In 1888 he was sent by the war department to study artillery in Europe, and upon his return he was placed in full charge of the construction of gun carriages for the army. With Gen. Adelbert R. Buffington (1837–1922), the chief of ordnance, he invented the Buffington-Crozier disappearing gun carriage (1896). He also invented a wire-wound gun and perfected many appliances connected with heavy and field ordnance. During the Spanish-American War he was inspector-general for the Atlantic and Gulf coast

defenses. In 1899 he was one of the American delegates to the Hague Peace conference. He later served in the Philippines and in 1901 became chief of the ordnance of the U.S. army, a post he held until 1917. During 1912–13 he was also president of the army war college. As a member of the war council he was in France and Italy during the first half of 1918. His *Notes on the Construction of Ordnance* was adopted as a textbook in the schools for officers. He died Nov. 10, 1942.

CRUCÉ, ÉMERIC (*c.* 1590–1648), French monk, teacher and writer, was a pioneer advocate of international arbitration. His principal work, *Le nouveau cynée* ("The New Cyneas"; 1623), advocated arbitration of disputes and an assembly of princes or their permanent delegates, sitting in Venice, to deal with international problems. Republics were to arbitrate if princes became deadlocked; the papacy and France were given pre-eminent positions in the organization. Moral pressure would suffice for enforcement, though sanctions might be necessary.

Crucé was preoccupied by such problems as free trade and communications, agriculture, weights and measures, and canals, also problems of taxation, luxury and population. He paid little attention to the Thirty Years' War (1618–48), but was inevitably influenced by it. A true humanitarian and cosmopolitan, he placed merchant above soldier, and opposed national, racial and religious differences. Interested in the problem of Turks and Jews, he urged inclusion of Asia and Africa in a world organization.

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CRUCIBLE STEEL. The crucible process was invented by British steel man and inventor Benjamin Huntsman about 1740. He took small pieces of carbon steel made by the old cementation (*q.v.*) process and charged them into fire clay crucibles which held about 100 lb. of metal. By heating these in a coke fire surrounding the crucibles he was able to melt the metal and obtain a homogeneous melt of uniform composition which he used to make into watch and clock springs. This was the first time that man was able to reach a temperature (2,900° F.) that would melt steel.

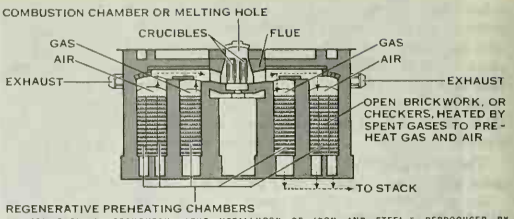
After about 1870 the Siemens gas-fired regenerative furnace replaced the old single coke-fire furnaces. These had regenerators which preheated the producer gas and air before combustion and yielded much higher temperatures (*see* SIEMENS). The accompanying figure shows such a furnace. It had a number of combustion chambers, or holes, each holding 4 to 6 crucibles, and heated as many as 100 crucibles at one time. It cut the time of heating to about 2½ hours compared to 6–8 hours by Huntsman coke-fire furnaces. The principle of regeneration was similar to that of the Cowper stove (*q.v.*).

The crucibles, however, remained small, about 100 lb. capacity, because that was all a man could lift out of a hole. They continued to be made of the highest grade of fire clay or a mixture of fire clay and graphite. Usually each plant made its own crucibles which were fired and vitrified before using. The crucibles were about 16 in. high, 10 in. in diameter at the bulge and about ¾ to 1 in. thick.

The charge in the crucibles was carefully measured as the only chemical reactions that took place were an increase in silicon content from the reaction between the carbon in the bath with the silica (SiO_2) of the crucible. There was also a slight drop in the carbon content. Originally the charge was made up of cement steel and low phosphorus wrought iron. Later mixtures of wrought iron and wash metal, high carbon pig iron treated to remove silicon and manganese, were used. After open-hearth steel scrap became available it was used with addition of charcoal or wash metal to make the cheapest charge.

After 1870, Robert F. Mushet added manganese in the charge to lower the oxygen and sulfur content. Once a satisfactory charge was found for a given grade of steel, it was rigidly adhered to. For many years all high-quality tool steel and high-speed steel (*qq.v.*) were made by this process.

The accurately charged crucibles were placed in the furnace and the metal was melted in about an hour. After it melted, carbon monoxide gas was produced and appeared as bubbles at the surface; in the meantime sulfides and silicates were melted and rose to the top of the bath as a slag. When gas evolution stopped the melter judged that the metal was dead or killed and he ordered the crucible to be lifted from the furnace.



ADAPTED FROM B. STOUGHTON, "THE METALLURGY OF IRON AND STEEL," REPRODUCED BY COURTESY OF THE MCGRAW-HILL BOOK CO.

CUTAWAY VIEW OF THE SIEMENS GAS-FIRED REGENERATIVE FURNACE

Dotted lines indicate direction of gas flow, which is reversed every fifteen or twenty minutes

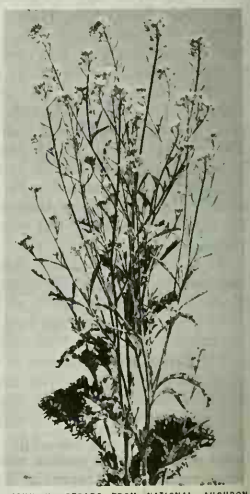
When the crucible was taken out of the furnace the cover was removed and most of the slag was swabbed by means of a ball on one end of a long iron rod. The molten metal was then poured into a split cast iron mold, any slag still present being held back with an iron rod.

After 1910, the electric arc furnace gradually replaced the crucible process because larger amounts could be melted, the cost was cheaper and the quality was even better. Heats weighing as much as 50 tons could be melted instead of the 100-lb. charge of the crucible. The last crucible steel plant in the United States was closed down in 1932.

See also FURNACE, METALLURGICAL.

See F. W. Harbord and J. W. Hall, *The Metallurgy of Steel,* 7th ed. (1923); *The Making, Shaping and Treating of Steel* (1957). (E. C. W.)

CRUCIFERAE, a family of mostly herbaceous flowering plants, which derives its name from the cross-shaped (cruciform) arrangement of the four petals of the flower. The alternative name Brassicaceae is acceptable under the International Code of Botanical Nomenclature. In this dicotyledonous family are found many well-known field and garden plants such as cabbage, cauliflower, collards, broccoli, brussels sprouts, kale, kohlrabi, mustard, radish and rutabaga or swede; wallflower, stock, rock cress, candytuft and alyssum. Many species are annuals; among these are some of the commonest weeds of fields, roadsides and waste places, including shepherd's purse (*Capsella bursa-pastoris*), charlock (*Brassica kaber*), wild mustard or bird rape (*B. campestris*), black mustard (*B. nigra*), hedge mustard (*Sisymbrium officinale*), tumble mustard (*Erysimum cheiranthoides*), garlic mustard or jack-by-the-hedge (*Alliaria petiolata*), mouse-ear cress (*Arabidopsis thaliana*), peppergrass (*Lepidium densiflorum, L. ruderale, L. virginicum,* etc.), fan weed or field penny cress (*Thlaspi arvense*), false flax (*Camelina microcarpa*) and whitlow grass (*Draba verna*). Other species are biennials producing a number of leaves on a short stem in the first year, and in the second sending up a flowering shoot at the expense of the nourishment



JOHN H. GERARD FROM NATIONAL AUDUBON SOCIETY

FIG. 1.—CURLED MUSTARD (BRASSICA JUNCEA CRISPIFOLIA)

stored in the thick taproot during the previous season. Under cultivation this root becomes much enlarged as in the turnip, rutabaga, etc. A large number of species are perennial and a few (*Cardaria draba, C. pubescens, Rorippa sylvestris*) have become pernicious field or lawn weeds, vigorously spreading by underground roots.

Plants of the Cruciferae have alternate leaves without stipules and the flowers are arranged in racemes mostly without bracts. The flowers are regular with four free sepals usually arranged in two pairs at right angles; four petals arranged crosswise in one series; and two sets of stamens, an outer whorl of two single stamens and an inner whorl of four arranged in two pairs. In nearly all genera the four inner stamens are longer than the two outer and the whole stamen set is said to be tetradynamous. In exceptional genera (*Warea, Stanleya, Romanschulzia, Macropodium, Cibotarium*, etc.), all six stamens are of equal length and usually exceed the other flower parts. The single pistil, which is at the centre of the flower, consists of two carpels joined at their

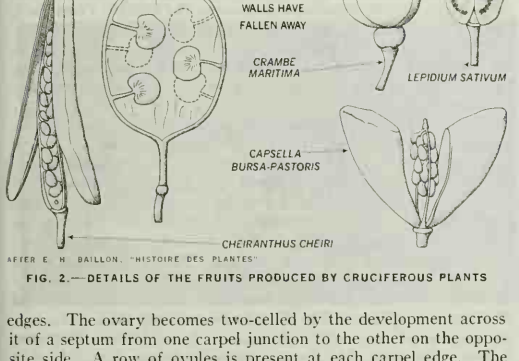


FIG. 2.—DETAILS OF THE FRUITS PRODUCED BY CRUCIFEROUS PLANTS

edges. The ovary becomes two-celled by the development across it of a septum from one carpel junction to the other on the opposite side. A row of ovules is present at each carpel edge. The fruit is usually a capsule or silique splitting by two valves from below upward and leaving funiculi with seeds attached to the replum or framework of the septum. The fruits of some genera are indehiscent (remaining closed when ripe). The seeds, lacking endosperm, are filled with a large embryo, the two cotyledons of which are variously folded. In germination the cotyledons come above ground and form the first green leaves of the plant.

Pollination is effected by insects which are attracted to the flowers by exudates of nectar from glands at the base of the stamens and petals. The petals are white, yellow or purple, or of intermediate shades. There are both inbreeding (self-pollinating) and outbreeding (cross-pollinating) species, the latter type apparently predominating in the family.

There is a wide variety of specific mustard oils present in the family and these provide the basis in the foliage, stems or roots for the sharp taste well known in water cress (*Rorippa nasturtium-aquaticum* or *Nasturtium officinale*), mustard greens (*Brassica hirta*) and radishes (*Raphanus sativus*). The common table condiment, mustard, is ordinarily obtained from the seeds of black mustard (*B. nigra*), but the seeds of several different species of *Brassica* are sometimes used as a source. Many species are known to be high in vitamin C content.

Early seamen sailed far out of their normal course to the Kerguelan Islands to gather Kerguelan cabbage (*Pringlea antiscorbutica*) which they consumed for the prevention of scurvy, and the arctic *Cochlearia* is still known as scurvy grass because of its early use by voyagers and explorers.

Cruciferae is a large family containing about 350 genera and about 3,000 species. It is most closely related to the capper family (Capparidaceae). The family is world-wide in distribution, but is most highly developed in the temperate and frigid zones, especially of the northern hemisphere, and as alpine plants. Certain genera are greatly differentiated in the Mediterranean region including northern Africa where some species are a dominant part of the vegetation. The peculiar rose of Jericho (*Anastatica hierochuntica*), which occurs from southern Iran to Morocco, is a resurrection plant. After lying dormant and apparently dead for many months, it can be revived with water to its normal green.

The family is well represented in both Europe and North America—among others by *Nasturtium* (not the gardener's nasturtium; *q.v.*), *Arabis* (rock cress), *Cardamine* (bitter cress), *Sisymbrium* (hedge mustard), etc.; *S. irio* is London rocket (so called because it sprang up after the fire of London in 1666), *Brassica, Diplotaxis* (rocket), *Cochlearia, Capsella, Thlaspi, Cakile* (sea rocket), *Raphanus* and others. There are native North American species in many of these genera and, in addition, European species are widespread as weeds in the western hemisphere. There is a major area of differentiation in western and southwestern North America, the plants occurring particularly on limestone soils. There occur a number of distinctive genera including *Stanleya* (desert plume), *Streptanthus, Thelypodium, Dithyrea* (spectacle pod), *Physaria* (double bladder pod), *Lesquerella* (cloth-of-gold or bladder pod) and a number of others. *Draba* (whitlow grass) is abundant at high elevations and *Smelowskia* is at the highest elevation of any seed plant on many of the mountain peaks.

Of economic importance are various species of *Brassica*, particularly varieties of *B. oleracea* (cabbage, cauliflower, broccoli, brussels sprouts, kale, collards and kohlrabi), *B. rapa* (turnip), *B. napobrassica* (rutabaga or swede), *B. chinensis* (Chinese cabbage or pakchoi), *B. hirta* (white mustard) and *B. nigra* (black mustard), *Raphanus sativus* (radish), *Armoracia lapathifolia* (horse radish). Water cress and garden cress (*Lepidium officinale*) are used in salads, etc. Dyers woad (*Isatis tinctoria*) produces a blue dye. Common garden ornamentals are wallflower (*Cheiranthus*), stock (*Matthiola*), candytuft (*Iberis*), alison, alyssum, or gold dust (*Alyssum*), rock cress (*Arabis*), dames violet (*Hesperis*), honesty (*Lunaria*) and rainbow rock cress (*Aubrieta*). Many other genera are grown in specialized gardens. (R. C. R.; X.)

See also articles on the various crucifers including CABBAGE; CRESS; RADISH; MUSTARD; ARABIS; STOCK; and references under "Cruciferae" in the Index volume.

CRUCIFIX, a model of the cross, on which is an image of the crucified Christ. *See* CROSS: *Crucifix.*

CRUCIFIXION, in the penal systems of the ancient world, was an important method of capital punishment, particularly among the Persians, Seleucids, Jews, Carthaginians and Romans (up to the emperor Constantine I, who abolished it). In Rome, where it was considered by Cicero the most horrible death, there were various methods of performing the execution. Usually the condemned man, after being whipped, dragged the crossbeam (*patibulum*) of his cross to the place of punishment where the upright shaft was already fixed in the ground. There he was stripped of his clothing and bound fast with outstretched arms to the crossbeam, or nailed firmly to it through the wrists. The crossbeam was then raised high against the upright shaft and made fast to it about 9 to 12 ft. from the ground. Next, the feet were tightly bound or nailed (each foot with a separate nail) to the upright shaft. A ledge (*sedile*) inserted about halfway up the upright shaft gave some support to the body; evidence for a similar ledge (*suppedaneum*) for the feet is rare and late. Over the criminal's head was placed a notice stating his name and his crime. Death, apparently caused by exhaustion or by heart failure, could be hastened by shattering the legs (*crurifragium*) with an iron club, but the medical reasons for death are not fully understood. Crucifixion was thought to be a suitable punishment chiefly for political or religious agitators, pirates, slaves or those who had no civil rights. In 519 B.C. Darius, king of Persia, crucified 3,000 political opponents in Babylon; in 175 B.C. Antiochus IV of Syria whipped and crucified lawbreaking Jews in Jerusalem; *c.* A.D. 32 Pontius Pilate crucified Jesus of Nazareth; and in A.D. 46 Tiberius Alexander crucified two Galilean rebels, Jacob and Simon ben Juda. *See* also CROSS; JESUS CHRIST.

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CRUDEN, ALEXANDER (1701–1770), British author of the best-known biblical concordance, still the standard concordance to the King James version, was born on May 31, 1701, at Aberdeen, Scot., but spent his adult life in or near London. Shortly after graduation from Marischal college, about 1721–22, he was confined for insanity. Never a stable personality, he was confined for two months in 1738 at Bethnal Green, from which he escaped, and again for 17 days in 1753 in Chelsea. After each of the later confinements, he wrote and published pamphlets seeking recompense for the indignities he suffered, dedicating the pamphlets to the king, and gaining only notoriety.

From 1722 to 1732 he was employed variously as private tutor or as reader or amanuensis. At least once he was discharged for ignorance of French pronunciation, a shortcoming he failed to overcome. In 1732 he opened a bookstore and in 1735 became "bookseller to the queen," an unremunerative position. He began his concordance in 1736, and on its publication, Nov. 3, 1737, sent a dedicatory copy to Queen Caroline; her death 17 days later frustrated this attempt for patronage. Enlarged editions of the concordance followed in 1761 and 1769. About 1740 he found his real talent as proofreader, and several editions of Greek and Latin classics owe their excellence to his care.

Influenced by the preaching of Wesley and others, joined with his success as proofreader, he came to believe himself divinely appointed as "Alexander the Corrector" of the nation's manners and morals. Under this delusion he committed many indiscretions that made him an object of ridicule. College students accepted appointments as his deputies, and at Cambridge he was knighted with mock ceremonies. Cruden died in London on Nov. 1, 1770.

His works include, in addition to the concordance, a *Scripture Dictionary*, printed shortly after his death, and a verbal index to Thomas Newton's edition of Milton (1769).

The earliest biography is that by Alexander Chalmers, prefixed to the 6th edition of the concordance (1810). *See* also E. Olivier, *The Eccentric Life of Alexander Cruden* (1934). (J. W. El.)

CRUDEN BAY, a village and civil parish on the east coast of Aberdeenshire, Scot. Pop. (1951) 2,295. It is situated at the head of Cruden bay, 24 mi. N.N.E. of Aberdeen by road, and has sandy beaches and a fine golf course on the stretch of sands to the north, called Ward of Cruden, at the end of which is the fishing village of Port Erroll. The Bishop's bridge, over the Cruden water, dates from 1697.

Near Ardendraught, not far from the shore, Malcolm II is said to have defeated Canute in 1014. Slains castle (1664), a former seat of the earl of Erroll, lies to the north of Cruden, but the old castle is about 5 mi. S.W. near the point where, according to tradition, the "St. Catherine" of the Spanish Armada foundered in 1588. The Bullers of Buchan (2 mi. N.) is a roofless cave in the rocks, 200 ft. deep and 50 ft. wide, impressive in a rough sea; it was visited by Samuel Johnson.

CRUIKSHANK, GEORGE (1792–1878), English artist, caricaturist and illustrator, was born in London, Sept. 27, 1792. By natural disposition and indirectly related circumstances he might be called a born humoristic artist. His grandfather had taken up the arts, and his father, Isaac Cruikshank, was a painter. George followed the family traditions with amazing facility, surpassing others of his period in his ability as an etcher. When his father died about 1811, George, still in his teens, was already a successful and popular artist. All his talents were natural and untrained; outside training, or a serious apprenticeship to art, were dispensed with, under the necessity of working for immediate profit. At times he found cause to regret this lack of academic training, and at intervals he attempted to cultivate accessible knowledge by studying from the antique and drawing from life at the schools. From boyhood he was accustomed to turn his artistic talents to ready account, disposing of designs and etchings to the print sellers and helping his father with his plates. Before he was 20 his spirited style and talent had secured popular recognition. The contemporary of Gillray, Rowlandson, Alken, Heath, Dighton and the established caricaturists of that generation, George developed great proficiency as an etcher. Gillray's matured and trained skill had some influence upon his executive powers, and when the older caricaturist died in 1815, George Cruikshank had already taken his place as a satirist. Prolific and dexterous beyond his competitors, for a generation Cruikshank delineated Tories, Whigs and Radicals with fine impartiality. Satirical capital came to him from every public event—wars abroad, the enemies of England (for he was always fervidly patriotic), the camp, the court, the senate, the church; low life, high life; the humours of the people, the follies of the great. George Cruikshank's technical and manipulative skill as an etcher was such that Ruskin placed his productions in the foremost rank.

Cruikshank died at 263 Hampstead road, London, on Feb. 1, 1878, and was buried in St. Paul's cathedral.

A vast number of Cruikshank's spirited cartoons were published as separate caricatures, all coloured by hand; others formed series or were contributed to satirical magazines, the *Satirist*, *Town Talk*, the *Scourge* (1811–16) and other ephemeral publications.

In conjunction with William Hone, Cruikshank produced political satires, *The Political House That Jack Built* (1819) and others, reissued by Hone in 1827 under the general title *Facetiae and Miscellanies*.

Of a more genially humoristic order are his famed book illustrations. Early in this series came *The Humorist* (1819–21) and *Life in Paris* (1822), the well-known series of *Life in London*, conjointly produced by the brothers I. R. and G. Cruikshank, and Grimm's *Collection of German Popular Stories* (1824–26), in two series, with 22 inimitable etchings. To the first 14 volumes (1837–43) of *Bentley's Miscellany* Cruikshank contributed 126 of his best plates, etched on steel, including the famous illustrations to *Oliver Twist*, *Jack Sheppard*, *Guy Fawkes* and *The Ingoldsby Legends*. For W. Harrison Ainsworth Cruikshank illustrated *Rookwood* (1836) and *The Tower of London* (1840). The first six volumes of *Ainsworth's Magazine* (1842–44) were illustrated by him with several of his finest groups of etchings. For C. Lever's *Arthur O'Leary* he supplied ten full-page etchings (1844), and 20 spirited graphic etchings for Maxwell's lurid *History of the Irish Rebellion in 1798* (1845).

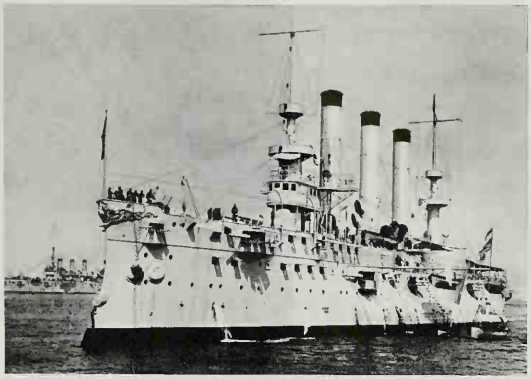
Of his own books of drawings, mention must be made of *George Cruikshank's Omnibus* (1841) and *George Cruikshank's Table Book* (1845), as well as his *Comic Almanack* (1835–53). *The Life of Sir John Falstaff* (1857–58) contained 20 full-page etchings. The best known of the pictures and illustrations produced by Cruikshank as an enthusiastic advocate of abstinence are *The Bottle*, eight plates (1847), with its sequel, *The Drunkard's Children*, eight plates (1848), and the ambitious work *The Worship of Bacchus*, published by subscription after the artist's oil painting, now in the National gallery, London, to which it was presented by his numerous admirers.

See also Caricature and Cartoon.

See *Cruikshank's Water-Colours*, with introduction by Joseph Grego (1903) and R. McLean, *George Cruikshank, His Life and Work as a Book Illustrator* (1948).

CRUISER, a warship built for high speed and great cruising radius, smaller than a battleship or aircraft carrier but larger than a destroyer. The word cruiser was used as a general term to describe frigates of the sailing ship era and also the sloops of war of the early days of steam power. It did not come into general use as a type name in the modern sense until after 1880. Great Britain began to build cruisers at that time and the United States authorized three cruisers in 1883 along with several monitors.

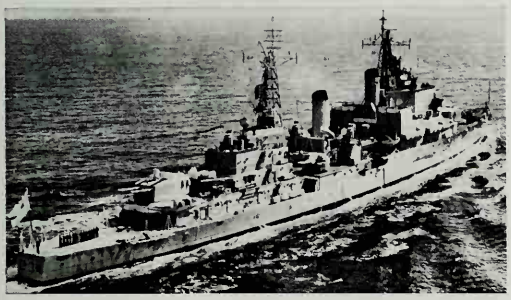
Shipbuilders were making increasing use of steel when the cruisers of the 1880s were begun. An early development was the armoured deck that used steel from two to four inches thick and was intended to protect machinery spaces and magazines against plunging fire. Such vessels were known as "protected cruisers." They were followed by the "armoured cruiser" that had armour belts on both sides, transverse armoured bulkheads fore and aft,



U.S.S. "Brooklyn" which saw service during the Spanish-American War and World War I. Displacement: 10,300 tons

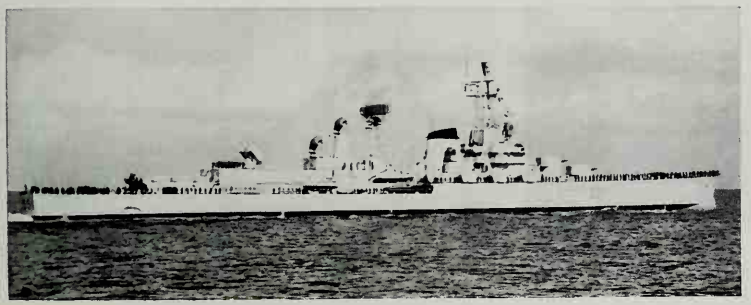
U.S.S. "Oklahoma City," "Cleveland" class guided-missile light cruiser. Displacement: 14,600 tons

"De Zeven Provincien," "De Ruyter" class cruiser of the Royal Netherlands Navy, rearmed with "Terrier" guided missiles. Displacement: 11,850 tons



H.M.S. "Lion," "Tiger" class cruiser of the Royal Navy, completely air conditioned and electrically driven. Displacement: 11,700 tons

U.S.S. "Long Beach," the U.S. navy's first nuclear-powered surface ship, a guided-missile heavy cruiser. Displacement: 18,000 tons



"Giuseppe Garibaldi," Italian converted "Garibaldi" class cruiser, armed with the "Terrier" guided missile. Displacement: 11,600 tons

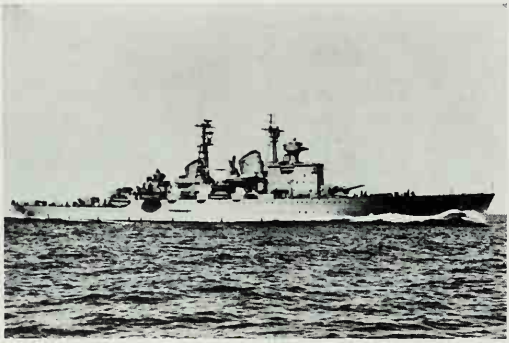
20TH-CENTURY CRUISERS

BY COURTESY OF (TOP, SECOND ROW LEFT, THIRD ROW RIGHT) U.S. NAVY, OFFICIAL NAVY PHOTOGRAPHS, (SECOND ROW RIGHT, THIRD ROW LEFT, BOTTOM) "JANE'S FIGHTING SHIPS"

CRUISER

MODERN CRUISERS

U.S.S. "Albany" firing three missiles in salvo



"Tre Kronor," Swedish Royal Navy cruiser of the "Tre Kronor" class. Displacement: 9,200 tons

U.S.S. "Albany," "Oregon City" class guided-missile heavy cruiser converted and recommissioned in 1962. Displacement: 17,500 tons

U.S.S. "Newport News," "Salem" class heavy cruiser completely air conditioned. Displacement: 21,500 tons

"Sverdlov," U.S.S.R. "Sverdlov" class heavy cruiser, reported converted to guided-missile cruiser. Displacement: 19,200 tons

BY COURTESY OF (TOP, SECOND ROW RIGHT, BOTTOM LEFT) U.S. NAVY, OFFICIAL NAVY PHOTOGRAPHS, (SECOND ROW LEFT, BOTTOM RIGHT) "JANE'S FIGHTING SHIPS"

and one or two armoured decks. "Scout cruisers" were usually smaller and had no armour of any kind.

Before 1900 these three types of cruisers were used to prey on enemy merchant ships, to defend friendly shipping, or to fight enemy cruisers. The advent of the torpedo boat and torpedo-boat destroyer brought a need for higher speeds and greater volume of gunfire if cruisers were to defend themselves against torpedo attacks. Another type, the "battle cruiser," appeared during the early 20th century. It had the big guns of a dreadnought battleship but carried less armour and was capable of higher speeds. "Light cruisers" displaced only about 5,000 tons, frequently no more than 1,500 or 2,000 tons, and carried 3-in. or 4-in. guns. The U.S.S. "Chicago," authorized in 1883, was at first classed as a cruiser, then as a cruiser 2nd line and finally as a light cruiser.

Limitation of Naval Armament.—The Washington treaty of 1922 provided that, "No vessel of war of any of the Contracting Parties, hereafter laid down, other than a capital ship, shall carry a gun with a calibre in excess of 8 inches." (*See* WASHINGTON, TREATIES OF.) This clearly meant that cruisers built after the treaty could not carry guns larger than 8-in. The treaty placed no explicit limit on the size of cruisers, although the definition of a capital ship as one displacing more than 10,000 tons obviously meant that cruisers were to be less than 10,000 tons standard displacement, the equivalent of about 14,000 tons fully loaded. To keep within these limitations cruiser designers employed light metals and other weight-saving devices that increased shipbuilding costs. The treaty restrictions also led to improvements in naval guns. On the basis of main-battery armament, two new classifications of cruisers came into common use: heavy cruisers carrying 8-in. guns, and light cruisers carrying 6-in. guns. Later there developed a third class, antiaircraft cruisers, with main batteries of dual-purpose guns, usually 5-in. or smaller, that could be used against either aircraft or surface vessels.

The Washington treaty limited the size of guns on cruisers but did not restrict the number of such ships a nation might build. The Geneva conference in 1927 failed to reach agreement on an overall limit to cruiser tonnage, but the London Naval treaty of 1930 covered the subject, extending the 5:5:3 ratio to cruisers as well as to capital ships. In the intervening years the subject caused much discussion and no little international wrangling. Throughout the entire period Britain pointed to her national need for cruisers to protect her vital trade routes. The acceptance of a limit by the British government in 1930 led to further political discussion in England during which the Ramsay MacDonald cabinet defended the action against attacks from the opposition. In view of all that was said in those years about the need for cruisers, an observer in the British Isles in the early 1960s might have been tempted to ask, "How can our commerce be protected now that we have only a very few cruisers?" The answer was that the British government was still relying on ships for the protection of trade, just as it had for centuries, but that many of the ships so employed were no longer called cruisers. The smallest cruisers of the 1960s were of about the same tonnage as the largest ones earmarked for commerce protection in the early years of the 20th century. There were no "cruisers" of 1,200 to 5,000 tons in 1960, but the Royal Navy had destroyers, destroyer types and other vessels available for duties that had once fallen to the smaller cruisers.

The resurgence of German naval power, one of the major developments of the 1930s, helped destroy the treaty limitations on naval armament. By the treaty of Versailles, Germany had been forbidden to acquire armoured ships displacing more than 10,000 tons. To get around this restriction German naval architects created the so-called pocket battleships, "Deutschland," "Admiral Scheer" and "Admiral Graf Spee." These ships conformed to the Versailles limitation on tonnage but they mounted 11-in. guns that far outclassed the 8-in. weapons on cruisers built by the signers of the Washington treaty. This gain in firepower, however, was made only by sacrificing armour and speed; many U.S. and British naval officers felt that mounting 11-in. guns on vessels of this type was a mistake. Germany laid the keels of two battle cruisers, "Scharnhorst" and "Gneisenau," in 1934 to serve as commerce raiders and to attack convoys. In Dec. 1941 the United States began to build a similar type classed as large cruisers.

Naming of Cruisers.—In accordance with various acts of Congress, the U.S. navy names cruisers for principal U.S. cities and towns, but there have been a few exceptions to the rule. The "Canberra" was named for the capital of Australia because an Australian cruiser of that name was lost while serving with U.S. ships at the battle of Savo Island, Aug. 9, 1942. The frigate "Norfolk," begun in 1949, was originally classified as a cruiser to be used for antisubmarine work. She retained the name after being reclassified as a frigate. The names "Alaska," "Guam" and "Hawaii" were assigned to large cruisers begun in 1941–42. "Hawaii" was 82% completed when work was suspended after 1945.

The U.S. navy uses CA to designate a heavy cruiser, or CAG if equipped with guided missiles. A light cruiser is CL, and with guided missiles becomes CLG. An antiaircraft cruiser is CLAA. Nuclear-powered guided missile cruisers of the "Long Beach" class are designated CG(N).

The Royal navy has named cruisers for famous ships of the past, for great fighting men or for cities or colonies. For example, the three cruisers completed in 1959 were named "Lion" (17th of her name), "Tiger" (15th) and "Blake" (3rd). Cruisers of the "Southampton" class were named for cities in the British Isles; cruisers of the "Mauritius" class were named for colonies.

Modern Cruisers.—Cruisers of the "Tiger" class (1959, first such British ships built since 1945) had a complement of 60 officers and 980 men. Their fully automatic 6-in. turrets had a rate of fire far in excess of any previous British cruisers. They carried twin 3-in. guns and Bofors 40-mm. antiaircraft guns. Their full-load displacement was more than 11,000 tons and their speed exceeded 30 knots. British cruisers completed between 1937 and 1945 had displacements ranging from 11,100 to 14,930 tons.

The U.S.S.R. had more than 35 light cruisers in the early 1960s. Some of these displaced nearly 20,000 tons, but the heaviest armament was the 7.1-in. gun. Many were also fitted for minelaying operations.

The U.S. navy in the early 1960s had several guided missile cruisers in commission, including "Boston" and "Canberra," the first ships to be so designated. On Dec. 2, 1957, the keel was laid at Quincy, Mass., for the first ship to be designed and built as a guided missile cruiser and the first surface vessel in the U.S. navy to employ nuclear power. The "Long Beach," launched in July, 1959, displaced 14,000 tons but was larger than other ships of that tonnage because the weight of her nuclear power plant and fuel was less than that of conventional systems. She required refueling not oftener than once in six months and her cruising radius was many times that of any earlier ship of any type. Her dimensions were approximately 700 ft. by 75 ft. by 26 ft. She carried three types of guided missiles as well as surface-to-surface antisubmarine weapons.

Prospective Developments.—The navies of the world have ceased to build battleships and have scrapped or decommissioned almost all of the remaining vessels of that type. There is little danger, however, that cruisers will suffer the same fate. In offensive power the "Salem" class of cruisers surpasses H.M.S. "Dreadnought" of 1906, and ships of this class are as large as that battleship was. With their rapid-fire guns and automatic loading systems modern cruisers have far higher rates of fire, greater range and superior fire control. Although their armour would appear to be less, their protection is probably relatively greater. The general performance of all cruisers in the test of battle between 1939 and

Cruisers of All Types
(Including Vessels Under Construction)

Year	Great Britain	France	Germany	Italy	U.S.S.R.	Japan	U.S.
1901	150	57	27	31	27	27	37
1914	145	25	57	13	18	27	32
1939	78	21	18	34	9	38	43
1945	59	12	7*	16	10	9*	92
1959	16	7	...	9	37	...	75

*Afterward scrapped or transferred.

1945 was well up to reasonable expectations. While the U.S. navy lost ten cruisers between Dec. 7, 1941, and Oct. 1, 1945, more than that number suffered severe damage and still managed to reach port. With nuclear power plants giving them almost unlimited cruising radius, practically eliminating the refueling problem that had been the major limiting factor in previous operations, and with probable developments in guided missiles the role of the cruiser would seem to be expanding.

See AIRCRAFT CARRIER; BATTLESHIP; DESTROYER; SHIP; *see* also references under "Cruiser" in the Index volume.

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CRUMHORN, a wind instrument, now obsolete, that flourished during the period 1500–1650 (French *cromorne, tournebout*). Its name is derived from the old English *crump,* crooked. It consists of a wooden pipe curved upward at the lower end, with a small, cylindrical bore and fingerholes like those on the recorder. It is sounded by a double reed enclosed in a wooden cap with blowing orifice in the top. *See* WIND INSTRUMENTS: *Reed Instruments.* (A. C. BA.)

CRUSADES (Sp. *cruzada,* "marked with the cross") is the name given to a series of wars undertaken by the Christians of western Europe with the authorization of the papacy from 1095 until the mid-15th century for the purpose of recovering the Holy Sepulchre at Jerusalem from the Muslims and defending possession of it. In a broader sense a crusade was a war sanctioned by the papacy and directed against anyone whom it declared to be the enemy of Christ.

Causes.—The immediate cause of the crusades was the interruption of the pilgrim traffic to the Holy Sepulchre as a result of the advance of the Seljuk Turks (*see* SELJUKS) in the 11th century. In 1055 the Seljuk chieftain, Tughrul-Beg, forced his nominal master, the Abbasid caliph at Baghdad, who was a Sunnite Muslim, to grant him the title of sultan. After the battle of Manzikert (*q.v.*) in 1071, nomadic bands of Turks overran the ancient Byzantine territory of Anatolia, making the journey of pilgrims from Europe increasingly difficult. After the death of the able sultan Malik Shah in 1092 his amirs began fighting over Syria, Palestine and the other Abbasid provinces, causing further disruption of pilgrim traffic. Since expeditions of pilgrims from Europe were becoming more frequent and included larger numbers of people, such interruptions caused great distress.

A second and general cause of the crusades was the release of expansive energy in western Europe. For about 200 years the west had endured the attacks of the Saracens, the Vikings and the Magyars. Then, about the beginning of the 11th century, the Vikings and the Magyars were Christianized, a rudimentary form of law and order was established by the great feudal princes and prelates, commerce began to revive and money to circulate.

The church was stirred at the same time by the progress of the Cluniac Benedictine reform in the monasteries by the great increase in the number of pilgrimages and by a quickening of the tempo of the religious wars conducted against the Muslims in Spain and Sicily. Toledo in Spain was captured in 1085; the Arab base of Mahdia in Tunisia was taken by the Genoese, the Pisans and their allies from other Italian cities in 1087; and the last Muslims were driven from Sicily in 1091. These campaigns were blessed by the papacy, a precedent for the future.

Most important of all were the plans of Pope Urban II, a disciple and protégé of Pope Gregory VII and a prominent leader of the Cluniac reform movement. The Cluniacs wished to institute a stern, pure and universal discipline in the church, to free it from all taint of feudal control, to enable the pope as the vicar of Christ to rule the church universal and to channel the activities of mankind into the service of God. Rule of the church universal would imply not only control in western Europe but also the healing of the diplomatic breach, the schism of 1054 between the papacy and the Byzantine patriarch and emperor, and ultimately a recognition of papal supremacy over the whole church in both east and west.

Upon becoming pope in 1088, Urban II resumed contacts with the Byzantines, but since he and the Byzantine emperor Alexius I Comnenus were both at first occupied in strengthening their positions at home nothing further of importance happened between them for a few years. Then, in the spring of 1095, Urban called a council at Piacenza to discuss ecclesiastical affairs. To this council Alexius sent an appeal for recruits for his army to fight the Turks (his predecessor, Michael VII, had made a similar appeal to Gregory VII in 1073 in offering to discuss healing the breach of 1054). Urban brought this problem to another church council which met at Clermont, in Auvergne, in Nov. 1095. However, instead of asking for volunteers for the Byzantine army he called for a papal army, as Gregory had considered doing on the previous occasion. Its symbol was to be the cross and its leader a papal legate. Its mission was to help Alexius drive the Turks from Anatolia, and then to go on to recover possession of the Holy Sepulchre at Jerusalem, as Gregory VII had originally planned. This latter purpose was not among the plans of Alexius, who had more immediate objectives. There is no evidence that Urban raised the troublesome issue of papal supremacy on this occasion and certainly none that he ever modified the principle. The conduct of the subsequent crusade indicates that he intended to recognize and restore the Greek Orthodox clergy as the crusade progressed. This was essential if the breach with the Byzantines were to be healed.

First Crusade.—Urban's appeal for a crusade was far more successful than he expected. There arose not only an army in southern France but also several in northern France and one in Apulia in southern Italy, all led by powerful feudal princes; there were also several bands of common people with popular leaders. The large army of Provençals under the rich and powerful Raymond IV (*q.v.*), count of Toulouse, was accompanied by Adhemar de Monteil, bishop of Le Puy, the papal legate. It was Raymond's ambition to be the military leader of the crusade, a kind of *advocatus* under the papal legate. Contingents from the north were led by Robert II Curthose, duke of Normandy; by Robert II, count of Flanders; and by Godfrey (*q.v.*) of Bouillon, duke of Lower Lorraine—all with large forces; and also by Stephen Henry, count of Blois, and by Hugh, count of Vermandois, with negligible forces. From the Norman duchy of Apulia came Bohemund (*q.v.*), son of Robert Guiscard, with a small but excellent army. Such leaders were not disposed either by rank or by temperament to take orders from Raymond or from one another, and it was clear that it would take much tact on the part of the papal legate to control them.

These forces of crusaders, or Franks as they were called, arrived at Constantinople at intervals from July 1096 to May 1097. Godfrey of Bouillon went across Hungary, Raymond through Dalmatia and the others via Apulia and Albania. Alexius, who had simply wanted soldiers for his armies, received instead hordes of ill-disciplined fighting men and, in addition, pilgrims, clergy and other noncombatants, under western leaders whom he could not control. Bohemund, who had accompanied Robert Guiscard in a dangerous invasion of the Byzantine possessions in Albania and Greece as recently as 1081–85, now blandly requested of Alexius the office of grand domestic of the east, which would have made him imperial viceroy for all the lands that the crusaders might conquer. There is no record that Alexius granted any such request. He did, however, exact from the Frankish princes an oath that they would return to him all former imperial territories taken by the Turks which they might reconquer and also imposed on them an oath of allegiance with respect to anything further that they might recover. This meant that he expected the return of the Anatolian peninsula and the city of Antioch but would be content with a form of feudal suzerainty over any other territory, such as Palestine if the crusaders cared to go there. The Frankish princes agreed with varying degrees of willingness, the wily Bohemund with alacrity. Raymond, suspicious of an oath that

WERNER BRAUN

GOLDEN GATE, EAST WALL OF JERUSALEM, OUTSIDE THE HARAM AREA

might put him under a grand domestic of the east, would agree only not to permit harm to the life and honour of Alexius.

The Franks and Byzantines had hardly begun their journey across Asia Minor when Frankish resentment was aroused at the emperor's introduction of soldiers into Nicaea after its surrender in June 1097, in order to prevent the town from being looted by the Frankish soldiers. His action intensified their instinctive dislike of the Greeks, whose religious customs were different from and whose cultural level was higher than their own. As the crusaders, having defeated the Seljuks at Dorylaeum (near the modern Eskisehir) in July, moved across the Anatolian highlands, Alexius turned to the reoccupation of his former provinces, sending on only a token force with the crusaders. This seemed like desertion to the common soldiery, but it was different when Godfrey's brother Baldwin of Boulogne, the future Baldwin I (*q.v.*) of Jerusalem, detached himself from the main army at Marash and set himself up as the ruler of the Armenians of Edessa, across the Euphrates, in March 1098; this seemed a valiant act and set an example which Bohemund was eager to follow.

Meanwhile the main army of the crusaders reached the environs of Antioch, the metropolis of northern Syria, in Oct. 1097. As a result of the jealousies and anarchy that had developed among the amirs and other governors of the Seljuk sultans after the death of Malik Shah, the ruler of Antioch, Yaghi-Siyan, got very little support from elsewhere. Yet, thanks to the strength of his position, to quarrels among the Frankish princes and to the decision of Alexius to occupy as much of Anatolia as possible and not come to Antioch until spring, he was able to hold out until June 1098. When Alexius finally started he was turned back at Philomelium (Aksehir) in June by the alarmist reports of the deserter Stephen Henry of Blois regarding the strength of the *atabeg* (regent) Kerbogha of Mosul, then marching to relieve Antioch. Alexius' decision was momentous, for he not only lost his chance to recover Antioch but he forfeited most of the lingering respect that he still enjoyed among the Franks.

During May 1098 Bohemund worked upon the crusaders' suspicions of Byzantine perfidy and wrung from the majority of the leaders the promise that if Alexius did not arrive the man who might effect the capture of the city should have it. Raymond, mindful of the pope's desire for good relations with the Byzantines, would not agree. Nevertheless Bohemund completed secret negotiations for the betrayal of the city, and Antioch was taken on June 3, 1098—not a moment too soon. Kerbogha arrived on June 5 and the besiegers became in their turn the besieged. Bohemund, however, managed to defeat Kerbogha's forces on June 28 and the Franks were saved.

The future of Antioch was now hotly debated between Bohemund, who held most of the city, and Raymond. Their quarrel delayed the further progress of the crusade for some months. Finally popular impatience compelled the princes to resume their journey toward the Holy Sepulchre in Nov. 1098. Bohemund turned back just after Christmas and, ejecting the guards that Raymond had left at Antioch, took complete possession of the city. In thus founding the second Frankish state in the east (after Edessa), he widened the breach with the Greeks, which the pope had hoped to heal.

After the long delay around Antioch the rest of the journey to Jerusalem was quickly accomplished. The Arab governors along the coast of Syria, most of whom were nominally subject to the Fatimid caliph of Cairo, were glad to provide the Franks with markets and food in return for security. However, when the crusaders reached Jerusalem itself on June 7, 1099, they encountered stiffer opposition, Jerusalem being after all also a holy city to the Muslims. Taking advantage of the Frankish hostilities against the Turks, the Shi'ite Fatimid government had seized the city from the Sunnite Turks the year before and was resolved to defend it. Nevertheless, the crusaders took Jerusalem by storm on July 15 and a horrible massacre of Muslims and Jews ensued. Under such circumstances the Holy Sepulchre was recovered.

Organization of the Latin States.—With the conquest of Jerusalem the establishment of a government was the next task. Godfrey of Bouillon was chosen *advocatus* (defender) of the Holy Sepulchre. The title was in deference to ecclesiastical wishes for a church state rather than a monarchy. The more secular or feudal interests were served by the choice of a willing partisan, Arnulf, chaplain to the duke of Normandy, as patriarch. No thought was given to restoring a Greek patriarch in the city.

Arnulf was soon set aside through the influence of Bohemund and of Archbishop Daimbert of Pisa, who arrived in Dec. 1099 ostensibly for the Christmas devotions at the Holy Sepulchre. The archbishop, playing upon Godfrey's need for naval support from Pisa in order to conquer the Palestinian ports, got himself chosen patriarch of Jerusalem and on that basis claimed to be the feudal suzerain of both Bohemund and Godfrey. This satisfied Bohemund, who went back to Antioch with a Latin Church sanction for his usurpation of that city from the Greeks, but Godfrey was victimized. Daimbert tried to rule both church and state at Jerusalem, to ignore Godfrey and even to induce him to give up the city of Jerusalem. Godfrey died on July 18, 1100, before an open break with Daimbert occurred.

Baldwin, Godfrey's brother, was summoned from Edessa by Arnulf and others as Godfrey's successor. Baldwin forced Daimbert to crown him king at Bethlehem on Christmas day, 1100. Then, step by step, he drove Daimbert from the country (1102) and gradually associated the royal title with Jerusalem, the holy city. In all this he was abetted by Arnulf, who eventually became patriarch again in 1112. Thus the cause of feudal monarchy triumphed at Jerusalem over that of an ecclesiastical state.

Besides Jerusalem three other Latin Christian states were established in the east. These were the countship of Edessa, the principality of Antioch and the countship of Tripoli (Tripoli was conquered during the years 1102–09 by the adherents of Raymond of Toulouse). Government in all three was feudal and was probably similar to that in Jerusalem.

In the case of Jerusalem in particular and to a lesser degree in that of Antioch there are elaborate records (the *Assizes*) of customs and laws written down largely in the 13th century. Those of

Jerusalem indicate a king, a group of tenants-in-chief belonging to a royal feudal council (the *haute cour*), a complete Latin Church hierarchy, an establishment of monasteries, a royal domain, a number of towns and a set of classes and estates all with elaborately defined rights and usually with courts to protect those rights. Three circumstances are noteworthy. First, the king was elected by the *haute cour* and was regarded as *primus inter pares* by its members. Second, the Italian colonies in the ports had almost independent extraterritorial rights, usually granted in return for naval aid in conquering the ports. Third, there were three great military orders of knighthood, the Templars, the Order of the Hospital of St. John of Jerusalem and in later times the Teutonic Order (*qq.v.*). Largely maintained by their own funds from Europe, the knights garrisoned many of the great castles which guarded the frontiers, and under resident grand masters enjoyed a large degree of independence.

Despite these limitations to his authority the king of Jerusalem could still wield much power if he were an able man. His royal domain could supply about two-fifths of the secular knights of the kingdom, he commanded all the armed forces in time of war and he usually controlled the selection of the patriarchs and the high churchmen. Furthermore, his guardianship of Jerusalem and the Holy Sepulchre gave him great advantages. He could claim moral leadership over the other three Latin states and often exercised it. Baldwin I was actually suzerain of the counts of Edessa and Tripoli. Jerusalem received most attention from the west and from the pope. To it came pilgrims, new crusaders and money. Through the pope the king could exert some influence and control over the other three states, over the grand masters of the military orders and over the patriarch.

With the exception of Edessa the crusader states lay along the coast. Since they all had to be constantly supplied and maintained from Europe, there was a continuous need for preaching crusades in Europe. The governing class of the four Latin states never numbered more than 2,000–3,000 western European nobles and clergy, mostly French in origin and speech. They ruled a heterogeneous population of native Muslims and Christians, the former more numerous in the kingdom of Jerusalem, the latter in the north. The countryside was divided into *casalia* (estates) worked by the native peasantry. In the seaports were native merchants and artisans and colonies of Genoese, Pisan and Venetian merchants and mariners. In time of peace Muslim merchants from the interior were usually welcomed and the Franks quickly adopted a tolerance toward Muslims and their ways, which always astonished idealistic pilgrims and crusaders fresh from Europe.

Tables I–IV show the rulers of the four Latin states.

Relations With the Muslim States.—Once the Franks were established in the east they faced the problem of survival among the Muslim states. There was much in their favour. The Abbasid caliphs of Baghdad and their Seljuk sultans were largely indifferent to Syria and Palestine, which lay on the periphery of their interests. Accustomed to Christians, especially to Byzantines, they at no time regarded the petty crusader states as dangerous and never attempted to drive out the Franks. This was also largely the attitude of the caliphate of Cairo. After a futile attack on the Franks of Jerusalem in 1105, al-Afdal, the vizier of Egypt, returned to a purely domestic policy. In Syria itself the local Turkish regimes at Aleppo and at Damascus were mutually hostile and sometimes ready to ally themselves with the Franks against each other. Under these circumstances the wisest policy for the Franks would have been to live with the neighbours who were willing to tolerate them and certainly never to let the Muslim states unite in a *jihad* or holy war.

Consequently, when Imad-al-Din (Zangi), *atabeg* of Mosul, seized Aleppo in 1128 and then tried to get possession of Damascus in order to start a *jihad*, the Franks should have helped the Burid dynasty of Damascus retain its independence. Instead they harassed Damascus from the south while Zangi invaded its lands in the north. In 1140 they had to be paid by the government of Damascus to save the city from a siege by Zangi, although it was in their own interest to keep Damascus free. Then in 1144 Zangi attacked Edessa, the capital of the first crusader state, and captured it. Zangi died in 1146, but his son Nureddin (Nur-al-Din Mahmud) continued his work for a holy war.

Second Crusade.—The fall of Edessa shocked western Europe, and Pope Eugenius III issued a call to arms, the second crusade. The pious Louis VII of France took the cross, as did the German king Conrad III—the latter in response to the preaching of Bernard of Clairvaux. They departed in the spring of 1147 with high hopes, traveling through Hungary, Conrad going on ahead. When Conrad's army reached Asia Minor, it was ambushed and destroyed by the Turks near Dorylaeum on Oct. 25, 1147. The army of Louis suffered almost as severely near Laodicea in Pisidia early in Jan. 1148.

Nevertheless, by the spring of 1148 both monarchs had got through with very small forces by sea, Louis to St. Symeon, near Antioch, and Conrad to Acre. At Antioch the prince, Raymond (*q.v.*) of Poitiers, uncle of the queen of France, Eleanor of Aquitaine, tried hard to induce Louis to operate against Aleppo, Nureddin's key base in northern Syria. This was the soundest possible military advice and might have helped Edessa, whose fall had led to the crusade. Louis, however, was piously determined to campaign closer to the Holy Sepulchre. He departed, moreover, with such suspicions about his queen's relations with her uncle Raymond that he procured an annulment of their marriage when they eventually returned to France.

TABLE I.—*Kingdom of Jerusalem*

Ruler	Right of succession	Reign
Godfrey (of Bouillon)		1099–1100
Baldwin I (of Boulogne)	Brother of Godfrey	1100–18
Baldwin II (of Bourcq)	Cousin of Godfrey and Baldwin I	1118–31
Melisande, heiress	Daughter of Baldwin II	1131–52
Fulk (of Anjou)	Consort of Melisande	1131–43
Baldwin III	Son of Melisande and Fulk	1143–63
Amalric I	Brother of Baldwin III	1163–74
Baldwin IV	Son of Amalric I	1174–85
Baldwin V	Nephew of Baldwin IV	1185–86
Sibyl, heiress	Daughter of Amalric I, mother of Baldwin V	1186–90
Guy (of Lusignan)	Consort of Sibyl	1186–92
Isabella (I), heiress	Sister of Sibyl	1192–*c.* 1205
Conrad (of Montferrat)	Consort of Isabella	April 1192
Henry (of Champagne), not styled king	Consort of Isabella	1192–97
Amalric II (of Lusignan)	Consort of Isabella	1198–1205
Mary, heiress	Daughter of Isabella and Conrad	1205–12
John (of Brienne)	Consort of Mary	1210–25
Isabella (II, or Yolande), heiress	Daughter of Mary and John	1212–28
Frederick (II, as emperor)	Consort of Isabella	1225–43*

*Frederick was crowned in Jerusalem in 1229, but his son by Isabella, the German king Conrad IV, could be regarded as having inherited the kingdom at the latest on his coming of age in 1243. Long after the fall of Jerusalem itself to the Muslims (1244), the royal title was disputed between (1) Frederick's descendants, of the house of Hohenstaufen; (2) the kings of Cyprus, of the house of Lusignan, descendants of Amalric II and also of Henry of Champagne's daughter Alice; and (3) the Angevin kings of Naples, descendants of Charles of Anjou, who in 1277 purchased the claims of Mary of Antioch, grandchild of Isabella (I) and Amalric II through their daughter Melisande, wife of Bohemund IV of Antioch.

TABLE II.—*Principality of Antioch*

Bohemund I	1098–1100	Baldwin, regent again	1130–31
Tancred, regent	1101–03	Fulk (of Jerusalem), regent	1131–36
Bohemund I, restored	1103–04	Raymond (of Poitiers)	1136–49
Tancred, regent again	1104–12	Raynald (of Châtillon)	1153–60
Roger, regent	1112–19	Bohemund III	1163–1201
Baldwin (II of Jerusalem), regent	1119–26	Bohemund IV	1201–33
Bohemund II	1126–30	Bohemund V	1233–52
Constance, heiress	1130–63	Bohemund VI	1252–68*

*Fall of Antioch.

TABLE III.—*Countship of Edessa*

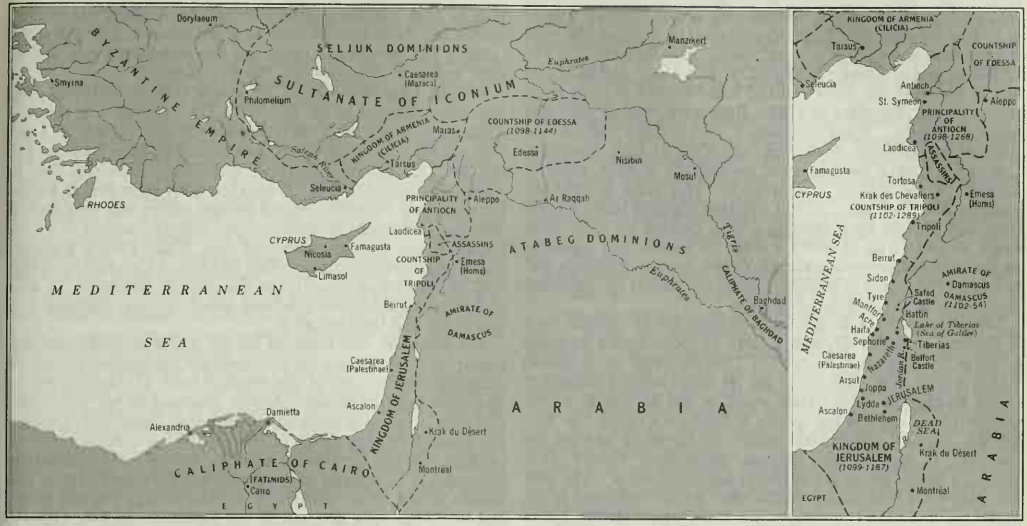
Baldwin I (of Boulogne)	1098–1100	Joscelin I (of Courtenay)	1118–31
Baldwin II (of Bourcq)	1100–18	Joscelin II (of Courtenay)	1131–44*

*Fall of Edessa.

TABLE IV.—*Countship of Tripoli*

Raymond (IV of Toulouse), begins conquest	1102–05	Bohemund (later IV of Antioch)	1187–1233
William	1105–09	Bohemund (V of Antioch)	1233–52
Bertrand, established as count	1109–12	Bohemund (VI of Antioch)	1252–75
Pons	1112–37	Bohemund VII	1275–87
Raymond II	1137–52	Lucia, heiress as Bohemund VII's sister	1288–89*
Raymond III	1152–87		

*Fall of Tripoli.



SYRIA DURING THE PERIOD OF THE CRUSADES

After Conrad and Louis had performed their devotions at the Holy Sepulchre they and the Franks of Jerusalem decided to attack Damascus. The chief reason for this decision was greed for rich fiefs. No thought was given to the fact that Damascus protected Jerusalem and the other crusader states from Nureddin, who was making mounting efforts to acquire it and enlist it in the holy war.

The siege of Damascus was a fiasco. The invaders attacked the city from the south for three days and then changed to the east, where they ran short of water. All this time they were locked in bitter disputes over whether Thierry of Alsace, the protégé of Conrad and Louis, or the Franks of Jerusalem should have Damascus and its rich lands. As a result the crusaders abandoned the siege on July 28, 1148, after four days and departed.

The results of the second crusade were as follows. The spell of success enjoyed by the Franks as a result of the first crusade was broken, and they lost prestige in the eyes of the Turks. There was increased resentment in western Europe against the Byzantines, who were held responsible for the disasters in Anatolia. In Damascus the population began seriously to question the wisdom of co-operation with the Franks, and to favour Nureddin and his policy of *jihad* instead.

Nureddin's Achievement and the Rise of Saladin.—After the second crusade Nureddin relentlessly continued his father's policies of uniting the Muslims and attempting to drive the Europeans out of Palestine and Syria. In 1149 he defeated and killed Raymond of Antioch at Inab, permanently weakening the principality of Antioch and making easier the operations against Damascus. His great victory made him appear to Sunnite Muslims as the champion of their faith. He cultivated this feeling, patronizing mosques and schools which taught the need of Muslim unity. This made it increasingly difficult for the regime at Damascus to maintain its independence by the policy of co-operation with the Franks. Starting in 1150 and excepting 1152, Nureddin annually invaded the rich lands of Damascus. He restrained his forces from engaging in much plundering, declared himself the true champion of Islam and thus attempted to shame the government inside the city.

In 1153 Baldwin III (*q.v.*), king of Jerusalem from 1143 to 1163, captured Ascalon, the Egyptian fortress 40 mi. S.W. of Jerusalem. Although the caliph of Egypt was a Shi'ite the fall of Ascalon was too much for Sunnite feeling in Damascus. The next year when Nureddin appeared the people of Damascus opened their gates without a fight. Syrian Islam was now united against the Franks.

Events now centred on the control of Egypt. The viziers of the Fatimid caliphs had since 1105 pursued a mainly domestic policy. It was essential for Nureddin to control Egypt in order to encircle the Franks and it was equally necessary for the latter to intervene in Egypt in order to prevent this. Amalric I (*q.v.*), king of Jerusalem from 1163 to 1174, took advantage of court factionalism in Cairo to invade the delta in 1163, 1164, 1167 and 1168. Each time Nureddin sent in his Kurdish general Asad-al-Din Shirquh to support the opposing side. In Jan. 1169 Shirquh succeeded in entering Cairo and, although a Sunnite, became the vizier to the Fatimid caliph. Shirquh died two months later and was succeeded by his nephew Saladin (*q.v.*; Salah-al-din Yusuf ibn Ayyub). In 1171, on order from Nureddin, Saladin proclaimed the authority of the Abbasid caliphate in Egypt. At last the Muslims of Iraq, Syria and Egypt were in religious and political harmony and the *jihad* had become a distinct probability.

When Nureddin died in 1174 there ensued a struggle for power among his family and officers, and the unity that he had built up appeared to vanish. Saladin at once secured control of Damascus. It was a decisive stroke, for it enabled him to operate against Aleppo and Mosul from Damascus and Egypt. He soon acquired the mantle of moral authority as leader of the Muslims by his consistent conduct and because the heirs of Nureddin by contrast now stood for Muslim division and weakness. By 1183 Saladin gained control of Aleppo and by 1186 he became overlord of Izz-al-Din of Mosul. Thus the Muslims were again united and able to hem in the Franks by land. During this time Saladin avoided serious trouble with the Franks, built up his army, wooed the Italian cities with commercial treaties with Egypt and played on the reciprocal suspicions of the Byzantines and of the Franks.

Saladin's Conquest of Jerusalem.—Jerusalem, Tripoli and Antioch, the three remaining crusader states, which Saladin now planned to eliminate, had impressive advantages. They occupied a central position, with huge castles guarding the frontiers and sea connections with western Europe, and they possessed cavalry and infantry intimately experienced in the ways of the Turks and Egyptians. What they lacked was unity and common sense.

The Franks of Jerusalem were plagued by an internal struggle for power. Baldwin IV (*q.v.*), king from 1174 to 1185, was fatally ill with leprosy and his nephew and heir, the future Baldwin V, was still a child. The barons of the kingdom, led by Raymond

III (*q.v.*), count of Tripoli, who was also lord of Tiberias, wanted to control the regency. They were opposed by a group who were relative newcomers to the country, among them Raynald (*q.v.*) of Châtillon, lord of Karak (Krak or Crac du Désert) and Montréal east of the Dead sea, and Gerard of Ridefort, who became grand master of the Templars in 1186. Both were reckless men and hated Raymond. When Baldwin V died (1186) Gerard and Raynald procured the clandestine coronation of their candidate, Guy of Lusignan, a weak man and the husband of Sibyl, sister of Baldwin IV and mother of Baldwin V. This move brought the kingdom near civil war. At this juncture Raynald broke a royal truce with Saladin by plundering a huge caravan en route from Egypt to Damascus, in which a sister of Saladin was traveling. As Raynald had previously raided pilgrim convoys to Mecca and as Saladin had vowed to kill him, Saladin was now at last provoked into beginning the long-deferred *jihad*.

Saladin crossed the Jordan south of the Lake of Tiberias (Sea of Galilee) in May 1187, with a force of about 20,000 men and laid siege to the castle in the town of Tiberias, which was defended by Raymond's wife. Guy called out the entire military manpower of his kingdom, a force nearly equal in size to Saladin's, and camped 15 mi. away at the springs of Sephorie (Tsippori or Saffuriya). Against the prudent advice of Raymond and on the insistence of his scornful enemies, particularly Gerard, Guy ordered a march across the waterless hills to Tiberias. The next day, July 4, the exhausted Frankish army was overwhelmed in the wastes south of a low two-pronged hill, the Horns of Hattin, within sight of the lake. Raymond escaped, Raynald was executed and Guy and Gerard were held for ransom. Thus as a result of a frivolous decision born of long-standing personal animosities a splendid army was annihilated.

Saladin then proceeded to take most of the cities and castles of the defenseless Latin states. Jerusalem fell on Oct. 2, 1187. After two years only Tyre and the castle of Belfort were left in the kingdom, Tripoli and four castles in the countship of Tripoli and Antioch and a few small places in the north. In general the wealthy Franks bought their freedom and departed while the poorer ones remained. The Jews, the native Monophysites and the Orthodox Christians were kindly treated and willingly accepted Muslim rule.

Third Crusade.—After the fall of Jerusalem, Pope Gregory VIII and his successor, Clement III, called for a new crusade, known as the third. Its leaders were to be Richard I of England, Philip II Augustus of France and the German king and Holy Roman emperor Frederick I Barbarossa. Frederick started first, in May 1189, traveling through Hungary and Constantinople, but was drowned in the Saleph or Calycadnus (Göksu) river, near Seleucia in Cilicia, on June 10, 1190. His forces broke up, some going on and some returning home. The German contribution to the third crusade was consequently small.

The fact that Richard of England held vast fiefs in France was a cause of hostility between him and Philip Augustus. Not trusting one another to go separately, they set out together in July 1190. Philip reached Acre on April 20, 1191. Richard stopped at Cyprus, quarreled with the self-styled emperor there, Isaac Ducas Comnenus, and conquered the island. He then resumed his journey, arriving at Acre on June 8.

Acre had been besieged since Aug. 1189 by King Guy of Jerusalem, who on his release by the Muslims had given his parole not to fight them again but subsequently had broken it. The three kings took Acre on July 12, 1191, after a memorable siege in which great heroism was shown on both sides. Then Philip Augustus, considering his vows completed, went home to harass Richard's fiefs in violation of his promise not to do so.

Richard, however, since he had gone to great expense and loved fighting, remained until Oct. 1192. He recovered the ports south of Acre (Haifa, Caesarea, Arsuf and Joppa) and gained for pilgrims the treaty right to visit the Holy Sepulchre. In regaining the coast he gave the truncated kingdom of Jerusalem a lease on life for another century. When Guy was deposed as king in 1192 Richard secured the transfer of Cyprus to him, thus establishing another crusader kingdom which lasted until it was absorbed by the Venetians in 1489. In comparison with Saladin, Richard was an abler soldier but much inferior both as a statesman and as a humanitarian. The legends and chronicles concerning both men are the most enduring results of the third crusade.

Fourth Crusade.—Hopes for a new crusade continued after the disappointment in the third. In 1199 Thibaut III, count of Champagne, and other French nobles decided to embark on a further crusade. The plan was at once blessed by Pope Innocent III, and the French barons arranged with Enrico Dandolo, doge of Venice, for transportation. When their army assembled at Venice, however, they lacked the agreed passage money and were soon in debt for subsistence in their camps. Dandolo agreed to accept postponement of their arrears of debt if the French crusaders would help Venice to conquer Zara (Zadar), a Christian town then held by the king of Hungary, on the coast of Dalmatia. In spite of Innocent's objections the force sailed to Zara, captured it in Nov. 1202 and then sacked it.

The crusaders, now stranded for the winter at Zara, were next persuaded to accompany the Venetians to Constantinople to set the pretender Alexius, son of the deposed Isaac II Angelus, on the Byzantine imperial throne. Alexius promised to pay their debts to Venice, to assist in an expected crusade to Egypt and to subject the Greek Orthodox clergy to the papacy. Accordingly the expedition sailed to Constantinople. The French and the Venetians succeeded in enthroning the pretender and his aged father as colleagues in Aug. 1203. Alexius IV, as their protégé was now called, and the Latins were detested by the populace. In Feb. 1204 the two co-emperors were removed by a palace revolution and the crusaders were defied. As a result the crusaders assaulted the city, captured it on April 12, 1204, and then submitted it to a merciless pillage.

Afterward a Latin emperor and a Latin patriarch were set up in Constantinople. Venice secured control of most of the commerce and many French barons found fiefs in peninsular Greece. The defiant Byzantines set up so-called empires at Nicaea and at Trebizond and a despotate in Epirus in Europe. They recovered control of their old capital in 1261 but from then on were only a minor power. The hope of a unified church cherished by Urban II and Innocent III was rendered impossible by the events of 1204, in spite of their apparent success. In the 15th century the Greek Orthodox of Constantinople preferred conquest by the Ottoman Turks to submission to the papacy as the price of aid. (*See* also Byzantine Empire.)

Fifth Crusade.—Though Innocent III acquiesced reluctantly in the startling results of the fourth crusade, he and his successor, Honorius III, continued to call for another. Largely as a result of their efforts an expedition gathered from various sources sailed in 1218. Initially led by John (*q.v.*) of Brienne, titular king of Jerusalem, it undertook the siege of Damietta in Egypt in June 1218, hoping to exchange it later for Jerusalem.

The siege of Damietta was long and bitter, lasting 17 months. Eventually Sultan al-Kamil of Egypt gave up hope and offered the restoration of the entire kingdom of Jerusalem west of the Jordan river in return for the evacuation of Egyptian soil by the crusaders. These terms were refused by Cardinal Pelagius of Albano, the papal legate, who hoped to go on and conquer Cairo and the whole of Egypt. He took Damietta on Nov. 5, 1219, but the war dragged on for a further 21 months. Finally Pelagius' army was trapped by a Nile flood. He extricated himself by ceding Damietta in Aug. 1221 and returning to Acre. Thus, the fifth crusade, which came near to being a success, was a disaster largely because of the wilfulness of its leader.

Sixth Crusade.—The emperor Frederick II, who was also king of Sicily, a brilliant man but a thorough-skeptic and opportunist, had taken the cross in 1215 but had since done nothing about a crusade except to repeat his promise on the occasion of his being crowned emperor by Pope Honorius III in 1220. His interests in Sicily and in Lombardy, however, combined with his Hohenstaufen ideas of an emperor's rights, made him seem extremely dangerous to the papacy. Consequently Honorius and his successor, Gregory IX, wanted him out of Italy, but it was only after his marriage (1225) to the heiress of Jerusalem, Yolande

(Isabella), daughter of John of Brienne, that Frederick became really interested in a crusade. (*See* FREDERICK II, Holy Roman emperor.)

Frederick eventually started in Sept. 1227, but turned back at once, ostensibly because of seasickness, while his fleet sailed on to Acre. For this he was excommunicated. Nevertheless he started out again, still excommunicate, in the summer of 1228. After some campaigning but little fighting and much diplomacy he concluded a treaty (Feb. 18, 1229) with the Egyptian sultan al-Kamil, then at war with his nephew al-Nasir of Damascus. Frederick gained Jerusalem, Bethlehem, Nazareth, Sidon, Lydda and other places and a period of peace for ten years. Al-Kamil had offered Cardinal Pelagius somewhat similar terms ten years before. Frederick was roundly denounced by the papacy for the way in which he had acquired Jerusalem: Muslims should be fought, not negotiated with. While he was in the Holy Land a papal "crusade" was conducted against his lands in Italy. The increasing use of crusades against papal enemies in Europe was subsequently to discredit the entire movement.

The years following Frederick's recovery of Jerusalem were wasted by the eastern Franks in frivolous civil wars. Sometimes they took opposite sides in the conflicts between Saladin's descendants in Egypt and in Damascus. As a result of one such intervention Jerusalem was captured in July 1244 by an army of Khwarizmian Turks in Egyptian pay. Within a year Sultan Ayyub of Egypt had conquered most of Frankish Palestine and even Damascus.

Seventh Crusade.—Christian idealism and fear of death during an illness caused Louis IX (*q.v.*) of France to take the cross in Dec. 1244. Having made careful preparations, he set out in 1248. The early events in the seventh crusade bore a striking resemblance to those of the fifth. Louis elected to attack Damietta, Egypt, hoping to exchange it for Jerusalem. When he took it (June 1249) Sultan Ayyub offered the desired exchange, but Louis's pious idealism now demanded the conquest of Cairo instead. Unlike Pelagius he avoided the Nile flood, but nevertheless was captured in April 1250. He ransomed himself and as many men as he could for a large sum of money and for the cession of Damietta in May 1250.

Louis remained in Palestine with a few followers for four more years and hoped to acquire Jerusalem by siding with Sultan Aybak of Egypt against al-Nasir of Aleppo and Damascus. Aybak promised Jerusalem but never delivered it. Louis also tried to make alliances with the Assassins (*q.v.*) and with the Mongols, both enemies of the caliphate of Baghdad, but nothing positive resulted. He felt justified in seeking an alliance with the Mongols because Nestorian Christian influence was momentarily strong at the court of Mongka, the great khan, in distant Karakorum, Mongolia. Finally Louis hoped for help from France or from the papacy but none came (Pope Innocent IV was then supporting a "crusade" against Frederick II's son, the German king Conrad IV). When Louis finally returned to France in 1254 it seemed to many that his failure was proof of God's indifference to crusades.

Mamelukes and Mongols: 'Ayn Jalut.—After the departure of Louis IX events in the Latin east were largely dominated by Egypt. In 1250 the Mamelukes of Cairo, warlike slave troops gathered from every eastern nation, began to build up a powerful military monarchy, a succession of sultans that was to last until the Ottoman Turkish conquest of 1517. Then, in 1258, Hulagu the Mongol captured and sacked Baghdad and killed the last Abbasid caliph, causing consternation throughout Islam. In 1260 the Mongols took Aleppo and Damascus. The Mameluke sultan Qutuz of Egypt and his general Baybars (*q.v.*), however, met the challenge to Islam by defeating and killing Kitbugha, the Nestorian Christian general of the Mongols, at 'Ayn Jalut, near Nazareth, on Sept. 3, 1260. It was one of the decisive battles of the world, for it saved the Mamelukes and it saved Islam in the middle east. It also weakened the slender chance that the Mongols would adopt Christianity as the Latins hoped. The Mongols soon turned to Islam themselves, as it seemed to them to be the religion of the strong.

'Ayn Jalut marked the beginning of the decline of the power of the Latins along the coasts of Palestine and Syria. Since most of them except the men of Acre had sided with the Christian Kitbugha, Baybars, now sultan, began to make systematic war on them all, even on Acre. He took Caesarea, Haifa and Arsuf in 1265, the castle of Safed (Safad) in 1266 and Joppa, the castle of Belfort and Antioch in 1268.

Eighth Crusade.—Baybars' hand was stayed briefly by Louis IX of France. In 1267 Louis decided on a new crusade, the eighth. Baybars was naturally uneasy until Louis was diverted to Tunisia in 1270 by the wiles of his bother, Charles of Anjou, king of Sicily. Charles was an enemy of the Byzantines and did not want a crusade to the Holy Sepulchre to distract attention from a prospective war against the Greeks. He was, moreover, on friendly terms with Baybars.

Fall of the Last Strongholds, 1271–1303.—When Louis died in Tunisia in 1270 Baybars was free to continue his attacks. In 1271 he took the last three remaining inland castles of the Franks, Safita, Krak des Chevaliers (between Safita and Homs) and Montfort. Sultan Qalawun captured Tripoli in 1289 in response to a faction's appeal against the Genoese. His son Sultan al-Ashraf Khalil took Acre in 1291, after newly arrived Venetians had murdered some Muslim merchants in the streets. By August the remaining Frankish mainland strongholds, Tyre, Beirut, Haifa, Tortosa (Tartus) and Athlit (Château Pèlerin or Atlib), had surrendered with no opposition, and Sidon with slight resistance. The Templars held out on the tiny island of Arwad (Ruad), two miles off Tortosa, until 1303.

Last of the Crusades.—The ideal of the crusade died hard. The popes continued to preach crusades against the Muslims, but with ever-diminishing effect. Nevertheless several expeditions were started, one which cruelly sacked Alexandria in Egypt in 1365 and others that were directed not against the rulers of the Holy Land at all but at the growing might of the Ottoman Turks; viz., the attack of 1344 on Smyrna and the two invasions of the Balkans, which ended in defeat at Nicopolis (Nikopol) in 1396 and at Varna in 1444. However, Rhodes as the base of the Knights of St. John until 1522 and Cyprus as a Frankish kingdom up to 1489 and as a Venetian outpost until 1571 long kept alive the official theme of hostility toward the Muslims of Syria and Egypt. Prince Henry the Navigator, Christopher Columbus and Alfonso d'Albuquerque all solemnly claimed that their voyages of discovery would circumvent the Muslims of the eastern Mediterranean. At the diet of Augsburg in 1530 the Lutherans piously affirmed their agreement with the purpose of a war against the Turks (who had embarked on the conquest of Hungary) before turning to the main business, their religious differences with the papacy.

Western Europeans, in fact, had from the beginning been ready to applaud the idea of holy war, but remained preoccupied with their own immediate problems, and no crusade had been supported with as much enthusiasm as the first. The wars of the Teutonic knights along the shores of the Baltic, the Hundred Years' War in France, the reconquest of Spain from the Moors and the campaigns against the Ottoman Turks all diverted attention from the Holy Sepulchre. Moreover, the popes from the time of the great western schism onward were never in any position to preach crusades successfully. Finally the rise of national monarchies, the spread of commerce, the increasing influence of the middle class, the gradual elimination of feudalism, manorial development, the Renaissance, geographical discovery and the Reformation all contributed to causing the ideal of the crusade to fade into the background.

Results of the Crusades.—One tragic result of the crusades was the destruction of the Byzantine empire and civilization. The Byzantines never recovered from the fourth crusade. Their government, restored to Constantinople in 1261, was thenceforth a shadow of its former self and fell to the Ottoman Turks in 1453. Thereafter Christian Orthodox culture inevitably declined throughout the territories of the former empire. Pope Urban II's hope of Christian unity between east and west was destroyed.

A second result of the crusades was the military triumph of Islam in the middle east. Not only were the crusaders ejected, but Islam, under the Ottoman Turks, was carried across the Balkans

in the 14th and 15th centuries and to the gates of Vienna in the 16th and 17th. Only in Spain and along the eastern Baltic coast did the crusading movement permanently extend Christian conquest.

Islam, however, was most adversely affected by the crusades. Whereas originally the Muslims had been quite tolerant of the Christians and Jews whom they conquered, the harsh treatment of Muslims by the crusaders during a period of three or four centuries inevitably made the Muslim rulers in turn, especially the Mameluke and Ottoman sultans, less tolerant of the unbeliever. Furthermore, the crusaders must share the blame with the Turks, Mongols and Mamelukes for that constant battering of the Arab aristocracies which gradually reduced them from an enlightened and urbane culture, superior to that of western Europe in tolerance and in breadth of intellectual interest, to a narrow religious conservatism under which secular learning declined. By the time the crusades were over, intellectual leadership had passed from the Arabs to western Europe, but this was a result not so much of the crusades as of the transfer of Arabic scholarly knowledge through Spain and Sicily, and of the Renaissance.

In Europe the effects of the crusades were many and varied. Western Christianity naturally suffered from the stain of intolerance. This showed itself in persecutions—of Jews as soon as the first crusade began, of Muslims and Orthodox Christians throughout the period of the crusades and of the Albigensians and enemies of the papacy such as the Hohenstaufens in Italy in the 13th century. In their onslaught on the Hohenstaufens the popes laid themselves open to the charge of discrediting not only the crusading ideal but also their own office. The crusades affected the Western Church in many other ways, some good and some bad. There was an initial enhancement of papal prestige, an increase in the power of the church to tax and to raise money, an extension of the canon law (particularly in the right to protect crusaders and their property), an increase in the use of indulgences and, certainly, a vast outpouring of faith not only by the crusaders and pilgrims but also by their friends and relatives who remained at home.

The trade across the Mediterranean between east and west was greatly stimulated by the crusades. Ships which set out from western European ports carrying men and goods in bulk, such as grain, timber and horses, had on the return journey cargo space to sell cheaply. Hence the freight rates on all types of eastern luxury goods were lowered. Spices, fabrics of all kinds, tapestries, cushions, rugs, drugs, fruits, sugar, jewelry, perfumes, glass and fine steel products came to the west in larger quantities than ever before. This commerce encouraged the development of a money economy, which had profound results on the rise of the merchant class, on the standard of living of the nobles, on serfdom and manorial economy and on the development of royal finance and government. Commerce as well as the need to transfer pilgrim and crusader funds prompted both Italian merchants and the Knights Templars to develop banking techniques. There was also a valuable increase in both navigational and geographical knowledge.

The nobility of the west was affected in various ways by the crusades. Knights learned to use heraldic emblems and coats of arms in order to identify themselves when far from home. They imported into Europe a knowledge of heavy stone masonry learned from the Byzantines and Arabs and soon huge stone castles (*see* CASTLE) and stone churches began to appear in western Europe. With the castles came a knowledge of mining, sapping and siege machinery. Some nobles were adversely affected by the sale of charters to towns in order to raise money for crusades, or by the loss of property for failure to pay crusader debts, or were ruined by extravagance in the purchase of oriental goods.

One important consequence of the crusades in the west was a vast literature in the form of storytelling, legends, songs, chronicles and historiography. Many of the songs and tales were in the vernacular, especially in French. There was a rich development of the things of the imagination, as can be seen not only in the *chansons* of the crusades but also in the kindred stories of Charlemagne and King Arthur, with their new presentation of the ideal of Christian knighthood and chivalry. Western Europe, on the other hand, did not contribute much of intellectual value to the east, for at the time of the crusades it had little to give.

Contemporary Historiography.—The anonymous *Gesta Francorum et aliorum Hierosolymitanorum* and the works of Raymond of Aguilers and of Fulcher of Chartres are eyewitness accounts of the first crusade. Caffaro de Cashifelone (*De liberatione civitatum orientis*), Ekkehard of Aura (*Hierosolymita*) and Ralph of Caen (*Gesta Tancredi*) were slightly later eyewitnesses. The account by Albert of Aix, which extends to 1120, is of great importance for its length and detail. For the period from 1127, when Fulcher's account ends, to 1184, William of Tyre is of the highest value. Historians of the second crusade were Odo of Deuil (on the expedition of Louis VII of France) and Otto of Freising. The period beginning with the fall of Jerusalem in 1187 and the third crusade was recorded in the *Chronique d'Ernoul et de Bernard le Trésorier* and in the *Estoire d'Eracles* by continuators of William of Tyre; in the *Libellus de expugnatione Terrae Sanctae* attributed to Ralph of Coggeshall; and in the *Estoire* of the Norman chronicler Ambrose, to which the *Iterarium peregrinorum et gesta regis Ricardi* is closely related. Further information is to be found in the works of Benedict of Peterborough, Ralph of Diceto, Roger of Hoveden, William of Newburgh, Richard of Devizes, Rigord and William la Breton. For the fourth crusade Geoffrey de Villehardouin and Robert de Clari (*La Conquête de Constantinople*) are important authorities. The fifth crusade is described by Oliver of Paderborn (*Historia Damiatana* and *Epistulae*) and by Jacques de Vitry (*Historia Hierosolymita*). Jean, sieur de Joinville, gives an incomparable account of Louis IX's crusade. For the later part of the 13th century, there are successive recensions of the *Estoire d'Eracles* (which carry the story down to 1277), the *Annales de Terre Sainte* and the *Gestes des Chiprois*, the latter two works being related to one another.

From the Byzantine point of view, the *Alexiad* of Anna Comnena, daughter of the emperor Alexius I, provides an eyewitness account written about 40 years after the first crusade. Other Byzantine historians of the 12th century were John Cinnamus and Nicetas Choniates. In Armenian there is the chronicle of Matthew of Edessa, written before 1140. Other Eastern Christians who left accounts were Michael the Syrian, Gregory abu'l-Faraj (Bar Hebraeus) and the anonymous Coptic author of a history of the patriarchs of Alexandria, which deals with the fifth crusade.

The contemporary Arabic literature on the crusades is of the greatest importance. Ibn al-Qalanisi's *Continuation of the History of Damascus* (from 1056), written between 1140 and 1160, is of high value and was used by most later Arab writers. The 11th-century Usamah ibn Munqidh's *Instruction by Examples* is a delightful set of personal memoirs. The *Complete Book of Chronicles* of the historian Ibn al-Athir (fl. early 13th century) is well documented and excellent, but his history of the *atabegs* of Aleppo is of less value. Sibt ibn al-Jawzi's *Mirror of the Times* is a universal history down to 1256. Kamal al-Din's *Cream of the History of Aleppo* is excellent on the Zangids, and Abu-Shamah's *Book of Two Gardens* is a prime source for Nureddin and Saladin. On Saladin, however, the best biography is that by Baha-al-Din. General information on the Arabs is provided by the biographical dictionary of Ibn Khallikan and in the historical work of Abulfeda. Al-Maqrizi's *Sermons and Learning by Example* deals with the crusade of Louis IX. Badr-al-Din al-Aini (d. 1451), in his *Collar of Pearls*, gives an account of the Mameluke sultans, as does Ibn Taghri-Birdi (1411–69) in *The Brilliant Stars regarding the Kings of Egypt and Cairo*. Finally there is the universal history of Ibn Khaldun, one of the greatest of all medieval historians. *See* also references under "Crusades" in the Index volume.

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CRUSHING AND GRINDING MACHINES. Crushing and grinding (comminution) refer to the size reduction of rocks and other materials; size reduction is generally accomplished by pressure, impact or attrition, or by combinations of these. Crushers are used when the feed (material to be processed) is coarse; grinding mills, when the feed is relatively fine. Crushing and grinding operations are frequently conducted in a series of stages utilizing several types of machines. Operations are often classified as "coarse," "intermediate" and "fine," depending on the size of particles produced.

The term "pulverizing" is applied to some fine-grinding operations, and the term "disintegration" is often used in the case of size reduction of soft or loosely bonded materials.

Most crushers operate dry, that is, without the addition of water, the end product being discharged by gravity or the movement of the crushing elements. Many grinding mills can be operated either dry or wet, with the water or air assisting in the discharge of the end product. When a series of crushing or grinding machines are used it is common practice to classify the end product of each machine into at least two fractions (by screening, or settling in water or air), and return the oversize to the machine. This is called a "closed circuit" operation.

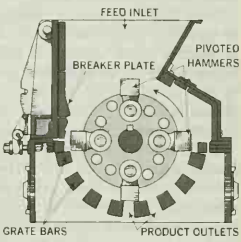
Types.—*Jaw crushers* have two crushing plates (jaws), with one or both pivoted, and moving alternately toward or away from each other. Maximum size feed is about 80 in. in diameter and usual reduction ratios (ratio of feed size to product size) are about 3:1 to 5:1.

Gyratory crushers have an outer stationary face which is a vertical, truncated conical shell (concave) with the smaller diameter at the bottom. The inner movable face is a similar shell (crushing head) mounted on a spindle, with the smaller diameter at the top. The movement of the spindle causes the crushing head to gyrate, alternately moving toward and away from all the points on the circumference of the concave. Maximum size feed is about 80 in. and usual reduction ratios are about 3:1 to 5:1. A cone crusher is a modification of the gyratory crusher, and is specially adapted to fine crushing. Maximum feed size for cone crushers is about 12 in.; reduction ratios are about 3:1 to 10:1.

Rolls can be classified as sledging rolls or crushing rolls. In both, the moving elements are cylindrical steel rolls rotating in a horizontal position.

A sledging roll, used for coarse crushing of relatively soft material, may consist of one roll with projecting teeth or knobs and a stationary breaker plate, or it may consist of two rolls driven toward each other at the top. Crushing rolls consist of two cylinders driven toward each other at the top where the feed is introduced.

The maximum feed size for sledging rolls is about 40 in., and for crushing rolls about 3 in. The usual reduction ratios are about 3:1 to 7:1.

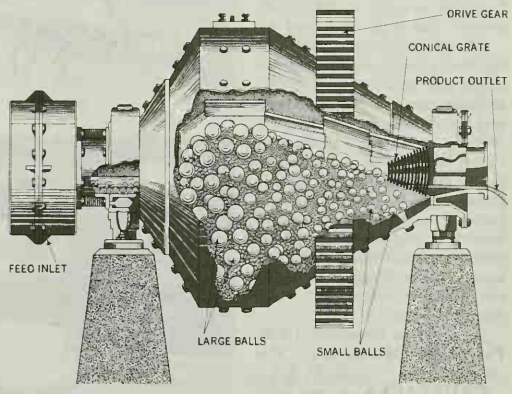


BY COURTESY OF THE JEFFREY MFG. CO.

FIG. 1.—HAMMER CRUSHER

Hammer mills are made in a number of different forms but consist essentially of a revolving shaft with rigid or swinging hammers (beaters). The hammers may be bars, special shapes or rings. The shaft and moving elements run in a housing which contains stationary plates or liners. A screen or grating may enclose the rotor to regulate the discharge size of the product. The grinding action results from impact of the hammers on the feed material. A multiple cage-mill is a modification, and consists of two cylindrical cages revolving in opposite directions inside of each other. Because of severe wear, hammer mills are normally limited to soft or friable materials. Some types are capable of reducing 10- to 30-in. material to less than 1 in.; other types are designed to reduce 0.5-in. feed to finer than 0.003 in.

Tumbling mills include rod, ball, pebble, tube, and compartment mills. These are all hollow horizontal rotating cylinders which contain grinding media such as steel balls, pebbles, steel rods, or even large pieces of rock. The material to be ground is usually fed at the centre of one end of the cylinder and discharged at the other end. The cascading and rolling action of the grinding medium results in the size reduction. A pebble mill with a length greater than two times the diameter usually is called a tube mill. A compartment mill is a tube mill divided into compartments along its length and frequently has an external means for trans-



HARDINGE CONICAL MILL, REGISTERED TRADE MARK. BY COURTESY OF HARDINGE CO., INC.

FIG. 2.—BALL MILL

ferring the discharge from one compartment to another. A cascade type mill has a diameter several times greater than its length, and normally uses large pieces of the feed material as the grinding medium. A modification of the tumbling mill is the conical mill which has a conical section on one or both ends of the cylindrical section. Another modification is the vibrating mill wherein an oscillating or vibrating motion is imparted to the shell. Tumbling mills range from 1 to 14 ft. in diameter, and even larger in the case of cascade mills. Although cascade mills require coarse feed as large as 24 in. in diameter, most tumbling mills will not handle material coarser than 1½ in. Tumbling mills grind to 0.003 in. or finer.

Ring-roller mills consist of rollers mounted on vertical shafts and driven in a manner that causes the rollers to revolve around the inside of a die (grinding ring). In certain types, the grinding ring revolves around the rollers; in still another type, a single row of balls revolves between a stationary and a rotating ring, similar to ball bearings in a race. Feed and produce sizes are in the same range as for tumbling mills.

Disk mills, sometimes called attrition mills, consist of two disks or grinding plates, one or both of which rotate in a vertical or horizontal plane, usually at high speeds. The feed is introduced between the plates near their centres and is ground as it progresses to the periphery of the disks. A modification, using cylindrical stones instead of steel disks, is a buhrstone mill, often used for grinding cereals, grains and paints.

Disk mills are used for pulverizing, tearing and shredding. One-quarter inch is about the maximum size of feed, and produce size for different materials ranges from about 0.03 to 0.0004 in.

Fluid energy mills, also referred to as jet mills, have no moving parts within the grinding chamber. The energy for grinding is achieved by the introduction of compressed air or superheated steam, into the grinding chamber through small nozzles, resulting in high velocities inside the mill. The feed material is introduced to the grinding chamber through the nozzles or more commonly through a separate opening in the grinding chamber. Attrition and impact of particles upon each other are the major causes of size reduction.

Maximum feed size ranges from ¼ in. to 0.005 in. Minimum product size is about 0.0001 in.

Miscellaneous types of crushing and grinding equipment include: pan crushers in which one or more crushing wheels (mullers) travel around a circular pan; stamp mills, having a pestle with a steel head, which is driven vertically downward against a die; rotary crushers with a toothed cone driven within a cylindrical housing having inward projecting teeth; arrastras which consist of heavy stones dragged around a stone-lined circular pit (*see* AMALGAMATION).

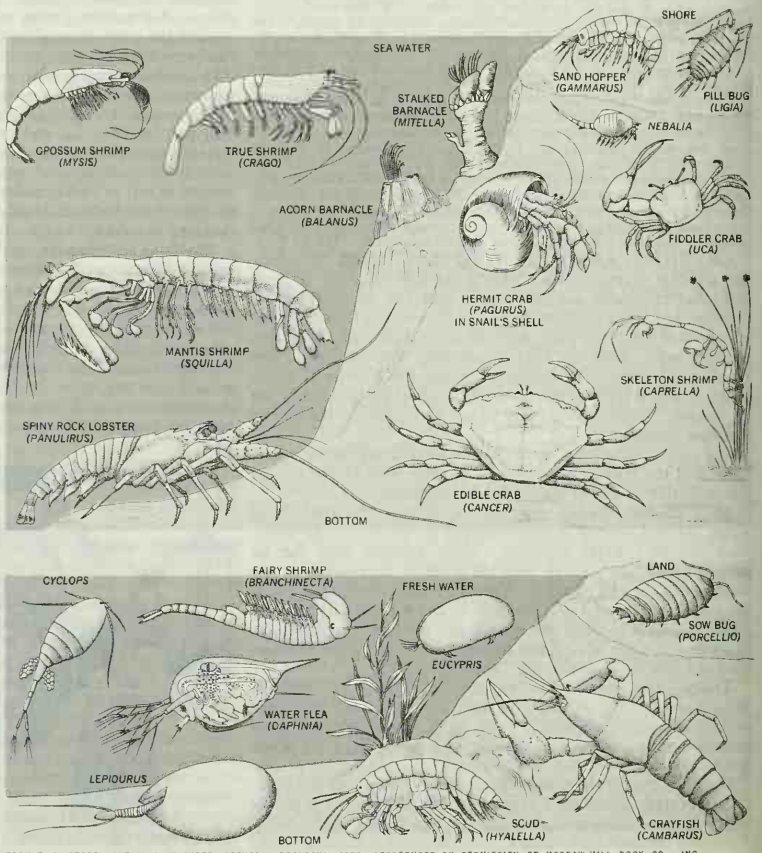
See also ORE DRESSING; CROP-PROCESSING MACHINERY; MACHINE TOOLS. (O. F. T.)

CRUSTACEA, a very large class of invertebrate animals of the phylum Arthropoda. Crustaceans include the crabs, lobsters, crayfish, prawns, shrimps, sand hoppers, wood lice, barnacles, water fleas and a vast multitude of less familiar forms that are not distinguished by any popular names. They are distinguished from the members of the other classes of arthropods by being generally of aquatic habits, breathing by gills or by the general surface of the body and having two pairs of antennalike appendages in front of the mouth and at least three pairs of postoral limbs acting as jaws. There is so much diversity, both of structure and of habits, within the class, that it is all but impossible to give a brief definition that would apply to all its members.

INTRODUCTION

It would not be altogether misleading to describe the Crustacea as the "insects of the sea." In the great oceans and in the narrow seas their teeming multitudes, the "things creeping innumerable" of the Psalmist, play a part not unlike that taken by the true insects in the life of the land. In fresh waters, where they have to meet with the competition of insects, they are hardly less abundant and there is scarcely a ditch or pond that does not harbour at least some of the more minute forms. On land they are less common, but the wood lice or pill bugs of our gardens and the land crabs of tropical regions have solved the problem of adaptation to a non-aquatic life.

The most familiar crustaceans are the larger crabs and lobsters that are used as food by man, but the part that these play in the economy of nature is small compared with that of the amphipods



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY"; 1957, REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 1.—REPRESENTATIVE SALT- AND FRESH-WATER CRUSTACEANS (NOT DRAWN TO SCALE)

and isopods that swarm in the shallower waters of the sea. These smaller crustaceans serve as scavengers, feeding on all kinds of animal and vegetable refuse and forming, in their turn, the food of many of the larger marine animals such as fishes. Vastly more important even than the amphipods and isopods, however, are the minute pelagic copepods, of which the shoals may discolour the surface waters of the ocean for many miles and serve to guide the fisherman and the whaler to the most profitable fishing grounds. Copepods form an important constituent of plankton (*q.v.*), the assemblage of minute floating animal and vegetable life in the surface waters of the ocean. It is on the plankton that a great part of the higher animal life of the sea ultimately depends for food. The copepods live upon diatoms and other microscopic plant life of the plankton and themselves form the food of many fishes such as herring and mackerel and even of gigantic whales.

FORM AND FUNCTION

External Features

The body, limbs and gills are dealt with in this section; other structures that appear on the body surface but that are more closely tied in with internal systems are the sense organs and dermal glands, discussions of which are found below under *Internal Features*.

Body.—As in all arthropods the firm outer covering or exoskeleton of the body consists of a series of segments or somites that may be jointed together or more or less coalesced. The typical form of a somite is seen, for instance, in the segments that make up the abdomen or "tail" of a lobster or crayfish. Each consists of a shelly ring separated from the rings in front and behind by areas of softer integument forming movable joints. The arched plate that forms the dorsal part of the segment is distinguished as the tergum and the narrower ventral bar as the sternum. The tergum is produced on either side as a free plate, the pleuron, and each segment has a pair of limbs articulated to the sternum. The posterior terminal segment of the body, on which the opening of the anus is situated, never bears typical limbs and is known as the telson.

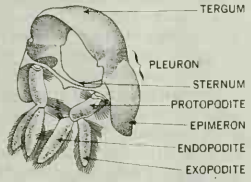


FIG. 2.—ABDOMINAL SEGMENT (SOMITE) OF SHELL OF LOBSTER, WITH BIRAMOUS APPENDAGES

In the larvae of the more primitive Crustacea, the number of somites, at first small, increases by the successive appearance of new somites between the last-formed somite and the terminal region that bears the anus. The "growing-point" of the body is, in fact, situated in front of this region, and, when the full number of somites has been reached, the unsegmented part remaining forms the telson of the adult.

In no crustacean are all the somites of the body distinct and separate from each other. The fore part of the body of the lobster, for instance, has an undivided shelly covering, the "barrel" or carapace; the number of somites composing this region is only to be inferred from the appendages attached to it. In all Crustacea an anterior region is marked off by having the somites obscured in this way.

Apart from the possible existence of an ocular somite corresponding to the eyes (the morphological nature of which is discussed below) the smallest number of somites so united in any adult crustacean is five. Even where a larger number of somites are fused there is generally a marked change in the character of the appendages after the fifth pair, and, since the integumental fold that forms the carapace seems to originate from this point, it is usual to regard these five somites as constituting the head, or cephalon. It is quite possible, however, that in the primitive ancestors of existing Crustacea a still smaller number of somites were united in the head. The first three pairs of appendages are alone present in the nauplius larva (see *Larval Stages* below), and they show certain peculiarities of structure and development that seem to place them in a different category from the other limbs. There is therefore some ground for regarding the three corresponding somites as forming a primary cephalon.

In the subclass Malacostraca, which includes all the larger and better-known Crustacea, the body proper is divided into two regions sharply distinguished by the character of the appendages. These are the thorax of eight somites and the abdomen. In the other subclasses, although the terms thorax and abdomen are often used as descriptive terms, the regions so named are not homologous with those of the Malacostraca. In many of the latter, as, for example, in the lobster, the head and thorax form a single undivided region that is known as the cephalothorax.

The shell or carapace covering the cephalothorax is not simply formed by the coalesced terga of the somites: in some of the lower Malacostraca, such as the Mysidacea, the carapace is a fold of the integument, enveloping, but remaining free from, the thoracic somites. In the lobster and other Decapoda, the carapace has coalesced with the thoracic terga in the middle of the back but remains free at the sides, enclosing a pair of chambers within which lie the gills.

The possession of this carapace, arising as a dorsal fold from the posterior margin of the head region, is a character that recurs in the most diverse groups of the Crustacea and is probably to be regarded as a primitive attribute of the class. The carapace may have the form of a bivalve shell, entirely enclosing the body and limbs, as in many Branchiopoda and in the Ostracoda. In the Cirripedia, or barnacles, the carapace forms a fleshy mantle strengthened by shelly plates that may have a very complex structure. In the Isopoda and Amphipoda, where, as a rule, all the thoracic somites except the first are distinct, there seems at first to be no carapace fold. A comparison with the related Tanaidacea and Cumacea, however, suggests that the coalescence of the first thoracic somite with the head really involves a vestigial shell fold, and this is possibly the case also in the Copepoda.

The only Crustacea in which there appears to be no trace of a carapace are the anostracous Branchiopoda and the remarkable syncaridan *Bathynella*.

The most extreme modifications of the general form of the body are shown in those Crustacea that have adopted a sedentary or a parasitic habit of life. The barnacles (Cirripedia) are, in the adult state, rooted to one spot by the head, and tend, in varying degrees, toward the radial symmetry that is often associated with a sedentary life. In parasites the segmentation of the body tends to disappear and the general shape is often greatly distorted. In the Rhizocephala, and other parasitic cirripedes, the adults have lost

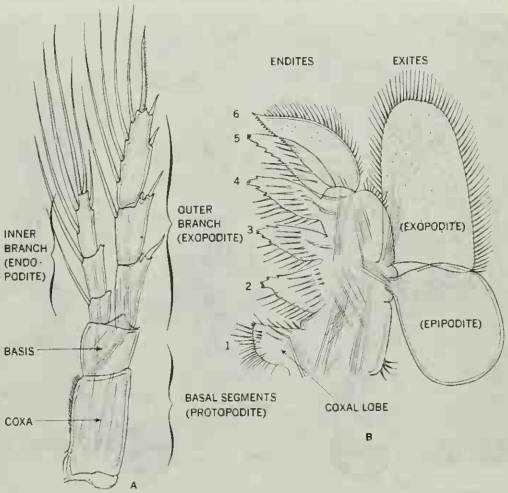


FIG. 3.—FOOT PARTS OF CRUSTACEA

Copepod (*Calanus*): (A) swimming foot of fifth pair of legs, a simple two-branched type of crustacean appendage. Branchiopod (*Lepidurus*): (B) a phyllopodium, one of the 19th pair of leaflike trunk limbs

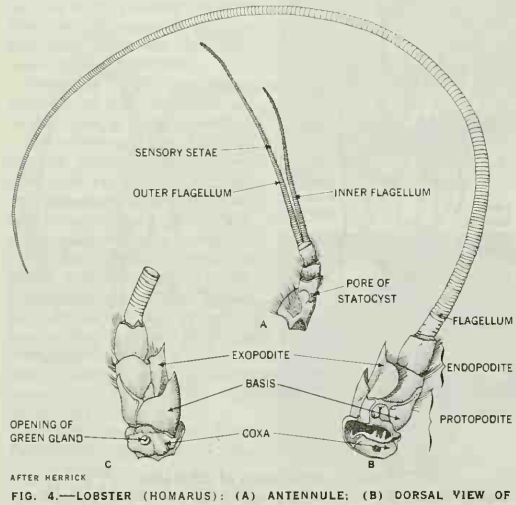
nearly every trace not only of crustacean but even of arthropodous structure; an example is Sacculina, parasitic in crabs.

General Structure of Limbs.—Amid the great variety of forms assumed by crustacean appendages, it is possible to trace, more or less plainly, the modifications of a fundamental type consisting of a peduncle, the protopodite (or sympodite), bearing two branches, the endopodite and exopodite. This simple biramous, or two-branched, form is shown in the swimming feet of Copepoda, the cirri of Cirripedia and the abdominal limbs of Malacostraca, and it is also found in the earliest and most primitive type of larva known as the nauplius. The protopodite may have, on its inner and outer margins, additional lobes or processes, known as endites and exites respectively. Some of the exites often function as gills, and the endites of appendages near the mouth frequently form jaw processes, assisting in mastication and known as gnathobases. In the flattened leaflike limbs characteristic of the Branchiopoda the endites and exites are so developed that the biramous form of the limb is obscured. It has been supposed that this form of limb, the phyllopodium, represents the primitive type from which the biramous type has been derived. The recurrence of the biramous type, however, in the most diverse forms of Crustacea and in the simplest larvae, and the evidence of the remarkable fossil branchiopod *Lepidocaris*, all indicate that it represents the fundamental plan of the crustacean limb.

In many Crustacea the paired eyes are borne on stalks that are movably articulated with the head and may be divided into two or three segments. The view has been held that these eyestalks are really limbs, homologous with the other appendages. The evidence of embryology, however, is decidedly against this view. The stalks appear late in the course of development, after many of the limbs of the trunk are fully formed, and the eyes, at their first appearance, are sessile on the sides of the head and only later become stalked. The most important evidence in favour of the appendicular nature of the eyestalks is found in the fact that when the eyestalk is removed from a living lobster or prawn, a many-jointed appendage like the flagellum of an antenna may grow in its place.

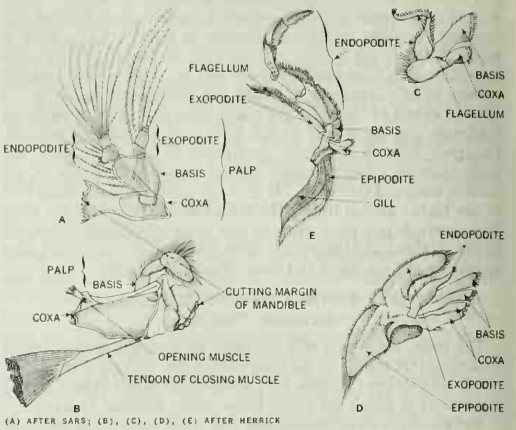
It is open to question, however, how far the evidence from such heteromorphic regeneration (*see* REGENERATION) can be regarded as conclusive on points of homology.

Specialization of Limbs.—The antennules (or first antennae) are generally regarded as true appendages, although they differ from all the other appendages in that they are always innervated from the brain (or preoral ganglia) and are uniramous in the earliest larvae and in the adults of all subclasses except the Malacostraca, where they are biramous or sometimes triramous. It is unlikely that the two branches of the biramous type (seen, for instance, in the antennules of the lobster) correspond to the endopodite and exopodite of the other limbs.



AFTER HERRICK

FIG. 4.—LOBSTER (HOMARUS): (A) ANTENNULE; (B) DORSAL VIEW OF ANTENNA; (C) VENTRAL VIEW OF BASAL PORTION OF ANTENNA (FLAGELLUM CUT OFF)



(A) AFTER SARS; (B), (C), (D), (E) AFTER HERRICK

FIG. 5.—MOUTH PARTS OF CRUSTACEA

Copepod (*Calanus*): (A) mandible with biramous palp. Lobster (*Homarus*): (B) mandible with reduced and unbranched palp; (C) maxillula; (D) maxilla; (E) third maxilliped

The antennae (or second antennae) are of special interest because of the clear evidence that, although preoral in position in all adult Crustacea, they were originally postoral appendages. In the nauplius larva they lie at the sides of the mouth and their basal portion carries a hooklike process that assists the similar processes of the mandibles in pushing food into the mouth.

In most Crustacea the antennules are purely sensory in function and carry numerous olfactory hairs. They are used as swimming organs in many larvae and some adults, and sometimes, in the male they form clasping organs for holding the female. In the Cirripedia the antennules of the larvae carry the openings of the cement glands and become, in the adult, involved in the attachment of the animal to its support.

The antennae are frequently swimming organs, but they may assume other functions as organs of attachment in parasites, as creeping legs or as male claspers. In the Malacostraca they are chiefly sensory, the endopodite forming a long many-jointed lash (flagellum), whereas the exopodite is often a flattened plate, probably used as a balancer in swimming.

The mandibles, like the antennae, have, in the nauplius, the form of biramous swimming limbs, with a jaw lobe on the protopodite. This form is retained in some adult Copepoda and Ostracoda. In most cases, however, the palp loses its exopodite and it often disappears altogether, and the basal lobe becomes a powerful jaw with the edge variously armed with teeth and spines. In blood-sucking parasites the mandibles are often piercing stylets enclosed in a tubular proboscis formed by the upper and lower lips.

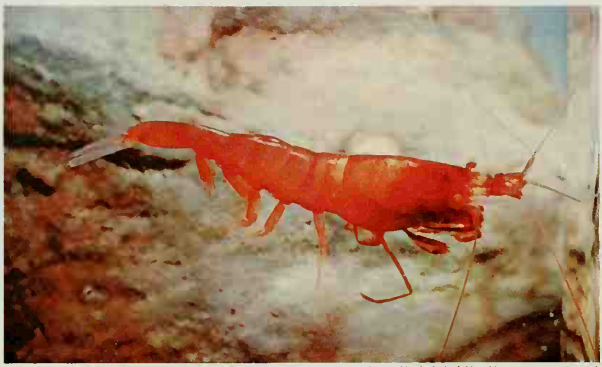
The maxillulae and maxillae, or, as they are often called, first and second maxillae, are nearly always flattened leaflike appendages with gnathobasic lobes or endites borne by the protopodite. The endopodite, when present, forms a palp of one or a few segments, and exites may also be present.

The limbs behind the head region show little differentiation among themselves in the Branchiopoda, Cirripedia and many Copepoda. It is characteristic of the Malacostraca that the limbs of the trunk are divided into two sharply defined series (tagmata), eight corresponding to the thoracic and six to the abdominal region. The thoracic series have the endopodites converted, for the most part, into more or less efficient walking legs, whereas the exopodites are formed into swimming organs or disappear. It is usual for

Stenorhynchus, a spider crab, so-called because of its spidery walking legs. This species is commonly found at moderate depths along the north Atlantic coasts

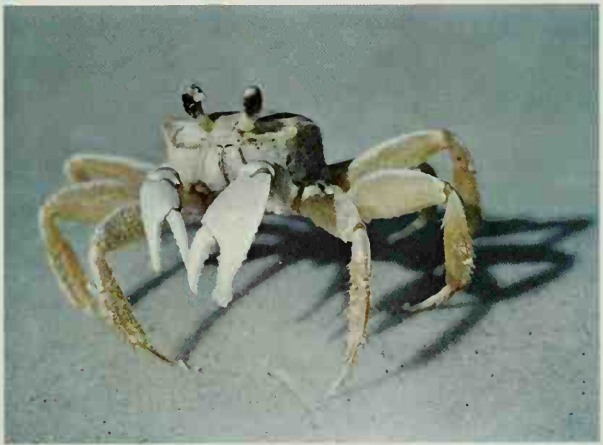
Marine cladoceran or water flea, one of the smallest living crustaceans. Cladocerans convert tinier aquatic and marine organisms into food for higher marine animals

Closed shells of acorn barnacles (*Balanus perforatus*), sessile crustaceans which live in the intertidal zone on rocks, pilings and ships. Extremely modified in form, adult barnacles bear little external resemblance to other crustaceans. *See* below



Red krill (*Euphausia*), a planktonic, phosphorescent shrimp that inhabits the open sea and provides the principal food for the whalebone (baleen) whale

Open shell of an acorn barnacle (*Balanus nubilis*) with extended cirri, the fine hairs of which strain plankton from the water during high tide. The shell closes during low tide to prevent loss of moisture. *See* above



Ghost crab (*Ocypode arenaria*), a land crab found on beaches from Long Island, N.Y., to Rio de Janeiro, Brazil. Ghost crabs are active at night; during the day they burrow into the sand above the high-water mark. They are about 2 in. across with a leg span of as much as 8 in.

MARINE CRUSTACEANS

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE RIGHT) DR. ROMAN VISHNIAC—PUBLIX, (CENTRE LEFT) DOUGLAS P. WILSON, (BOTTOM LEFT) M. WOODBRIDGE WILLIAMS, (BOTTOM RIGHT) WILLIAM J. JAHODA FROM NATIONAL AUDUBON SOCIETY

CRUSTACEA

Blue crab, an edible species (*Callinectes sapidus*) found along the east coast of the U.S. from Cape Cod to Louisiana, is valued by the fishing industry. Fully grown males may attain a shell width of more than 8 in.

Temora longicornis, a marine copepod, microscopic in size. Among the most numerous animals in the sea, copepods play an important role in the economy of the sea, ranking first as food for other marine animals

Scud (*Gammarus*), an amphipod found in the fresh waters of the U.S. Less than an inch long, it is shown here on its side, its natural position for swimming

Microscopic female *Cyclops*, a fresh-water planktonic copepod, carrying egg sacs attached to each side of its body. Planktonic copepods are colourless and transparent; the colour here results from the use of special illumination to reveal the physical details of the specimen

Common shrimp (*Penaeus setiferus*), commercially one of the most important species on the south Atlantic and Gulf coasts of the U.S. At one year males are about 6 in. long, females 6½ to 7 in. Commercially fished shrimp are about 3½ in. long

Burrowing crayfish (*Cambarus diogenes*) emerging from the mud chimney that surrounds its burrow. Crayfish are found in and around fresh waters of all continental land masses except Africa

MARINE AND FRESH-WATER CRUSTACEANS

BY COURTESY OF (BOTTOM LEFT) MARINELAND OF FLORIDA, PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT) DOUGLAS P. WILSON, (CENTRE RIGHT) DR. ROMAN VISHNIAC—PUBLIX

Female copepod (*Corycaeus anglicus*) with egg sac, a marine copepod common in the English channel. Many copepods are parasitic; the mouth structure of this species indicates that it is probably semiparasitic in habit

Spider crab (*Maia squinado*) common to the littoral zone of the Atlantic and Mediterranean. Spider crabs affect a protective camouflage by covering their bodies with seaweed and other organic materials from their surroundings

Colony of marine copepods (*Pseudocalanus elongatus*). Copepods live on diatoms and other microscopic life and form one of the most important constituents of the plankton

Aquatic sow bug (*Asellus*), a fresh-water isopod about 1 in. long. It is found on the muddy bottom of shallow waters, where it acts as a scavenger, feeding on animal and vegetable debris of all kinds

Hermit crab (*Coenobita rugosa*), a land crab of the east African coasts. Lacking a hard-shell covering of its own, the hermit crab lives in the empty shell of a gastropod mollusk

"Mantis shrimp" (*Pseudosquilla bigelowi*), a predatory marine crustacean found in shallow waters of all warmer seas, where it burrows into the sand or lurks in crevices, waiting for a small fish to come within reach of its jackknife claw

MARINE AND FRESH-WATER CRUSTACEANS

PHOTOGRAPHS, (TOP LEFT AND RIGHT, CENTRE LEFT, BOTTOM RIGHT) DOUGLAS P WILSON, (CENTRE RIGHT) JOHN H GERARD, (BOTTOM LEFT) RALPH BUCHSBAUM

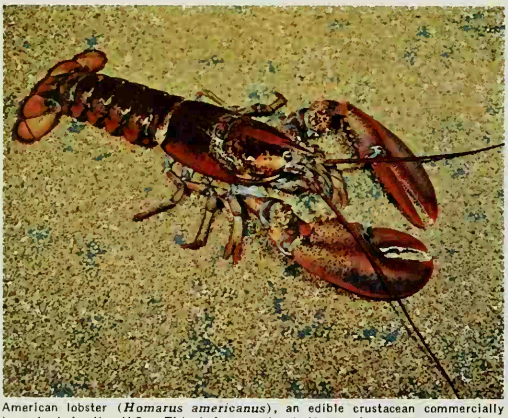
CRUSTACEA

Gooseneck barnacles (*Lepas anatifera*), found along the seashore attached to driftwood. The main body of the animal is enclosed in calcareous plates that hang from a stalk. These barnacles obtain food in the same way as acorn barnacles. *See* Plate I

Mature female *Daphnia*, the most common fresh-water cladoceran or water flea. The transparency of cladocerans permits the study of internal structure; unborn young can be seen in the dorsal brood pouch of this specimen

Pill bug (*Ligia pallasii*), an isopod that inhabits the rocky seacoast from Alaska to California. It feeds in the intertidal zone when the tide is out, but returns to land when the tide comes in

Sand hopper or beach flea (*Orchestoidea californiana*), a land amphipod ranging in size from ½ in. to 2½ in. It lives on ocean beaches, hiding in burrows in the sand above the high-water mark and searching for food under piles of rotting seaweed



American lobster (*Homarus americanus*), an edible crustacean commercially important in the U.S. Fished from rocky bottoms of shallow waters from Labrador to North Carolina, an average-sized lobster in a catch is about 9 in. in total length

Barber-shop or coral shrimp (*Stenopus hispidus*), a bizarre-looking shrimp that scavenges for food on coral reefs and wharf pilings throughout the West Indies

MARINE AND FRESH-WATER CRUSTACEANS

BY COURTESY OF (BOTTOM RIGHT) MARINELAND OF FLORIDA; PHOTOGRAPHS, (TOP LEFT) DOUGLAS P. WILSON, (TOP RIGHT) DR. ROMAN VISHNIAC—PUBLIX, (CENTRE LEFT AND RIGHT) RALPH BUCHSBAUM, (BOTTOM LEFT) JOHN H. GERARD

one or more of the anterior pairs to be modified as "foot-jaws" or maxillipeds. The abdominal limbs are usually biramous swimming structures, the last pair being large and flattened and forming with the telson a lamellar "tail-fan."

Gills.—In many of the smaller Crustacea no special gills are present and respiration is carried on by the general surface of the body and limbs. When gills are present they are generally formed by some of the exites near the base of the limb, which are flattened, thin-walled and permeated by a network of blood channels. In the Decapoda the gills are inserted, in three series, at or near the bases of the thoracic limbs, and lie within a pair of branchial chambers covered by the carapace.

Adaptations for aerial respiration are found in those Crustacea that have taken to terrestrial life. In the land crabs (of several different families) the branchial chambers are enlarged and serve as lungs, the lining membrane being richly supplied with blood vessels. In some of the terrestrial Isopoda, or wood lice, the abdominal appendages contain tufts of branching tubules filled with air, like the tracheae of insects and other terrestrial Arthropoda.

Internal Features

Digestive System.—In almost all Crustaceae the food canal runs straight through the body, except in front where it curves downward to the ventrally placed mouth. In a few cases its course is sinuous or twisted and in one or two instances (Cladocera, Cumacea) it is actually coiled upon itself. As in other Arthropoda, the digestive system consists of three divisions, the fore-, mid- and hind-gut, the first and last being lined by an inturning of the chitinous cuticle. In the Malacostraca, the fore-gut is dilated to form a so-called stomach, furnished internally with ridges armed with spines and hairs forming a straining apparatus. In the Decapoda this apparatus reaches its greatest complexity, forming a gastric mill in which three teeth connected with a system of articulated ossicles are moved by special muscles so as to pulverize the food that is passed into the stomach.

The mid-gut is essentially the digestive and absorptive region of the alimentary canal and its surface is, in nearly all Crustacea, increased by pouchlike or tubular outgrowths that not only serve as glands for secretion of the digestive juices but aid in the absorption of the digested food. In the Decapoda these outgrowths form a massive digestive gland of "liver."

In some decapods, as the crayfish, the mid-gut is very short, nearly the whole length of the food canal being formed by the fore- and hind-guts. In a few highly modified parasites the alimentary canal is vestigial or absent throughout life as in the Rhizocephala (*see* Barnacle).

Circulatory System.—As in the other Arthropoda, the circulatory system in Crustacea is largely lacunar, the blood flowing in sinuses or channels lacking definite walls. The heart is of the usual arthropodous type, lying in a pericardial blood sinus with which it communicates by valvular openings, or ostia. In most Branchiopoda and in some Malacostraca the heart retains more or less completely the primitive form of a long tube, extending throughout the greater part of the length of the body and having a pair of ostia in each somite. In most Crustacea, however, the heart is shortened and gives off one or more main arteries that carry the blood for some distance to pour into the blood spaces of the body. In many of the smaller Crustacea there is no heart, and it is impossible to speak of a circulation in the proper sense of the word, the blood being merely driven hither and thither by the movements of the body and limbs and of the alimentary canal.

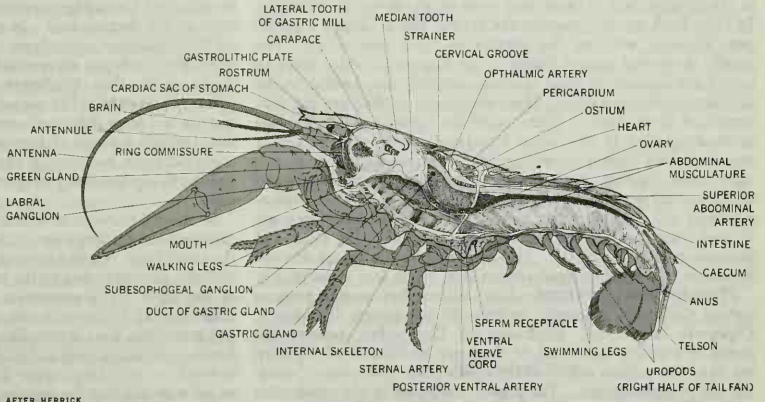
Excretory System.—The most important excretory organs of the Crustacea are two pairs of glands lying at the base of the antennae and of the maxillae respectively. The two are rarely functional together, although one may replace the other in the course of development. In the adult it is sometimes the antennal, sometimes the maxillary gland that persists. The structure of both glands is essentially the same, and they are to be regarded as the survivors of a primitive series of segmentally arranged nephridia. Each gland consists of a thin-walled end sac which developmental studies show to be a vestigial portion of the coelom, communicating with the exterior by a convoluted duct, part of which has glandular walls. Probably in most cases the greater part of this duct arises from mesoderm and only a short terminal part from ectoderm, but it is stated that in some cases the whole duct is ectodermic.

In the Decapoda the antennal gland is largely developed and is known as the "green gland." The external part of the duct is often dilated into a bladder, and may sometimes send out pouches, or diverticula, forming a system of sinuses ramifying through the body.

Other excretory organs have been described in certain Crustacea, consisting of groups of mesodermal cells in various parts of the body within which the excretory products are stored up instead of being expelled. Possibly some of these are vestiges of segmentally arranged nephridia.

Nervous System.—The central nervous system is constructed on the same general plan as in other Arthropoda, consisting of a supra-esophageal ganglionic mass or brain, united by circumesophageal connectives with a double ventral chain of segmentally arranged ganglia. In the primitive Branchiopoda the ventral chain retains the ladderlike arrangement found in some annelids, the two halves being widely separated and the pairs of ganglia connected together across the middle line by double transverse commissures. In the other groups the two halves of the chain are more or less coalesced, and, in addition, the ganglia tend to draw together in a longitudinal direction and to fuse, ultimately, into a single mass representing the whole of the ventral chain. This is seen, for example, in the true crabs (Brachyura) among the Decapoda.

The brain, or supra-esophageal ganglion, shows various degrees of complexity. In the Branchiopoda it contains two pairs of ganglionic centres giving origin, respectively, to the optic and the antennular nerves. The centres for the antennal nerves form ganglionic swellings on the esophageal connectives. In the higher forms these centres have moved forward to become incorporated in the brain, but the fibres that unite them still run backward to form a transverse commissure behind the esophagus. This is of importance as showing that the antennae were originally postoral



AFTER HERRICK

FIG. 6.—LONGITUDINAL SECTION OF FEMALE LOBSTER (HOMARUS), RIGHT HALF SHOWN; HEAD IS SLIGHTLY ENLARGED TO SHOW NERVOUS SYSTEM

limbs. In the higher Decapoda, additional centres are developed in the brain and its structure becomes very complex. A system of visceral nerves and ganglia associated with the alimentary canal and the heart is well developed in the Decapoda.

Eyes.—The eyes of Crustacea are of two kinds, the unpaired median, or nauplius, eye, and the paired compound eyes. The median eye is generally present in the earliest larval stages (nauplius), and in some instances, as in the Copepoda, it forms the sole organ of vision. It may persist along with the paired eyes, as in the Branchiopoda, or it may become vestigial or disappear in the adult, as in most Malacostraca. It consists typically of three cup-shaped masses of pigment, the cavity of each cup being filled with columnar retinal cells connected at their outer ends with nerve fibres from the brain.

The compound eyes are very similar in the details of their structure to those of insects, consisting of a varying number of visual elements or ommatidia separated by pigment sheaths. Each sheath terminates in a crystalline body covered by the transparent external cuticle that forms the cornea. In most cases the cornea is divided into lenslike facets corresponding to the underlying ommatidia.

Other Sense Organs.—As in other Arthropoda, the hairs, or setae, on the surface of the body are important organs of sense and are variously modified for special functions. Many, perhaps all, of them are organs of the sense of touch. Those setae that are feathered or provided with secondary barbs respond to movements or vibrations in the surrounding water and some of them are thought to have an auditory function. Organs formerly regarded as auditory, but now known to be connected with the maintenance of equilibrium of the body, are the statocysts found in various positions in different Crustacea, notably at the base of the antennules in most decapods. Statocysts are open or closed vesicles having sensory hairs on their inner surface and containing one or more statoliths. The latter may be grains of sand introduced from the exterior.

Another type of sensory setae is associated with the sense of smell, or rather, perhaps the chemical sense. These are bluntly pointed filaments in which the cuticle is extremely delicate. They are found chiefly on the antennules, and are often especially developed in the males, in which they are thought to act as sensitive devices for detecting the presence of females.

Glands.—The most important glandular structures in Crustacea (in addition to the digestive and excretory glands already mentioned) are various types of dermal glands that occur on the surface of the body and limbs. Some of these in the region of the mouth or on the walls of the esophagus have been regarded as salivary, but in some cases are now known to produce a mucous secretion that serves to entangle minute food particles. In some Amphipoda the secretion of glands on the surface of the body and limbs is used in the construction of protective cases in which the animals live. In some fresh-water Copepoda the dermal glands secrete a gelatinous envelope enabling the animals to resist desiccation. The greatly developed cement glands of the Cirripedia, which serve to attach the animals to their support, probably also belong to the category of dermal glands. More intensively studied are the very important sinus glands. Often called the eyestalk glands because of their location in the higher Crustacea, they are a part of a neurosecretory system whose hormones control colour change, colour pattern, molting, development of the eggs within the ovary and perhaps other nervous and physiological reactions. Chromatophorotropins and perhaps other hormonal substances have been extracted from parts of the central nervous system, the brain and thoracic cord in particular. This may well be the source of such hormones in the sessile-eyed crustaceans, which lack sinus glands.

Phosphorescent Organs.—Like many other marine animals certain Crustacea, belonging to very diverse groups (Ostracoda, Copepoda, Mysidacea, Euphausiacea, Decapoda), possess the power of emitting light. All of them are inhabitants of the deep sea or of the surface waters of the ocean. No fresh-water Crustacea are phosphorescent. The organs concerned in the production of light are curiously varied. In the Ostracoda and Copepoda certain dermal glands produce a luminous secretion. In some Mysidacea and Decapoda the secretion of the excretory organs (maxillary or antennal glands) is luminous. In the Euphausiacea and certain Decapoda the light-producing organs found on the body and limbs are complex structures provided with a reflector and a condensing lens and movable by special muscles so as to vary the direction of the emitted beam. The part that phosphorescence plays in the life of the animals can only be conjectured. In some instances it may serve to attract prey; in others it may help individuals of the same species to keep together in a shoal or to find their mates. The clouds of luminous secretion thrown out by some species may serve to baffle pursuers as does the cloud of ink thrown out by a cuttlefish. The elaborate "searchlights" may illuminate objects within the range of vision. But even conjecture seems at a loss when it is found that certain deep-sea prawns have complex light organs placed so as to illuminate the interior of the gill chambers.

REPRODUCTION AND DEVELOPMENT

Reproductive System.—In the great majority of Crustacea the sexes are separate, but in the Cirripedia and in some parasitic Isopoda hermaphroditism is the rule, and isolated instances occur in other groups, especially among Decapoda. Parthenogenesis is common in Branchiopoda and Ostracoda and occurs in at least one genus of terrestrial Isopoda.

Where the sexes are separate, sexual dimorphism is often striking. The males are often provided with clasping organs for holding the female, and these may be formed by modification of almost any of the appendages—antennules, antennae, thoracic limbs or even some of the mouth parts. Some of the appendages in the region of the genital openings may be modified for the purpose of transferring the sperm to the female, as, for instance, the first and second abdominal appendages in the Decapoda.

In the higher Decapoda the male is often larger than the female, but in other groups the reverse is more frequently the case. In some parasitic Copepoda and Isopoda the disparity in size is carried to an extreme degree, and the minute male is attached, like a parasite, to the enormously larger female.

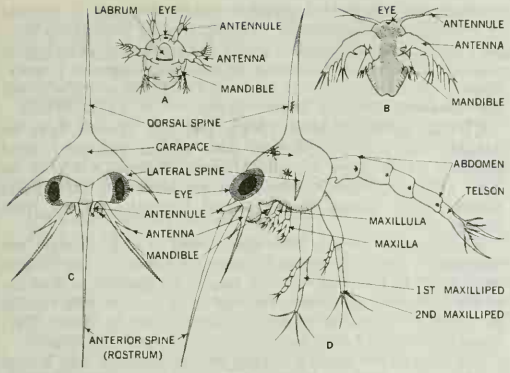
In the Cirripedia some very aberrant types of sexual relationship exist. Whereas the great majority are hermaphrodites capable of both cross- and self-fertilization, it was discovered by Darwin that, in certain species, minute degenerated males exist, attached to the ordinary individuals. Since these dwarf males pair, not with females but with hermaphrodites, Darwin termed them "complemental" males. In other species the large individuals have become purely female by atrophy of the male organs and are entirely dependent on the dwarf males for fertilization.

Nearly all Crustacea carry the eggs in some way or other after extrusion. They are retained between the valves of the carapace in some Branchiopoda and Ostracoda, or within the mantle cavity in Cirripedia. Among the Malacostraca the Peracarida have a brood pouch formed by overlapping plates attached to the bases of some of the thoracic legs. In most Decapoda the eggs are carried on the abdominal appendages of the female. In a few cases the developing embryos are nourished by a special secretion while in the brood chamber (Cladocera, terrestrial Isopoda).

Larval Stages.—The majority of Crustacea are hatched from the egg in a form differing more or less from that of the adult and pass through a series of free-swimming larval stages. There are many instances, however, in which the metamorphosis is suppressed and the newly-hatched young resemble the parent in general structure.

In those Crustacea in which the series of larval stages is most complete the earliest stage is the nauplius already mentioned. In the usual form, this has an oval unsegmented body and three pairs of limbs corresponding to the antennules, antennae and mandibles of the adult. The antennules are simple, the others each two-branched; all three pairs are used in swimming. The antennae and mandibles have a spinelike process at the base and share the function of seizing food and pushing it into the mouth. The mouth is overhung by a large upper lip, or labrum. The paired eyes are as yet wanting, but the unpaired eye is usually conspicuous.

A nauplius larva differing only in details from that just described is found in most of the Branchiopoda. Copepoda and Cirripedia



(A) FROM SNODGRASS AFTER ZIEGELMAYR; (B) FROM SNODGRASS AFTER CLAUS; (C), (D) AFTER PEARSON

FIG. 7.—COMMON LARVAL FORMS

Copepod (*Cyclops*): (A) nauplius. Branchiopod (*Apus*): (B) nauplius. Crab (*Cancer*): (C) anterior view of zoea; (D) longitudinal view of zoea

and, in a more modified form, in some Ostracoda. Among the Malacostraca the nauplius is found in the Euphausiacea and some of the most primitive Decapoda. In many of the Crustacea that hatch at a later stage there is more or less clear evidence of a nauplius stage in the embryonic development. It seems certain, therefore, that the possession of a nauplius larva must be regarded as a very primitive character of the Crustacea.

As development proceeds, the body of the nauplius elongates and its posterior part becomes segmented, new somites being added at successive molts from a formative zone in front of the telsonic region. The appendages, which appear as buds on the ventral surface of the somites, become differentiated, like the somites that bear them, in regular order from front to rear. With the elongation of the body, its dorsal covering begins to project behind as a shell fold, the beginning of the carapace. The paired eyes appear under the cuticle at the sides of the head but only become stalked at a comparatively late stage.

The course of development here outlined, in which the somites and appendages appear in regular order, agrees so well with that observed in the typical Annelida that it must be regarded as the most primitive. It is most closely followed in some Branchiopoda and Copepoda.

In most Crustacea, however, this primitive scheme is more or less modified. The earlier stages may be passed through within the egg; thus the larva, on hatching, has reached a stage more advanced than the nauplius. The gradual appearance of somites and appendages may be accelerated so that comparatively great advances take place at a single molt, or individual somites or pairs of appendages may appear in advance of their neighbours, disturbing the regular order of succession. This last type of modification is especially evident in the Malacostraca in which it leads to the very peculiar larva known as the zoea. In the usual form of zoea, found in the true crabs, the posterior five or six thoracic somites are delayed in development. These somites are still represented by a short unsegmented region of the body at a stage when the abdominal somites behind them are fully formed and even carry appendages.

Most of the larval forms swim freely at the surface of the sea and show adaptations to this pelagic habit of life. Various spines and processes from the surface of the body are often developed and are probably less important as defensive organs than as aids to flotation. Also considered as aids to flotation are the greatly developed carapace of stomatopod larvae and the extreme flattening of the body in the membranous phyllosoma larvae of the spiny lobsters and their allies.

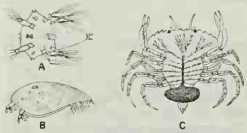
Complete suppression of metamorphosis is found in the fresh-water crayfish and the river crabs, but is by no means universal among fresh-water Crustacea. On the other hand, a few marine crabs are known to be hatched in a form differing little from that of the adult.

PHYLOGENY AND EVOLUTION

Fossil remains of Crustacea are abundant in rock strata belonging to all the main divisions of the geological time-scale from the most ancient up to the most recent, but they disclose disappointingly little regarding the phylogeny of the class. This is partly due to the fact that many important forms must have escaped fossilization altogether owing to their small size and delicate structure. Very many of those actually preserved are known only from the carapace or shell, the limbs being absent or represented only by indecipherable fragments. The fortunate accident that has preserved with marvellous completeness the minute branchiopod *Lepidocaris* in the Old Red Sandstone of northwestern Europe is not likely to have been often repeated. *Lepidocaris*, however, is of recent date as compared with the varied fauna of Crustacea discovered by C. D. Walcott in the Middle Cambrian layers of the Canadian Rockies. There is reason to believe that many of the chief groups were already differentiated even before the beginning of the geological record. Shrimplike forms that can be definitely referred to the Malacostraca begin to appear in the Upper Devonian, and Mysidacea and Syncarida can be recognized in the Carboniferous, but it is not until true decapods appear in the Triassic that anything like a connected story can be made out.

In the dearth of evidence from palaeontology one is compelled to rely on the data afforded by comparative anatomy and embryology in attempting to reconstruct the course of evolution within the class. Conclusions reached in this way must of course remain more or less speculative so long as they cannot be checked by the results of palaeontology.

The earlier attempts to reconstruct the genealogical history of the Crustacea were based on the "theory of recapitulation," in this instance the assumption that the successive stages of the larval history, especially the nauplius and zoea, reproduced the actual structure of ancestral types. It is now generally agreed that this theory cannot be applied to the zoea, the characters of which must be due to secondary modification. As regards the nauplius, however, the constancy of its general structure in the most diverse groups of Crustacea strongly suggests that it is a very ancient type, and the view has been strongly advocated that the Crustacea must have arisen from an unsegmented naupliuslike ancestor. Yet resemblances between the more primitive Crustacea and annelid worms, in such characters as the structure of the nervous system and the mode of growth of the somites, can hardly be ignored, and it is reasonable to suppose that the Crustacea originated from some stock that already possessed these characters.



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY"; 1957. REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 8.—LIFE CYCLE OF A PARASITIC CRUSTACEA

Barnacle (*Sacculina*) that lives in crab: (A) nauplius (floating) larva; (B) cypris (free-swimming) larva; (C) degenerate saclike adult (heavily stippled), with rootlike extensions, attached to underside of crab

The hypothetical ancestral crustacean is thought to have resembled, in general form, some such branchiopod as *Apus*, with an elongated body composed of numerous similar somites and ending in a caudal fork; a carapace originating as a shell fold from the maxillary somite; the eyes probably stalked; the antennae and mandibles both biramous and armed with masticatory processes; and the limbs of the trunk all similar, biramous, with additional endites and exites, and probably all bearing gnathobases. It is to be noted that, except for the absence of a carapace fold and of eyestalks, the trilobites (*q.v.*) are not very far removed from this primitive crustacean.

CLASSIFICATION

The diversity of structure in the members of the class Crustacea is much greater than in any of the other classes of Arthropoda, and the scheme of classification that must be devised in order to ex-

press their affinities is correspondingly complex. Early in the 19th century P. A. Latreille divided the class into two main groups, Malacostraca and Entomostraca. The Malacostraca constituted a well-defined, natural subclass that is still recognized today. The Entomostraca, however, covered such a heterogeneous assemblage of Crustacea that it has ceased to be a definitive term, though it is still occasionally used to refer to the nonmalacostracan crustaceans generally. The Crustacea are presently classified into eight subclasses: the Malacostraca, which is divided into two series, Leptostraca and Eumalacostraca; and the seven subclasses of the nonmalacostracan crustaceans.

The following is a synopsis of the classification. Some further details will be found in the articles dealing with the subclasses.

Class Crustacea
- Subclass Cephalocarida (2 species)
- Subclass Branchiopoda (more than 800 species)
  - Orders Anostraca, Lipostraca (fossil only), Notostraca, Conchostraca and Cladocera
- Subclass Ostracoda (perhaps 2,000 species)
  - Orders Myodocopa, Cladocopa, Podocopa, Platycopa
- Subclass Mystacocarida (3 species)
- Subclass Copepoda (more than 5,000 species)
  - Orders Calanoida, Harpacticoida, Cyclopoida, Monstrilloida, Caligoida, Lernaepodoida
- Subclass Branchiura (at least 75 species)
  - Order Arguloida
- Subclass Cirripedia (800 plus species)
  - Orders Thoracica, Acrothoracica, Ascothoracica, Apoda, Rhizocephala
- Subclass Malacostraca (over 18,000 species)
  - Series Leptostraca
    - Superorder Phyllocarida
      - Order Nebaliacea
  - Series Eumalacostraca
    - Superorder Syncarida
      - Orders Anaspidacea, Bathynellacea
    - Superorder Peracarida
      - Orders Thermosbaenacea*, Spelaeogriphacea, Mysidacea, Cumacea, Tanaidacea, Isopoda, Amphipoda
    - Superorder Eucarida
      - Orders Euphausiacea, Decapoda
    - Superorder Hoplocarida
      - Order Stomatopoda

*A superorder Pancarida has been urged recently for the Thermosbaenacea following the Syncarida, but its acceptance has been limited.

See also references under "Crustacea" in the Index volume.

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CRUVEILHIER, JEAN (1791–1874), French pathologist, born at Limoges on Feb. 9, 1791, first occupant of the chair of pathology after it was established at the University of Paris in 1836. He gave the first description of multiple sclerosis and left an early account of progressive muscular atrophy, but he erroneously supposed that pyemia (generalized blood poisoning accompanied by multiple abscesses) was always the result of phlebitis, which he referred to as an original coagulation of the blood. He even went to the extreme of asserting that phlebitis dominates all pathology. His name is still used as part of the medical names for congenital cirrhosis of the liver and stomach ulcers caused by excess acid. Cruveilhier died at Sussac on March 6, 1874. His chief works are *Anatomie descriptive* (1834–36); *Anatomie pathologique du corps humain* (1829–42), with many coloured plates; *Traité d'anatomie pathologique générale* (1849–64); *Anatomie du système nerveux de l'homme* (1845); *Traité d'anatomie descriptive* (1851).

CRUZ, RAMÓN DE LA (1731–1794), Spanish dramatist of spontaneously comic genius who excelled in short sketches (*sainetes*), was born on March 28, 1731, in Madrid, where he died on March 5, 1794. Some of his most popular sketches depict or tolerantly satirize Madrid life. Some treat slyly of topical preoccupations; some, with appropriate dialect or jargon, of regional or professional idiosyncrasies. Others, rivaling John Gay's *Beggar's Opera*, glorify back-alley scenes and characters, as a form of nonsense literature, or to parody the unpopular Augustan tragedy. Typical are *El prado por la noche* ("The Prado at night") and the "laughable" tragedy *Manolo* (1769). (I. L. McC.)

CRUZ, SOR JUANA INÉS DE LA (Juana Inés de Asbaje) (1651–1695), Mexican poet, scholar and nun, called Mexico's Tenth Muse and the Mexican Phoenix, was born on Nov. 12, 1651 (recent research sets her birth date three years earlier) in the village of San Miguel Nepantla, not far from Mexico City.

A precocious child, at three she learned to read; at eight she composed a *loa* (short dramatic poem) in honour of the Blessed Sacrament; at the same time she begged her parents to send her to the University of Mexico, but had to be content with reading her grandfather's books; at nine she went to live in Mexico City, where she studied Latin, mastering the language in 20 lessons.

The fame of her learning reached viceroy Mancera, who invited her to court, where she became very popular because of her wit, facility in writing poetry, beauty and magnetic personality. In an oral examination arranged by the viceroy, Juana Inés, who was then 17, astonished 40 professors with her knowledge.

In order to dedicate her life to learning, and perhaps influenced by a disappointment in love, Juana Inés entered the convent of San Jerónimo on Feb. 24, 1669. There she assembled a library of about 4,000 volumes, experimented in the sciences, wrote poems and religious and secular plays. Attempts were made, however, to curb her scholastic activities. The bishop of Puebla, under the pseudonym of Sor Filotea, admonished her to concentrate on religious studies. In her *Respuesta a Sor Filotea*, a long letter written March 1, 1691, she defended her desire for broad knowledge and her course of life. Two years later, however, she gave up all contact with the world, signed a confession with her own blood, sold her books, scientific and musical instruments, distributed the money to the poor and devoted her time exclusively to religious duties. She died on April 17, 1695, the victim of an epidemic, while nursing her sister nuns.

The three volumes of her works were printed in Spain; the first, *Inundación castálida* . . . appeared in Madrid in 1689; the second, *Segundo volumen de las obras de Sóror Juana Inés de la Cruz*, in Seville in 1692; and the third, *Fama y obras póstumas* . . . in Madrid in 1700. Several editions of the three volumes appeared during the 18th century. Other of her productions were printed separately. The influence of Góngora and Calderón is evident in some of her works. More important, however, is the subtlety, grace, fervour and versatility of her poetical compositions.

Bibliography.—E. A. Chávez, *Ensayo de psicología de Sor Juana Inés de la Cruz* (1931); E. A. Gómez, *Sor Juana Inés de la Cruz, bibliografía y biblioteca* (1934); Karl Vossler, *Die zehnte Muse von Mexico* (1934); Elizabeth Wallace, *Sor Juana Inés de la Cruz, poetisa de corte y convento* (1944); Julio Jiménez Rueda, *Sor Juana Inés de la Cruz en su Época* (1951); Alfonso Méndez Plancarte (ed.), *Obras completas de Sor Juana Inés de la Cruz*: I. *Lírica personal* (1951); II. *Villancicos y letras sacras* (1952); III. *Autos y loas* (1955); IV. A. G. Salceda (ed.), *Comedias, sainetes y prosa* (1957). (L. Ll.)

CRUZ E SILVA, ANTÓNIO DINIS DA (1731–1799), Portuguese poet chiefly remembered for a satirical poem, *O Hissope*, was born of humble parentage in Lisbon on July 4, 1731, and was educated at the University of Coimbra where he took his degree in law in 1753. He obtained judicial appointments in various towns, and in 1756 helped to found the literary society known as the *Arcádia Lusitana* which combated 17th-century extravagances and sought to resuscitate Portuguese poetry by urging closer adherence to Greek and Latin models. In 1776 he was sent as a judge to Rio de Janeiro where he died on Oct. 5, 1799. Like the other poets of his day, Cruz e Silva attempted many kinds of verse but his fame rests mainly on his witty satire, *O Hissope*, the best of the mock-heroic genre in Portugal, in eight cantos of blank verse. It was published posthumously in 1802, but written probably before 1773 and revised later. The theme is based on a quarrel between the bishop and the dean at Elvas.

Bibliography.—Cruz e Silva's poems were published in 6 vol. (1807–

1817). A critical edition of the *Hissope* by J. R. Coelho appeared in 1879 with an introductory study on the poet's life and writings. *See* also T. Braga, *A Arcádia Lusitana* (1899) and *Os Árcades* (1918); Hernâni Cidade, *Lições de cultura e literatura portuguesas*, vol. ii (1940); A. J. Saraiva and O. Lopes, *História da literatura portuguesa* (1954). (N. J. L.)

CRWTH, a Welsh stringed instrument that became extinct early in the 19th century, known also in medieval England (the *crouth* or *crowd*). Basically it is a lyre (*q.v.*), but from about 1300 it was given a fingerboard and played with a bow like a fiddle, one or more strings lying off the fingerboard for "drone" use.

(A. C. Ba.)

CRYOGENICS: *see* Low-Temperature Physics.

CRYOLITE, a mineral discovered in Greenland, in 1794, is a sodium aluminum fluoride. The principal use of cryolite is in the electrolytic production of aluminum (*q.v.*), where it serves as an electrolyte. Cryolite also has numerous other metallurgical applications, is used in the glass and enamel industries, in bonded abrasives as a filler, and in the manufacture of insecticides.

Cryolite is found in a large deposit at Ivigtut in the Arksukfiord, Frederikshaad district, west Greenland. It occurs as a pegmatitic body in a granite stock intrusive into gneiss. Cryolite also has been found in small amounts in the U.S.S.R., Spain and in Colorado. The deposit at Ivigtut is the only natural commercial source of cryolite. A large proportion of the cryolite used in industry each year is produced synthetically from calcium fluoride or fluorite (*q.v.*).

The formula of cryolite is Na_3AlF_6. Its crystals are monoclinic. It is usually massive with no cleavage but having pseudocubic parting and uneven fracture. Other principal physical properties include: hardness 2.5; specific gravity 2.97; lustre vitreous to greasy; colour white, also brownish, reddish, rarely black; refractive index 1.338; maximum birefringence 0.001. (G. S. Sr.)

CRYPT, a vault or subterranean chamber, especially under a church floor. In Latin, *crypta* designated any vaulted building partially or entirely below the ground level, such as a sewer, the vaulted stalls for horses and chariots in a circus, farm storage cellars and a long, vaulted gallery known as cryptoporticus, like that on the Palatine hill. The tunnel to the north of Naples now known as the Grotto of Posilipo, through which passes the road to Pozzuoli (anc. Puteoli), was called *crypta Neapolitana* by Seneca. It was natural, therefore, for the early Christians to call their catacombs (*q.v.*) crypts, and when churches came to be built over the tombs of saints and martyrs, subterranean chapels, known as *confessiones*, around the actual tomb, were included. These also were called crypts. The most famous of these was St. Peter's, built on the site of St. Peter's martyrdom, over the circus of Nero (4th century).

Other notable Roman examples are those of S. Prisca, S. Prassede and S. Lorenzo fuori le Mura. In the basilica of S. Maria Maggiore a crypt was furnished, although there was no tomb or martyrdom site to commemorate; thus, as early as the reign of Constantine, the crypt was considered a normal part of the church building.

Further incentive to the building of crypts was given by the growing practice of burials within the church walls. This was a much debated usage, and the Council of Braga (563) gave permission for burials only within the churchyard, but not within the church itself. The Council of Mainz (813), however, stated that bishops, abbots, worthy priests or loyal laymen might be buried in a church, and from that time burials within the church multiplied. These were usually in the crypt. An early example of such a burial crypt exists in the church of S. Apollinare in Classe, Ravenna (6th century), where it takes the form of a small, underground passage around the altar and just within the apse walls.

Later the size of the crypt was increased to include the entire space under the floor of the church choir or chancel, as in the 10th-century crypt of S. Ambrogio at Milan. With the increased desire for richness in all parts of the church and increased technical skill, a further step was taken by raising the choir floor boldly and opening the front of the crypt to the nave, which was on an intermediate level between the crypt and the choir, with monumental flights of

ALINARI

FIG. 1.—VAULTED CRYPT OF S. MINIATO, FLORENCE (1013)

steps leading down to the crypt in the centre and up to the choir on either side. The arcaded fronts of these crypts formed an effective decoration for the church, as in the 12th-century church of S. Zeno in Verona, and that of S. Miniato at Florence (1013). The latter is particularly rich with inlaid polychrome marbles. Within, these crypts were usually apsidal and the ranges of columns whose vaults supported the floor above gave interesting perspective effects.

Where Byzantine influence was strong, crypts were less common, and when found, were of a totally different type, frequently existing as cellars under the entire church area, as in Trani cathedral in southern Italy (12th century). St. Mark's at Venice has a remarkable crypt of Greek cross plan, with many short and stumpy columns. This crypt was, in fact, a secondary church; its choir screen is still extant.

Outside Italy there was great variation both in frequency and in size of crypts. Lombard influence in Germany was shown by the large number of Rhenish churches that followed the Italian precedent of an appreciably raised choir with an important crypt beneath it. The end beneath the nave was usually closed, however. Elsewhere in western Europe the choir level was much less raised, and the crypt, where present, tended more and more to become a lower church with a plan largely reproducing that of the church above. The cathedral of St. Bénigne at Dijon possesses the strange crypt of a curious round chapel which seems to date back to the 6th century. It was built over the tomb of the patron saint and is peculiar in the fact that the central circular area, surrounded by a double aisle, ran up through the upper portion of the building and was open to the sky.

There is also a remarkable crypt in the cathedral of Auxerre believed to date from 1085, and several examples in Normandy, notably that of Bayeux and the Abbaye aux Dames at Caen, both of the late 11th century. These are in a crude Norman style with many similarities to contemporary crypts in England. The crypts of Chartres and Bourges cathedrals deserve notice as instances of the more developed type of early Gothic of the late 12th and early 13th centuries.

Crypts were highly developed in English work throughout the Romanesque and Gothic periods. The one at Canterbury, the western half of which is attributed to Ernulf (*c.* 1100), and the eastern half to William the Englishman, 75 years later, forms a large and complex church, with apse and chapels. The extreme east end, under Trinity chapel, is famous as the original burial place of Thomas à Becket. Slightly earlier (late 11th century), the crypts of Winchester, Worcester and Gloucester are similarly apsidal but simpler in plan. Of these, Worcester (1084) is the most decorative. Parts of the crypt at Rochester, that at Hereford and the crypt, no longer existing, of old St. Paul's in London were of rich Gothic type, the last so large that it served as the parish church of St. Faith. Other notable examples in Great Britain are

the exquisite crypt of St. Stephen's chapel at Westminster, now incorporated within the houses of parliament, and the richly carved 13th-century crypt of the cathedral at Glasgow.

Small crypts under parish churches are common in England, as at Lastingham in Yorkshire (probably 1080), notable for its size and the crude pseudoclassic character of its ornament, and at Repton in Derbyshire. Another very fine Norman example is the crypt of St. Peter's-in-the-East at Oxford.

Technically, many medieval houses may be said to have had crypts, as they were built over vaulted substructures, and remains of such nonecclesiastical crypts occur widely throughout Europe. The German *Rathäuser* have many fine and richly decorated crypts, such as the famous cellar of the Bremen town hall; a notable monastic cellar still exists in Mainz, and the cellars of the residential buildings at Mont St. Michel in France furnish numerous examples of great size and magnificence in almost all the medieval styles dating from the 11th to the 15th century. Oxford, Rochester and Bristol, in England, contain many remains of vaulted medieval cellars, and the city of Chester is built, in great areas, over ranges of such vaults.

Notable examples in London are those of Gerard's hall, now destroyed (reign of Edward I), and of the Guildhall, which dates from 1411 and is notable for its rich and intricate ribbed vault, in the design of which the subsidiary ribs, called liernes, play an important part.

A. F. KERSTING

FIG. 2.—EARLY ENGLISH GOTHIC CRYPT AT HEREFORD CATHEDRAL, ENGLAND

Many great modern cathedrals contain crypts. Notable examples exist at Washington, D.C., and in New York city, where the crypt at the cathedral of St. John the Divine contains an elaborate mosaic altar and reredos. (T. F. H.)

CRYPTOLOGY (Cryptography) is the science concerned with the methods and the paraphernalia employed in secret communications (from Gr. *kryptos*, "hidden," and *logos*, "word"). Because of the growth of governments, the expansion of commerce and especially the remarkable progress made in communications-electronics technology, cryptology has come to play a very important role in governmental communications, especially diplomatic and military. It also plays a minor role in commercial, industrial and banking communications. Among the more uncommon uses of cryptology are those in connection with attempts to establish authorship in questionable cases, as, for example, that of the Shakespeare plays.

In its early stages cryptology was concerned almost exclusively with secrecy in written communications, and this article will be restricted very largely thereto, but the science has developed to the stage where it deals not only with enciphered writing (cryptograms) but also with other mediums of cryptocommunication, such as enciphered telephony (ciphony) and enciphered facsimile (cifax) transmissions.

Cryptology embraces the twin or complementary sciences of signal security and signal intelligence. The former deals with all the means and methods of protecting one's own signals against interception and reading or utilization by unauthorized persons generally referred to as "the enemy." The latter deals with all the means and methods employed in acquiring information or intelligence by intercepting and solving the enemy's cryptosignals or nullifying his signal security so that the signals or information derived from them can be used against him.

Signal Security.—The principal components of this phase of cryptology are: (1) physical and personnel security; (2) transmission security; and (3) cryptosecurity. The first deals with the precautions and measures taken to assure that the physical arrangements and the facilities or procedures for safeguarding the paraphernalia or cryptomaterials used, *i.e.*, the codes, ciphers, key lists, etc., are adequate for the purpose and that the personnel employed in operating the codes and ciphers or cipher machines are trustworthy. The second component deals with the means, methods and procedures for assuring that no information is inadvertently disclosed either by indiscretions of operators or by faults in the transmitting or receiving apparatus which may assist in the solution of the transmissions. The third component, cryptosecurity, which deals with the technical adequacy of the cryptosystems employed, is usually of greater interest and deserves more extensive treatment than the other two. In an article of this nature it is possible only to deal briefly with cryptography (from Gr. *kryptos*, "hidden," and *graphein*, "to write"), it being understood that many of the cryptoprinciples employed for the protection of written communications, or signals representing them, can also be used in protecting or disguising other types of cryptosignaling; *e.g.*, ciphony and cifax. Cryptography deals with the processes, methods or means involved in preparing cryptograms; that is, messages or writings which are intended to be incomprehensible except to those who legitimately possess the proper special paraphernalia and the keys for those cryptograms and know how to use them in order to reproduce the original plain text of the messages. These processes are usually accomplished by means of cryptosystems employing codes or ciphers. The process of converting a plain-text message into a cryptogram is called enciphering (or encoding); that of reconverting the cryptogram back into its intelligible form, when done by a legitimate or authorized communicator, *i.e.*, one who legitimately holds the paraphernalia and the key, is called deciphering (or decoding).

Although in theory no sharp line of demarcation can be drawn between code systems and cipher systems, in modern practice the technical differences between them are sufficiently marked to warrant their being treated as separate categories of methods. Some authors include as a third and separate category the extensive but much less important one containing the so-called "concealment systems," which are sometimes employed to hide an internal or secret message within an external or apparently innocent piece of writing with a view to avoiding arousing suspicion in the minds of persons not privy to the secret, or to eluding censorship in wartime. In such systems the message or its elements are hidden or disguised by any one of hundreds of different means and methods, including such mediums as secret or invisible inks, microscopic writing, etc., but none of these concealment systems or devices will even be mentioned again herein. It is convenient to consider cipher systems first, then code systems, with the understanding that only a very few of the limited number of systems suitable for serious usage can here be outlined.

Cipher Systems.—In general, cipher systems involve a cryptographic treatment of textual units of constant and equal length, usually single letters, sometimes pairs, rarely sets of three letters, these textual units being treated as symbols without reference to their identities as component parts of words, phrases and sentences. Every practical cipher system must combine (1) a set of rules, processes or steps constituting the basic cryptographic method of treatment or procedure, called the general system, which is agreed upon in advance by the communicators and which is constant in character, with (2) a specific key which is variable in character. In enciphering plain text, the specific key, which

may consist of a number or a series of numbers or a word, phrase, sentence, etc., controls the steps under the general system and determines the specific nature or exact composition of the cipher message produced; in decipherment the specific key similarly controls the steps and determines what the deciphered text will be. When all operations are performed correctly, the two plain texts (before and after the cryptography) should be identical or nearly so, save for minor differences arising from errors in their encipherment and transmission or in their reception and decipherment. The general system should be such that even if it is known to the enemy no properly enciphered message can be read by him unless he also knows the specific key or keys applicable to that message.

Despite a great diversity in the external appearance and internal constitution of ciphers, there are only two basic classes of systems—transposition and substitution. (Concealment ciphers are excluded from the discussion.) A transposition cipher involves a rearrangement or change in the sequence of the letters of the plain-text message without any change in their identity; a substitution cipher involves a replacement of the plain-text letters by other letters (or by other symbols) without any change in their sequence. The two systems may be combined in a single cryptosystem.

Plain-text message: **DELAY DEPARTURE UNTIL FURTHER NOTICE.**

T	E	L	E	G	R	A	P	H
9	2	6	3	4	8	1	7	5
D	E	L	A	Y	D	E	P	A
R	T	U	R	E	U	N	T	I
L	F	U	R	T	H	E	R	N
O	T	I	C	E				

Key

Cryptogram

ENEET FTARR CYETE AINLU UIPTR DUHDR LO

Fig. 1.—An example of simple columnar transposition. The numerical key is derived by numbering the letters of the keyword ("telegraph") in accordance with their relative order of appearance in the ordinary alphabet, repeated letters, if present in the key, being numbered in sequence from left to right. The message is written in the normal manner from left to right in successive horizontal lines underneath the key, forming a "rectangle" of columns of letters. These letters are then transcribed in regular groups of five from the rectangle by reading down the columns, taking the latter in the sequence indicated by the key numbers. The last line of the rectangle may be completely filled with letters, nonsignificants being added if necessary; but the security of the method is considerably increased if the last line shows one or more blank spaces, as in this example.

The majority of transposition systems involve inscribing the letters of the plain text in a geometrical design called a matrix, beginning at a prearranged initial point and following a prescribed route, and then transcribing the letters from the matrix, beginning at another prearranged initial point and following another prescribed route. The matrix may take the form of a rectangle, trapezoid, octagon, triangle, etc., but systems in which the specific keys consist solely in keeping the matrices, the initial points and the routes secret are not often now employed because of their limited variability and, therefore, their relatively low degree of security. In this same class also fall systems which employ perforated cardboard matrices called grilles, descriptions of which will be found in most of the older books on cryptography. The transposition system most commonly used in practice is that designated as columnar transposition, wherein the transposition matrix takes the form of a simple rectangular figure the dimensions of which are determined in each instance jointly by the length of the individual message and the length of the specific key. An example is shown in fig. 1.

In the foregoing case the letters undergo a single transposition; in cases involving double transposition, that is, wherein the letters undergo two successive transpositions, the security of the cryptograms is very greatly increased, provided the methods selected are such as will effectively disarrange individual letters and not merely whole columns or rows. A practical system of double transposition is illustrated in fig. 2. The principal advantages of transposition systems lie in their comparative simplicity, speed of operation and, in some cases, their high degree of security; but despite these important considerations they do not at the present time play a prominent role in practical cryptography.

Substitution systems involve the use of conventional or cipher

Plain-text message: **DELAY DEPARTURE UNTIL FURTHER NOTICE.**

T	E	L	E	G	R	A	P	H
9	2	6	3	4	8	1	7	5
D	E	L	A	Y	D	E	P	A
R	T	U	R	E	U	N	T	I
L	F	U	R	T	H	E	R	N
O	T	I	C	E				

(a)

T	E	L	E	G	R	A	P	H
9	2	6	3	4	8	1	7	5
E	N	E	E	T	F	T	A	R
R	C	Y	E	T	E	A	I	N
L	U	U	I	P	T	R	D	U
H	D	R	L	O				

(b)

Cryptogram

TARNC UDEEI LTTPO RNUEY URAID FETER LH

Fig. 2.—An example of true double transposition. The cipher letters resulting from the first transposition rectangle (a) are written under the key of the second transposition rectangle (b) just as though they constituted plain-text, that is, from left to right, in successive horizontal rows. The final transposition is then performed in exactly the same manner as in fig. 1, yielding five-letter groups. The two rectangles may be based upon the same keyword, as in this example, or upon wholly different keywords.

alphabets composed of two juxtaposed sequences, one (either expressed or implied) corresponding to the letters of the ordinary alphabet (a, b, c . . . x, y, z), the other containing their respective cipher equivalents. The complexity of a substitution system usually depends upon three factors: (1) the specific composition of the cipher alphabet or alphabets employed; (2) the number of them involved in a single cryptogram; and (3) the specific manner in which they are used. As to their composition, cipher alphabets are of various types and are known under various names, such as standard, direct, reversed, systematically mixed, key-word mixed, random mixed, reciprocal, etc., all having reference to the nature of the two sequences composing them, the interrelations existing among them internally or externally, etc. The most important factor in connection with a cipher alphabet is whether its two sequences, regardless of their composition, are known or unknown to the enemy; for, if known, any conventional or disarranged alphabet may be handled with the same facility as the normal alphabet. As to the number of alphabets involved in it, a cryptogram is either monoalphabetic, involving a single cipher alphabet, or polyalphabetic, involving two or more alphabets. In essence the difference between the two types lies in the fact that in the former the equivalence between plain-text and cipher letters is invariant, *i.e.*, the equivalence is of a constant or invariable nature throughout the cryptogram, whereas in the latter it is of a changing or variable nature, controlled by the key. With regard to secrecy, the third condition mentioned above, namely, the specific manner in which the various cipher alphabets are employed, is the most important in determining the degree of security or resistance the cryptogram will have against cryptanalysis, as explained below.

Monoalphabetic substitution is usually uniliteral; *i.e.*, each letter of the plain text is replaced by a single character. Cases of biliteral, triliteral, etc., substitution are sometimes encountered; an example using biliteral equivalents is shown in fig. 3. No matter how many characters are in the groups composing the cipher equivalents for plain-text letters, if the groups are always the same for each letter, the substitution system is still monoalphabetic and the cipher can be treated as such.

Plain-text message: **DELAY DEPARTURE UNTIL FURTHER NOTICE.**

Second letter

First letter	A	B	C	D	E
A	T	E	L	G	R
B	A	P	H	B	C
C	D	F	I	K	M
D	N	O	Q	S	U
E	V	W	X	Y	Z

Enciphering

Plain: D E L A Y D E P A R T
Cipher: CA AB AC BA ED CA AB BB BA AE AA

Plain: U R E U N T I L F U R
Cipher: DE AE AB DE DA AA CC AC CB DE AE

Plain: T H E R N O T I C E
Cipher: AA BC AB AE DA DB AA CC BE AB

Cryptogram

CAABA CBAED CAABB BBAAE etc.

Fig. 3.—An example of biliteral, monoalphabetic substitution. A keyword alphabet of 25 letters (I serving also for J) is written in a square 5 x 5. (In this case the alphabet is based upon the word "telegraph.)" The letters (A,B,C,D, E) at the side and top of the square, taken in pairs, can then be used to represent the letters within the square. Thus, D = CA, E = AB, etc. The letters at the side of the square may be the same as or different from those at the top; in both cases keywords, identical or different, may be used instead of the letters A,B,C,D,E.

Polyalphabetic systems are often referred to as double-key systems and, as noted above, employ two or more cipher alphabets in the encipherment of single dispatches. In a given system the cipher alphabets may be entirely independent or they may be interrelated. In the simplest case of interrelated alphabets, that resulting from juxtaposing, at all points of coincidence, two primary sequences which are normal sequences proceeding in the same direction (a, b, c . . . x, y, z), the secondary cipher alphabets are called standard alphabets; these when successively tabulated yield a symmetrical or square table (fig. 4), which is generally referred to in the literature as a Vigenère table, a quadricular table, etc.

Plain-text letter

Key letter	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

Fig. 4.—The simple Vigenère table. The cipher equivalent of a given plain-text letter enciphered by a given key letter is that letter which stands at the intersection of the vertical column headed by the former and the horizontal row begun by the latter. Thus, plain-text letter E enciphered by key letter M yields cipher letter Q, or, in brief notation, $E_p(M_k) = Q_c$; $E_p(X_k) = B_c$, etc.

Such a table may be used in several ways. The most common method employs the top row of letters as the plain-text sequence and the successive horizontal rows as the cipher sequences, each of which may be designated by its initial letter. Thus the fourth or D alphabet is the one in which plain text A is represented by cipher D; *i.e.*, $A_p = D_c$, $B_p = E_c$, etc. In the ninth or I alphabet, $A_p = I_c$, $B_p = J_c$, etc. Therefore, when several such alphabets are to be employed, the letters of a key word can serve to indicate the number, identity and sequence of the cipher alphabets to be used consecutively in the cryptographic operations.

This type of cryptogram is usually referred to as the Vigenère cipher or as *le chiffre indéchiffrable*, although Blaise de Vigenère never claimed that he invented the table or the system; he was merely among the first to describe it (*see* below).

Various modifications of the simple square table are encountered, these involving different types and arrangements of the sequences therein, but in every case where these sequences can be arranged so as to exhibit symmetry of position as regards the order in which the letters fall in the successive rows or columns, sliding or concentric primary sequences may be employed to produce the same results as the table and are often more convenient.

Polyalphabetic substitution systems may be classified as periodic or aperiodic, depending upon whether or not the cryptograms produced by them exhibit external phenomena of a cyclic nature. Periodicity is exhibited externally whenever the substitution process involves the use of keying elements which are used in a repetitive manner and which in a single message operate in conjunction with a fixed number of cipher alphabets, as would the example shown in fig. 5.

Key:	T	R	O	Y	T	R	O	Y	T	R	A	O	Y	T	R	O	Y	T	R	O	Y	Y	T	R	O	Y
Plain-text:	L	E	T	T	E	R	N	O	T	Y	E	T	R	E	C	E	I	V	E	D						
Cipher:	E	V	H	R	X	I	B	M	M	P	S	R	K	V	Q	C	B	M	S	B						

Fig. 5.—An example of multiple alphabet substitution. The alphabets of the simple Vigenère table (fig. 4) are used in conjunction with the keyword TROY, which is written above the plain text and repeated as many times as required. Each letter is then enciphered by the keyletter above it. Thus, for the first letter, $L_T = E_c$; for the second letter, $E_R(R_E) = V_c$, etc. Usually all the plain-text letters governed by the first letter of the key are enciphered in succession, then those governed by the second, etc., this method reducing the possibility of error. In practice, the keyword, and therefore the period, is usually longer than that employed in this example, words and phrases of 15 to 20 or more letters being common. Much more important, however, is the fact that the alphabets employed in modern times are seldom those of the simple Vigenère table, but are mixed alphabets, the use of which makes the cryptograms more secure against solution.

Polyalphabetic systems of the aperiodic type are of great diversity in construction. In these systems periodicity is either entirely lacking because of the nature of the method or it is suppressed by incorporating elements which serve as periodicity interrupters. In the well-known aperiodic system designated as the running-key or nonrepeating-key system, periodicity is avoided by employing for the key the running text of a book, identical copies of which are in possession of the correspondents. The starting point of the keying sequence is agreed upon in advance, or is indicated in one of many ways by means of elements called indicators, which designate the exact point where the sequence begins. Another type of nonrepeating-key system, often designated as the autokey system, is that in which, beginning with a preconcerted key letter, each cipher letter (or sometimes each plain-text letter) becomes the key letter for the encipherment of the next plain-text letter.

The various systems of substitution thus far mentioned are monographic in nature, involving single plain-text letters. In digraphic systems substitution is by pairs of letters and uses preagreed cipher squares or matrices in which the letters of the alphabet are disposed according to some key and the cipher equivalents of pairs of plain-text letters are found by following prearranged rules. One of the best-known systems of this sort is that called the Playfair cipher, named after Lyon, Baron Playfair, but invented by Sir Charles Wheatstone. It is illustrated in fig. 6.

Properly selected methods of transposition and substitution when combined into a single system result in producing cryptograms of great security, but because of the additional complexities of operation introduced by the combination, with the resultant increased possibilities of error, such systems are not often encountered in practice.

L	E	X	I	N
G	T	O	A	B
C	D	F	H	K
M	P	Q	R	S
U	V	W	Y	Z

1. Message: AM FOLLOWING ON NEXT TRAIN.
2. Plain-text: AM FO LX LO WI NG ON NE XT TR AI NX
3. Cipher: GR QF EI XG YX LB BX LX EO AP HA LI

Cryptogram

4. GRQFE IXGYX LBBXL XEOAP HALI

Fig. 6.—The Playfair cipher; an example of digraphic substitution. An alphabet square of 25 letters (I serving also as J) based upon a keyword (in this case "Lexington") is drawn up, and substitution is performed with pairs of letters. Three cases as regards the position occupied in the square by the members of a pair are possible; they lie (1) in the same horizontal row, or (2) in the same vertical column, or (3) at the opposite ends of one of the diagonals of an imaginary rectangle. By studying the following examples under each case the method of finding equivalents will become apparent: Case (1) LI = EN, AB = BG, OB = AG; Case (2) ED = TP, EV = TE, PV = VE; Case (3) ER = IP, IM = LR, ST = PB. The text of the message to be enciphered, line 1 in the figure, is divided up into pairs, line 2. Double-letter pairs in the text are to be separated by an interposed letter such as X, as shown in the case of the word "following" in this example. Note also the addition of the letter "X" to the end of the message in order to make a pair of letters. The cipher equivalents are shown in line 3, the final cryptogram in five-letter groups, in line 4. Various arrangements of letters in the alphabet square are possible, and completely disarranged alphabets may be employed.

Code Systems.—Basically, a code system is merely a type of substitution system in which the textual units that undergo cryptographic treatment are of varying and unequal lengths. Generally they are entire words, but often they may be single letters, syllables, numbers or phrases of varying length and sometimes whole sentences. The cryptoprinciple underlying code systems is very old and has as its essential element a specially compiled list of words, phrases and sentences, each of which is accompanied by a code group which may be another word (real or artificial) or a group of letters or figures. Identical copies of specialized lists of the foregoing sort, called codebooks or codes, are held by the communicators. In encoding a message it is necessary merely to refer to the codebook and replace the words, phrases or sentences composing the message by the code groups assigned them, constructing the code message, step by step, in this manner and

using the fewest code groups possible. As to their cryptographic construction or arrangement of contents, codes may be of the one-part or the two-part type, the principal difference between them being shown in fig. 7.

One-part Code	Two-part Code	
	Encoding	*Decoding*
ABABA—A		
ABACE—Abandon-ing-s	KABOL—A	ABABA—Abeyance
ABADI—Abandoned	STOLG—Abandon-ing-s	ABACE—Procedure
ABAFO—Abate-ing-s	EXIFO—Abandoned	ABADI—To purchase
ABAGU—Abated	ZUMRA—Abated	ABAFO—Commenced
ABAHY—Abeyance	ABABA—Abeyance	ABAGU—Do not think
ABEBE—Abide-ing-s	ROABY—Abide-ing-s	ABAHY—Recorded
ABECI—Abided		
ZYZYZ—Zone-s	BIKUR—Zone-s	ZYZYZ—According to

Fig. 7.—Extracts from typical one-part and two-part codes. In the one-part type the code groups and the vocabulary are arranged in parallel, alphabetic (or numerical) sequences, so that a single book serves for encoding as well as for decoding. In the two-part type the encoding book lists the elements of the vocabulary in alphabetic order but the code groups are in random order, so that a decoding book, in which the code groups appear in alphabetic (or numerical) order accompanied by their meanings, is essential. The degree of secrecy afforded by a code of the latter type is much greater than that afforded by one of the former type, all other things being equal.

The condensing power of a code obviously depends upon the extent and the nature of its vocabulary. The security of a code system depends somewhat upon the distribution and construction of the codebook, but mostly upon whether it is used in conjunction with a good cipher system which is superimposed on the code text and the purpose of which is to afford secrecy, in the case of purchasable or publicly available codes, or additional secrecy, in the case of private or governmental codes. Code messages which undergo this second step are said to be superenciphered, re-enciphered, or simply, reciphered. The principal purpose of code in commercial communications is to effect economy in their cost of electrical transmission, secrecy being usually of secondary importance (except in certain types of banking operations). Codes for general business communications are purchasable from their publishers and therefore in themselves provide no secrecy. Many business firms, however, use specially compiled private codes which, if carefully restricted in distribution, may be regarded as confidential or secret. In governmental and especially in diplomatic or military communications secrecy is generally of primary importance, economy is secondary.

Governmental codes which are intended to be secret are, of course, very carefully guarded in their production, distribution and usage and, as a general rule, messages in such codes are superenciphered.

Cryptoapparatus.—Cryptodevices and cryptomachines vary in complexity from simple, superimposed, concentrically or eccentrically rotating disks to large mechanical machines and electrically operated cryptoteleprinting apparatus. One of the best devices of the more simple, mechanical type is that known as the Bazeries cylinder (*see* fig. 8), named after the French cryptographer who is commonly credited with its invention in 1891. The principle upon which the device is based was, however, conceived many years before by Thomas Jefferson (*see* Jefferson's *Papers* in the Library of Congress, vol. 232, item 41,575).

Devices of the sort exemplified in fig. 8 soon proved to be inadequate for modern cryptocommunications, as regards not only speed, accuracy and facility in operation but also security of the end product. It was not long, therefore, before more automatic and more secure types of apparatus were invented and developed. In such apparatus rotatory components referred to as cipher rotors have come to be of primary importance. The rotors may be of a mechanical or an electrical type. Fig. 9 shows a machine which uses a series of mechanical rotors to produce an extremely long, continuously changing key for encipherment. Although the results of manipulating the machine are printed upon a paper tape, the absence of a typewriter keyboard makes operation of the machine slow and tedious. Another machine uses a series of juxtaposed electrical rotors and stators to form a path for the passage of electric currents connecting the 26 keys of a keyboard to the 26 lamps of a light board upon which the results of manipulating the keys are indicated. Automatic angular displacements of the rotors serve to vary the path with each depression of any key of the keyboard. From a practical point of view such a machine is not satisfactory for offices engaging extensively in cryptocommunication since it lacks an automatic recording or printing mechanism and the results of operating the keyboard have to be recorded by the operator by hand. Therefore a machine combining both a keyboard and a printing mechanism had to come sooner or later. Such a combination of components is shown in fig. 10. Machines of this type, which are not necessarily associated with the electrical communication system but which merely produce an end product (a printed record) that can be given to a communication centre or telegraph office for transmission, are called off-line cryptomachines.

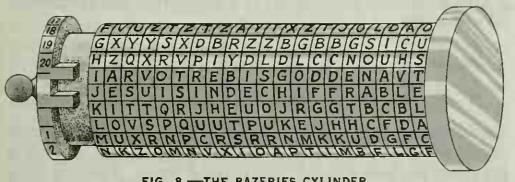

FIG. 8.—THE BAZERIES CYLINDER

The Bazeries cylinder consists of a set of 20 disks, each bearing on its periphery a differently mixed alphabet. The disks, which bear identifying numbers from 1 to 20, are assembled on the shaft in an order that corresponds to a numerical key. To encipher the message, 20 letters are taken at a time, and the disks are revolved so as to align the 20 letters horizontally; the letters of any row can be taken for the cipher text. In deciphering, the cipher letters, taken 20 at a time, are aligned horizontally; the disks are then locked into position. By slowly revolving the whole cylinder and examining each row of letters, one and only one row will be found to yield intelligible text all the way across

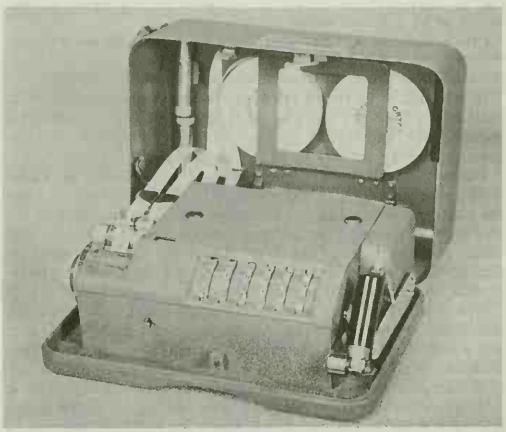

FIG. 9.—PORTABLE CRYPTODEVICE WHICH PRODUCES A PRINTED RECORD OF THE CIPHER TEXT AS WELL AS OF THE PLAIN TEXT

The letters to be enciphered or deciphered are set by twirling the indicating disk shown at left and operating the lever at the right. The six wheels control the cryptography, in conjunction with certain other variable keying elements inside the machine

But even this stage in improvement in cryptocommunications proved inadequate and communicators soon began to see need for on-line cryptomachines; *i.e.*, apparatus which combines in a single and instantaneous operation the following steps: (1) manipulation of a key of the keyboard at the transmitting station to correspond to a character of the plain-text message; (2) automatic encipherment of that character to form a cipher character; (3) electrical representation of that character by a signal or a permutation or combination of signals corresponding to the cipher character; (4) electrical transmission of the signal or signals; (5) their reception at the distant end; (6) their translation into a cipher character; (7) automatic decipherment of the character; and (8) printing the deciphered character—all this at the rate of at least 300 characters (=60 words) per minute. It is obvious, of course, that machines of this advanced type can be employed only where

FIG. 10.—CRYPTODEVICE OF FIG. 9 EQUIPPED WITH A KEYBOARD AND DRIVEN BY AN ELECTRIC MOTOR

The two machines are cryptographically intercommunicable. The operating lever at right is used in case of power failure

there is direct access to transmission and reception facilities.

As a result of extensive research and development after 1920, machines of the sorts here described have undergone considerable improvement, and further progress in written-cryptocommunications technology appears to lie in this direction.

Signal Intelligence.—The principal components of signal intelligence are: (1) communication intelligence, derived from the interception and analysis of signals which are involved in the exchange of messages or communications between persons and which are therefore of the type designated as communication signals; and (2) electronic intelligence, derived from the interception and analysis of electromagnetic radiations which are of a type other than those used in communications, such as radar, identification and recognition signals, navigational beacons, etc., and which are therefore designated as noncommunication signals. It should be noted, however, that it is often difficult to draw a line of demarcation between communication intelligence and electronic intelligence because these two fields deal with signals which merge into each other in the continuous spectrum generally referred to as that pertaining to communications electronics. (*See* SIGNAL COMMUNICATION.)

Communication Intelligence.—This phase of cryptology deals with the processes, methods or means employed in deriving information by intercepting and analyzing enemy communications. Its principal components are: (1) interception and forwarding of traffic (messages) to analysis centres; (2) traffic analysis, including radio direction or position finding and operator identification; and (3) cryptanalysis or solution (and translation, when necessary) of the texts of the messages. Only the last two components will be discussed.

Traffic Analysis.—Stated in general terms, traffic analysis involves studying the messages exchanged within a communications network for the purpose of penetrating the signal security camouflage superimposed thereon.

Such study permits reconstructing the networks from data such as volume, direction and routing of messages, frequencies, schedules and call signs used, etc. When the most important features of the networks have been thus ascertained, the analyst is not only able to ascertain the geographic locations and dispositions of military units (order of battle) and important movements of these units, but also to predict with varying degrees of reliability (based upon inferences) the area and extent of future military tactical or strategic operations.

Cryptanalysis.—The science of solving cryptograms by analysis is called cryptanalysis, to distinguish the indirect methods of reading cryptograms from the direct methods which, of course, require a knowledge of the basic method and specific key, in the case of ciphers, or possession of the codebook, in the case of codes. Apart from the more simple, classical types, nearly every scientifically constructed cryptographic system presents a unique case in cryptanalysis, the unraveling of which requires the exercise of unusual powers of observation, inductive and deductive reasoning, much concentration, perseverance and a vivid imagination; but all these qualities are of little avail without a special aptitude arising from extensive practical experience. It is worthwhile to note that the resistance which a specific cryptosystem will have against cryptanalysis is often vitally affected by the sophistication of the rules for its use and by the degree to which these rules are observed by cipher clerks. In respect to the latter, Francis Bacon's comment in his *Of the Advancement of Learning* (1605) is as true today as the day it was written: "But in regarde of the rawnesse and unskillfulnesse of the hands, through which they passe, the greatest Matters, are many times carryed in the weakest cyphars."

A preliminary requisite to the analysis of a cryptogram is a determination of the language in which its plain text is written, information which is either already at hand in the case of official communications or which, in the case of private ones, can usually be obtained from extraneous circumstances. Next comes a determination as to whether a cipher or a code system is involved; this is based upon the fact that differences in their external appearance are usually sufficiently well marked to be detectable. If the cryptogram is in cipher, the next step is to determine whether transposition or substitution is involved. This determination is made on the basis of the fact that in plain text the vowels and consonants are present in definite proportions. Since transposition involves only a rearrangement of the original letters, it follows that if a cryptogram contains vowels and consonants in the proportions normally found in plain text in the language in question, it is of the transposition class; if not, it is of the substitution class. The solution of transposition ciphers involves much experimentation with matrices of various types and dimensions, clues to which are afforded by the number of letters in the messages and extraneous circumstances. The assumption of the presence of probable words is often necessary. Special methods of solution based upon a study of messages of identical lengths, or with identical beginnings or endings, are often possible to apply when much traffic has been intercepted. Finally, the presence of letters which individually are of low frequency but which when present have a great affinity for each other and form pairs of moderate or high frequency, such as *qu* in Spanish or *ch* in German, afford clues leading to solution.

The basis upon which the solution of practically all substitution ciphers rests is the well-known fact that every written alphabetic language manifests a high degree of constancy in the relative frequencies with which its individual letters and combinations of letters are employed. For example, English telegraphic texts show the following relative frequencies in 1,000 letters, based upon an actual count of 100,000 letters appearing in a large but miscellaneous assortment of telegrams of a commercial and governmental nature, but all in plain language:

E	T	R	I	N	O	A	S	D	L	C	H	F
126	90	83	76	76	74	72	58	40	36	33	33	30
U	P	M	Y	G	W	V	B	X	K	Q	J	Z
30	27	25	21	18	14	13	11	5	3	3	2	1

These characteristic relative frequencies serve as a basis for identifying the plain-text values of the cipher letters, but only when the cipher has been reduced to its simplest terms. Thus the problem of solving a monoalphabetic substitution cipher involves only one step, since the text is already in the simplest possible terms, and regardless of the kind of cipher alphabet employed practically every example of 25 or more characters representing the monoalphabetic encipherment of a "sensible" message in English can readily be solved by the well-known principles of frequency, made popular by Edgar Allan Poe's romantic tale *The Gold Bug*. How-

ever, the problem of solving a polyalphabetic substitution cipher involves three principal steps: (1) determining the number of cipher alphabets involved; (2) distributing the cipher letters into the respective individual frequency tables to which they belong; and (3) analyzing each of the latter on the basis of normal frequencies in plain text of the language involved. In the case of aperiodic ciphers, because of the absence of cyclic phenomena, these steps are often very difficult, especially when the volume of text is limited. Frequently the only recourse is to employ repetitions as a basis for superimposing separate messages so that, irrespective of the number of alphabets involved or their sequence, the letters pertaining to identical cipher alphabets fall into the same columns, and then the respective columns are treated as monoalphabetic frequency tables. The analysis of the frequency distributions of a polyalphabetic cipher is effected much more readily when the alphabets are interrelated than when they are independent.

The question as to whether an absolutely unsolvable cipher system can be devised is of more interest to laymen than to professional cryptographers. Edgar Allan Poe's dictum that "it may be roundly asserted that human ingenuity cannot concoct a cipher which human ingenuity cannot resolve" is misleading unless qualified by restricting its application to the great majority of the practical systems employed for a voluminous, regular correspondence. Isolated short cryptograms prepared by certain methods may resist solution indefinitely; and a letter-for-letter cipher system which employs, once and only once, a keying sequence composed of characters or elements in a random and entirely unpredictable sequence may be considered holocryptic, that is, messages in such a system cannot be read by indirect processes involving cryptanalysis, but only by direct processes involving possession of the key or keys, obtained either legitimately, by virtue of being among the intended communicators, or by stealth.

History.—It may as well be stated at the outset that at mid-20th century there did not exist in any language a detailed, authentic and publicly available history of cryptology. Moreover, because of the curtain of secrecy which is invariably placed around cryptologic work of an official character, accurate accounts of historically important events or of noteworthy inventions and improvements in cryptologic technology usually enter into the public domain only many years after the event or invention has occurred. Therefore, although it is difficult or impossible to ascertain with certainty much about the origin of any specific item or fact of cryptographic or cryptanalytic importance, the data should be traced back at least as far as the open or public records will permit.

With this limitation kept in mind, this account will begin by noting that secret modes of signaling and communication have probably been in use from the earliest times, since the desire or need for secrecy in communication is certainly as old or nearly as old as the art of writing itself. However, mysteries such as the prophetic and apocalyptic writings of the orient and the sayings of the Sibylline oracles are generally not regarded by cryptologists as coming within their province; nor do they generally do anything more than merely refer to the various systems of stenography or shorthand used since the time of the Romans, including that known as Tironian notes, named after Tullius Tiro, Cicero's learned freedman and friend, who elaborated a system which was popular for almost 1,000 years. Although it is valid to assume that cryptography was used by all of the peoples of antiquity, the assumption has been confirmed in the case of Egyptian hieroglyphic writing by the outcome of studies which were begun by Jean François Champollion and which culminated in 1932, disclosing that not one but three different sorts or degrees of cryptography were actually used by the ancient Egyptians. Cryptography was practised among the ancient Jews, whose Talmudic scholars dealt with it as a part or phase of their Cabala, which includes certain operations of a cryptographic nature. The ancient Greeks were users of the art, and at least one cryptographic device, called the scytale, is known to have been employed by the Lacedemonians for secret communications between military commanders in the field and their superiors at home.

Aeneas Tacticus (4th century B.C.) wrote the very earliest treatise on cryptography thus far discovered; in addition to treating of secret dispatches, it contains a description of a cipher disk, a detailed explanation of which cannot here be included. Numerous ancient Greek documents exist which are either partially or wholly in cipher; and one cipher alphabet found therein has been traced back to the 9th century A.D. Despite the fact that Roman cryptographic documents are rather rare, it is well known that the Romans used ciphers, for there are numerous references to those which Caesar and Augustus employed. In fact, the name Caesar is often used in cryptologic literature to designate the type of cipher alphabet and cipher system known as the monoalphabetic cipher using standard alphabets. In the middle ages (*c.* 450–1450) cryptography was employed rather infrequently, for the most part in connection with the pseudo sciences of alchemy and astrology. The most widespread cryptographic system of that period corresponds to that used by the Roman emperor Augustus, in which a letter was merely replaced by the one following it in the normal alphabet (but z was replaced by aa). Most often, however, only certain letters were thus replaced, sometimes only the vowels.

The beginnings of modern cryptography can be traced back to Italy, the birthplace, as well, of modern diplomacy. Many cipher alphabets have come down to us which were used in the official messages of the papacy as well as in those of the early Italian republics. Ciphers were used in Venice as far back as in 1226; in Mantua and in Modena as early as 1305; and in Lucca, Florence, Siena, Pisa and Milan before 1450. It was also in Italy, beginning soon after 1500, that cryptologic operations first came to be organized on an effective basis. The invention of new cipher systems was promoted, and reserves of cryptographic vocabularies were prepared and kept in readiness for prompt issue as replacements for old or compromised ones. The earliest extant piece of work of a cryptographic nature is a small manual or compilation of the ciphers used about 1379 by Gabriel de Lavinde of Parma and preserved in the Vatican archives. In these ciphers all the letters were represented by arbitrary symbols, and the vowels were treated no differently than the consonants in regard to the number of equivalents assigned them. However, some of these ciphers included nulls and others included brief lists of words and proper nouns, compilations first called nomenclators, then repertories and, later, small codes. By 1400 it had become apparent that each of the vowels should have more than a single cipher equivalent, and there is a record of a cipher system involving a reversed standard alphabet with three different supplementary symbols as variants for each vowel. By the 15th century, according to Aloys Meister, Italian cryptography had been elaborated to the point where "three to six different symbols could be used to represent a single letter of the alphabet, the individual syllables—arranged alphabetically for this purpose, ba, be, bi, bo, bu, ca, ce, ci, etc.—had specific cipher equivalents, and an ever increasing number of complete words were incorporated into the nomenclators. Their abundance in content became so great that it was possible to fill a lengthy alphabetic index with the special equivalents for syllables and words. . . ." The first complete cipher, *i.e.*, one containing arbitrary symbols for each of the letters and variants for the vowels as well as nulls and a nomenclator, is exemplified by a Venetian cipher of 1411 cited by Luigi Pasini. In the first half of the 15th century, after some further expansion in content, nomenclators attained such a state of development and practical utility that they remained for centuries the prototype of the diplomatic repertories used by nearly all European governments, as well as by that of the young and rapidly growing republic in the western hemisphere, the United States.

Before continuing the account of cryptosystems of this sort, it may be well to direct attention to the invention and development of another cryptosystem which, originating in the very simple devices of the ancients, culminated some time during the 16th century in the so-called *chiffre indéchiffrable* ("the indecipherable cipher"), often referred to as the Vigenère cipher (fig. 4). It should be noted, however, that Vigenère's description of the cipher differs decidedly from the form usually ascribed to

him and presents an essentially more difficult problem to the cryptanalyst, that Vigenère nowhere speaks of the cipher as the *chiffre indéchiffrable par excellence* and that, except for an autokeying principle, Vigenère lays no claim to having originated the cipher.

Despite the much advertised virtues and security of the Vigenère cipher, practical cryptographers and cryptanalysts tended to put their faith rather in the older nomenclators and repertories, and it is therefore necessary to turn once more to these cryptoaids and follow their progress.

The repertories used by France in the 16th century under Louis XIII and Louis XIV underwent important improvement with the introduction of an innovation which is now called the randomized or two-part arrangement of contents, illustrated in fig. 7. This improvement also soon found its way into the official cryptography of England and other countries. The repertories used by the papal court in the same century incorporated an additional new feature, that of making some or all of the cipher characters represent two or more different letters. After attaining this fairly advanced state of development, European cryptography went into a decline that reached its lowest level under Napoleon I; it is possible that one of the factors leading to the disaster which overtook him in Russia was the solution by the Russians of intercepted French ciphers. After the middle of the 19th century, stimulated perhaps by the spreading use of electromagnetic telegraphy, there came an expansion in the content of repertories, soon to be called codes. By the end of that century large codes containing 100,000 or more words and phrases were compiled not only for governmental but also for commercial communications. In such codes, of course, the length of the code equivalents had to be increased too, and code groups came to be composed, first, of groups of figures or of bona fide dictionary words, then of artificial words and, later, of five-letter groups constructed scientifically so as to obtain the maximum not only in economy in cost of transmission but also in efficiency in the correction of transmission errors. For another 75 years, beginning about 1860, the cryptoprinciples embodied in the early nomenclators but now expanded into large codes were the ones preferred for diplomatic and commercial cryptocommunications; literal or letter-for-letter ciphers were used only rarely for such communications. On the other hand, for military cryptocommunications, cipher systems of the latter type were preferred, except for high-level or strategic communications. In the U.S., during the Civil War (1861–65), the Federal army employed small repertories in connection with word transposition, the so-called route cipher. The Confederate army used the Vigenère cipher—which the Federal army cryptanalysts are said to have been able to solve every time a message in it was intercepted.

During the first two years of World War I, cipher systems were used almost to the exclusion of code systems by all belligerents for protecting tactical communications in the field of operations, although code systems continued to be used for diplomatic and high-level strategic military cryptocommunications. By 1917, however, codes came to be used for the secret communications of the smaller and intermediate-size military formations. The extent of their vocabularies varied with the size of the unit, so that the code for communications between large units might contain 10,000 words and phrases, whereas that for communications between small units might contain only a few hundred or less. After about 1925 the direction of development and improvement in governmental cryptocommunications tended to explore and exploit the possibilities of automatic cipher machines, as indicated earlier in this article, and this took place in all types of secret communications: diplomatic, military, naval, air, etc. This change in direction of evolution and development of cryptosystems, code systems giving way to cipher systems in practical cryptocommunications where secrecy is the primary consideration, is only an obvious result, in the field of communications, of the increased tempo of mechanization in all fields since the beginning of the 20th century. Cipher systems, the units of which are generally single letters, lend themselves much more readily to mechanization than do code systems, the units of which are generally complete words and often long phrases or sentences, because the number and lengths of different permutations and combinations of electrical signals needed to represent the relatively small number of different basic units of a written alphabetic language (in English 26 letters) are very much smaller than the number and lengths of different permutations and combinations that would be required to represent the large number of different words in such a language, not to mention long phrases and sentences.

This brief account of technological developments in cryptography has its counterpart in cryptanalysis, but if it is difficult to ascertain with certainty data concerning the origin of any specific cryptosystem because of the veil of secrecy already mentioned, it is almost impossible to ascertain with certainty by whom, where or when a specific cryptanalytic principle or process was first conceived or employed. The veil in this area becomes an almost impenetrable curtain, so that it is certainly valid to assume that news of cryptanalytic success or of the invention of a new technique becomes public only many years after the events or, perhaps, never.

Under these circumstances one hardly expects to find a historical account of the very first success in cryptanalysis, but the earliest brochure on record dealing with cryptanalytic theory is that of Leon Battista Alberti, whose *Trattati in cifra*, written between 1467 and 1472, deals not only with cryptanalytic theories and processes but also with cryptography and statistical data. It is, therefore, the oldest treatise on cryptology in existence. The brief treatise of Sicco Simonetta, a cryptanalyst of the Sforzas at the court of Milan, which is dated July 4, 1474, and which is a strictly practical guide to cryptanalytic procedures, is the oldest treatise in the world purely devoted to cryptanalysis. Beginning about 1506 and until 1539 another Italian professional cryptanalyst, Giovanni Soro, devoted his leisure hours to the preparation of a treatise which has never been found. As was the case with cryptography, so on the cryptanalytic side the activities in the various small Italian republics and the papacy came to be organized as serious enterprises. In order to protect these activities against indiscretions or leakage, the principles of secrecy and security were firmly established and willful violations were treated as capital offenses. The development of technical skill was rewarded, and instruction in cryptanalysis was often carried on from one generation to the next in the same family. But, as in the cryptographic field so in the cryptanalytic field, there have been periods of progression and retrogression in technology. However, after about 1930 cryptanalytic technology progressed rather notably. The mechanization which affected cryptography also affected cryptanalysis, and the invention and development or improvement of machines to aid in or speed up the tedious processes usually involved in the solution of complex cryptosystems exercised an important effect upon the standards by which cryptosecurity had to be measured.

The foregoing is a brief history of technological developments in cryptology. Nothing has yet been said about the usually very secret but quite important roles which poor cryptography or good cryptanalysis have played in international relations, both in peace and war, and in respect to both diplomatic and military affairs. As already stated, the historical accounts of these instances usually lag many years behind the events to which they relate. But in at least one case in modern history the revelation of the spectacular role played by cryptology in diplomacy and warfare took place not very long after the event. Hearings held in Washington, D.C., 1945–46, by the joint committee on the investigation of the Pearl Harbor attack, made it clear that shortly before and during World War II U.S. cryptanalysts had considerable success in solving Japanese codes and ciphers, success indeed to the extent that it was possible for the committee to state that all witnesses familiar with the intelligence produced "have testified that it contributed enormously to the defeat of the enemy, greatly shortened the war, and saved many thousands of lives." For other instances the reader must consult some of the books listed in the bibliography, but not many will be found that pertain to relatively recent history.

BIBLIOGRAPHY.—Although no comprehensive and authentic history of cryptology had been published by the 1950s, there does exist a comprehensive and scholarly bibliography covering practically all publicly available books and important papers on the subject: Joseph S. Galland, *An Historical and Analytical Bibliography of the Literature of Cryptology* (1945). Such a compilation is more helpful to specialists than to the general reader, therefore, a selection of items from the Galland bibliography may be useful. Also, after 1945 there were published a few items of importance which should be mentioned herein. Modern works worthy of special mention are as follows: André Lange and E.-A. Soudart, *Traité de cryptographie* (1925); Marcel Givierge, *Cours de cryptographie* (1925); Roger Baudouin, *Éléments de cryptographie* (1939); H. F. Gaines, *Elementary Cryptanalysis* (1939); Luigi Sacco, *Manuale de crittografia*, 3rd ed. (1947); Charles Eyraud, *Precis de cryptographie moderne* (1953). (W. F. F.)

CRYPTOMERIA, a genus of conifers native to Japan and containing a single species, *C. japonica*, known as cryptomeria, Japanese cedar or sugi. It is one of the finest of Japanese evergreen trees, the reddish-brown trunk reaching a height of 100 or more feet, usually divested of branches along the lower part and crowned with a conical head. The narrow, pointed leaves are spirally arranged and persist for four or five years; the cones are small, globose and borne at the ends of the branchlets; the scales are thickened at the extremity and divided into sharply pointed lobes; three to five seeds are borne on each scale. *Cryptomeria* is extensively used in Japan for reforesting denuded lands, as it is a valuable timber tree; it is also planted in temple gardens and along avenues. Many curious varieties have been obtained by Japanese horticulturists, including dwarf forms a few feet in height. Outside its native habitat cryptomeria often turns from its normal bluish-green to a bronzy colour during winter; it requires a deep, well-drained soil with plenty of moisture, and protection from cold winds.

CRYSTALLITE, a name given by Hermann Vogelsang in 1875 to the microscopic bodies occurring in many glassy igneous rocks, such as obsidian, pitchstone and tachylyte (*qq.v.*). Though possessing no distinct reaction under polarized light and often no recognizable crystallographic form, they are regarded as incipient crystals. The larger bodies, often with good crystal form and evident double refraction, are termed microlites.

According to their shape and structural arrangement crystallites are subdivided into globulites (small globules), margarites (coalescing globules arranged in rows), cumulites (cloudy aggregate of globules) and globospherites (groups of globulites with a radiate arrangement). Other crystallites assume threadlike forms (trichites) or appear as elongated cylinders or rods (longulites, belonites, baculites). When sufficiently large to be recognizable as mineral species (microlites) they can usually be classified as feldspar, pyroxene, amphibole or iron oxides. Acicular or needlelike microlites bearing divergent arborescent branches are termed scopulites.

The pitchstones of Arran are known for the variety and beauty of their crystallite and microlite constituents (amphibole). In the basaltic glasses of the Hawaiian Islands similar growths are formed of pyroxene.

CRYSTALLIZATION, the art of obtaining a substance in the form of crystals. It is an important process in chemistry, since it permits the purification of a substance or the separation of the constituents of a mixture. Generally a substance is more soluble in a solvent at a high temperature than at a low one, and consequently, if a boiling strong solution be allowed to cool, the substance will separate in virtue of the diminished solubility. The slower the cooling the larger and more perfect will be the crystals formed.

If, as sometimes occurs, such a solution refuses to crystallize, the expedient of "inoculating" the solution with a minute crystal of the same substance, or with a similar substance, may be adopted; shaking the solution or adding a drop of another solvent may also occasion the desired result. "Fractional crystallization" consists in repeatedly partially crystallizing the salt content of a solution so as to separate the substances of different solubilities.

Crystallization is also an important process in mineralogy. Most minerals are the product of crystallization, formed by the solidification of an element, compound or mixture under favourable conditions from a molten, liquid or gaseous state, or by solid-state crystallization. The process may be incomplete, as in crystallite (*q.v.*), or the product of solidification may be noncrystalline, as in glass (*q.v.*). For discussion of crystallization and crystallization processes *see* PETROLOGY, especially the section on *Petrographical Provinces. See* also GEOCHEMISTRY: *Geochemistry of the Lithosphere;* MINERALOGY; SEDIMENTARY ROCKS. For specific information the reader is referred to the separate articles on kinds of rocks, such as DOLOMITE and SCHIST, and on mineral species, such as QUARTZ, and on groups, such as FELDSPAR.

A special application of crystallization is to be found in the manufacture of artificial rubies and other gem stones, primarily by a flame-fusion process developed by A. Verneuil (*see* GEM: *Synthetic Gems*). The study of crystals and crystallization is a special field dealt with in the article CRYSTALLOGRAPHY.

CRYSTALLOGRAPHY. Matter exists in three main varieties—the gaseous state, the liquid state and the solid state. Solid matter in which the atoms, molecules or ions are arranged in a regularly repeating pattern throughout is said to be crystalline; all other solid matter is said to be amorphous (noncrystalline), although the distinction is not always sharp. Practically all metals, minerals and alloys are crystalline, while glasses, plastics, ceramics and gels are amorphous. A single piece of crystalline matter is called a crystal. (In the electronics industry the word "crystal" is usually restricted in meaning to a crystalline substance that exhibits the piezoelectric effect; *e.g.*, quartz [*see* PIEZOELECTRICITY].) Crystallography is the science of crystals and of the crystalline state. Since most solid matter is crystalline, the properties of crystals are to a large extent also the properties of ordinary solid materials.

The topics discussed in this article are outlined below. A number of these topics involve some rather difficult concepts, and the reader who possesses no knowledge of solid state physics (*q.v.*) would be well advised to read that article first. The optical properties of crystals are treated in detail in the final section of the present article; other physical properties and related information on crystal science are covered elsewhere (*see* ALLOYS; CRYSTALS, DISLOCATIONS OF; ELASTICITY; ELECTRICITY, CONDUCTION OF: *Conduction in Solids;* HEAT: *Conduction of Heat in Solids;* INTERMETALLIC COMPOUNDS; LUMINESCENCE; MAGNETISM; METALLURGY; METAL; MINERALOGY; X-RAYS).

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(M. J. Bu.)

I. INTRODUCTION

The feature that distinguishes matter in the crystalline state from the same matter in the liquid or gaseous state is that in the crystalline state matter is ordered in a certain geometrical way, while in the liquid and gaseous states it lacks this order. The crystalline state is thus the ordered state of matter—a fact which endows it with special properties that are of utmost importance in physics, chemistry, mineralogy, metallurgy and even in biology.

Crystallography may be said to have made a start as a science in 1669 when the Danish physician Nicolaus Steno discovered that, although quartz crystals may differ in appearance from one another, the angles between corresponding faces are always the same. Steno's findings were confirmed in 1772 by J. B. L. Romé de Lisle, who further noted that these interfacial angles are characteristic of the substance. In 1774 René Just Haüy published the book *Essai d'une théorie sur la structure des cristaux,* in which he showed that the known interfacial angles of crystals could be accounted for if the crystal were made up of units which correspond to the present-day unit cells. He explained not only crystal faces but also symmetry and cleavage on this basis. Because Haüy proposed this essentially correct basis of crystal structure, he is usually regarded as the father of crystallography.

Few fields of science changed more in the first half of the 20th century than did crystallography, and none so extended the range of its application. Before 1912, when Max von Laue's discovery of X-ray diffraction provided the key to the inner structure of crystals, virtually nothing was known of the arrangements of atoms in solid matter. The methods of chemistry could be applied to solids only after the solids had been melted, vaporized or brought into solution. Even the science of crystallography itself had not progressed farther than measuring and registering the external faces of crystals. Its function was mainly that of identifying and classifying minerals, and crystallography was regarded as a branch of mineralogy. Knowledge of the properties of solids was a matter of practical testing without a clue as to the underlying reasons and therefore without the possibility of changing the properties except by repeated variations and trials. Sir Arthur Eddington could remark quite truly in 1927 that more was known about the interior of a star than about the interior of a table.

Later the situation was entirely transformed. As a result of new diffraction methods it became possible to determine the molecular structure of any kind of solid, whether crystalline or not, and even to determine something of the structure of liquids. The results of these analyses, begun by Sir William H. Bragg and his son Sir Lawrence Bragg, and carried on by armies of research workers in nearly every country in the world, soon had the effect of transforming many of the ideas of chemistry and mineralogy and notably influencing geology and biology. In industry the practical applications were quite as marked, particularly in metallurgy, where X-ray diffraction became as essential a tool as the microscope, and in the new industries of artificial fibres and plastics. Indeed, as there is practically no industry where the properties of solids does not play a part, the range of utility of the new crystallography, after it had shown its powers in practice, rapidly increased.

The knowledge of the precise ways atoms are arranged in crystals—their distance apart, the form of the regular geometrical patterns they make in space—gave many new qualitative and quantitative data to chemistry. The sizes of the different atoms and the lengths of the bonds joining them were revealed. The new crystallography furnished a microscope which, in competent hands, could discern molecules, atoms and even the distribution of electrons. These data were a valuable adjunct to the quantum theory in the reinterpretation of chemical formulas and in the establishment of new ones. Inorganic chemistry—the chemistry of acids, bases and salts—was largely rewritten in terms of ions (electrically charged atoms). The complexities of mineral chemistry, particularly of the silicates (which constitute the bulk of the earth's crust), were unraveled as a result of crystallography. The science of geochemistry, which offers clues to the distribution of minerals in the earth, was largely built on a basis of crystal structures.

Even greater was the contribution of crystallography to metallurgy. The composition of metals and alloys seemed to defy all the rules of chemistry. New rules were found for their composition in terms of relatively simple crystal structures. These same structures explained for the first time the plastic properties of metals that enable them to be rolled and drawn, as well as the inner mechanism of many age-old processes such as annealing and tempering.

In biology, X-ray techniques revealed the fine structures of tissues which were beyond the range of the optical microscope or even of the electron microscope. Although these studies are extremely complex, already much is known of the structure of hard tissues—cell walls, hair, skin and tendons—and a start has been made on the major problem of protein structure.

II. TRANSLATIONAL ORDER IN CRYSTALS

A pure chemical substance can be regarded as made up of an aggregate of chemical units of the same kind. In some cases, especially in organic compounds, these units are molecules. From this point of view, every pure chemical substance can be regarded as a collection of copies of some model cluster of atoms. These copies have no special geometrical order in the gaseous or liquid state, but in the crystalline state the copies are arranged in space as if all were derived from some arbitrarily chosen model cluster by a simple geometrical operation repeated again and again. While crystals of various substances differ among themselves as to which geometrical operations appear to repeat the cluster, they all have in common one simple type of repetition; namely, periodic repetition by translations. An example of this kind of repetition, using an arbitrary motif, is shown in fig. 1(A). It is evident that

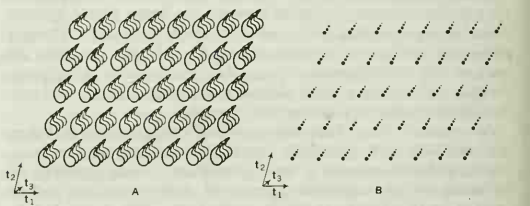

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FIG. 1.—(A) PATTERN PRODUCED BY PERIODIC REPETITION IN THREE DIMENSIONS AND DEFINED BY TRANSLATIONS $\mathbf{t}_1$, $\mathbf{t}_2$ AND $\mathbf{t}_3$; (B) THREE-DIMENSIONAL LATTICE OF PATTERN IN (A)

fig. 1(A) shows a periodic pattern in which the motif is a comma. All commas can be thought of as copies of any particular comma, which may be arbitrarily regarded as the original model for all others. If this view is adopted, any comma may be thought of as derived from the original model by moving it to new locations, making repeated use only of the three translations $\mathbf{t}_1$, $\mathbf{t}_2$ and $\mathbf{t}_3$, which can be regarded as vectors. Thus, if the comma at the lower left-hand forward point is regarded as the original prototype, any comma in the lower forward row can be thought of as derived from it by using a translation

$$\mathbf{T} = u\mathbf{t}_1 \tag{1}$$

where $\mathbf{t}_1$ is the vector shown in the diagram, and u is an integer. By generalization, any comma at any position in the pattern can be derived from the lower left-hand forward one by application of a translation $\mathbf{T}$ having components given by

$$\mathbf{T} = u\mathbf{t}_1 + v\mathbf{t}_2 + w\mathbf{t}_3 \tag{2}$$

where u, v and w are appropriate integers.

1. Lattices and Cells.—All crystals have at least this kind of order, which can be described as a periodic repetition of their atomic chemical motif by translations. It is convenient to divorce this kind of repetition from the nature of the motif. This can be done by representing the motif by a point. With this simplification, the chief characteristic of the repetition can be represented by a collection of points repeated from some original point.

This is illustrated in fig. 1(B). This collection of periodically translated points is called a lattice, or sometimes, more specifically, a space lattice if the translations embrace three dimensions, as in (2). A lattice is a collection of periodically translated points; it is a shorthand way of representing and visualizing periodic repetition by translation. Given a lattice, if any motif is imagined as placed at a lattice point, the motif appears in a corresponding position at all lattice points, and in the same orientation.

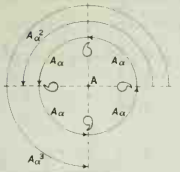

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FIG. 2.—REPETITION BY A PERIODICALLY REPEATED ROTATION THROUGH ANGLE α ABOUT AXIS A

The three translations, $\mathbf{t}_1$, $\mathbf{t}_2$ and $\mathbf{t}_3$, of (2) and fig. 1 determine three edges of a parallelepiped. This parallelepiped has a volume which contains one motif (or its equivalent). The parallelepiped, including its contained motif, is repeated by the lattice to become the entire crystal. The parallelepiped is called a *cell*, in particular a *primitive cell*, because it contains the volume of one motif which, repeated by the translations, reproduces the crystal. Multiple cells, which contain several motifs, can also be defined, and such cells are useful in certain cases to be noted later.

2. Indices of Points, Lines and Planes.—The edges of the cell constitute an excellent co-ordinate system for describing the geometry of the crystal. Any point in the lattice can be reached by the translations described by (2). A lattice point is said to have indices $u\ v\ w$. Since three integers are used for many kinds of representation in crystallography, the indices of a point may be distinguished by placing them between centred dots, thus, $\cdot u\ v\ w\cdot$ (for example, ·153·).

The line which runs from the origin to a point $\cdot u\ v\ w\cdot$ fixes a direction in a crystal. The three integers in (2) uniquely define the direction of **T**, and are called the indices of the direction. To distinguish the indices of a direction from other indices, the former are enclosed in brackets, thus, $[u\ v\ w]$; for example, [1 5 3] is the direction from the origin, ·0 0 0·, to the point ·1 5 3·.

A plane can also be represented by three indices. These are placed between parentheses, thus, (hkl); for example, (123). The indices of a plane, called the Miller indices after William Hallowes Miller (1839), are derived from the intercept form of the equation of a plane. In particular, the equation of a plane can be written

$$\frac{x}{1/h}+\frac{y}{1/k}+\frac{z}{1/l}=1 \qquad (3)$$

The denominators on the left of (3) are the intercepts of the plane. The plane evidently intercepts the axes of x, y and z at $1/h$, $1/k$ and $1/l$ units; that is, it cuts the unit of x into h parts, the unit of y into k parts, and the unit of z into l parts. The directions and units of x, y and z are the edges $\mathbf{t}_1$, $\mathbf{t}_2$ and $\mathbf{t}_3$, respectively, of the cell.

3. Rational and Irrational Geometrical Features.—Geometrical features of a crystal which are defined by lattice points are said to be rational. Thus, in (2), if u, v and w are integers, the point $\cdot uvw\cdot$ is a lattice point, and the direction $[uvw]$ not only starts at the origin lattice point ·000· but extends to the lattice point $\cdot uvw\cdot$. It therefore encounters lattice points periodically at intervals **T** of (2). Similarly it can be shown that the plane (hkl) contains lattice points periodically arranged on its surface if h, k and l are integers. Geometrical features that are not so defined by lattice points are said to be irrational. Thus, if a point, line or plane contains no lattice point, it is irrational. A line or plane is also irrational if it contains only one lattice point, and a plane is also irrational if it contains only one line of lattice points.

III. ROTATIONAL ORDER IN CRYSTALS

It was seen above that a motif can be repeated by translation to form a periodic pattern. It can also be repeated to form another kind of periodic pattern by rotating it about an axis, and repeating it periodically after turning through some angle, as shown in fig. 2. This repetition is obviously cyclical, and its end must coincide with the beginning. This restricts the angular period of $2\pi/n$, where n is an integer. Furthermore, it is found that, when the requirements of translational repetition are considered in connection with angular repetition, the angular frequency n, per cycle, is restricted to 1, 2, 3, 4 and 6.

1. Symmetry.—The whole set of n features comprises an n-fold repetition of the same feature. The set is said to be symmetrical with respect to an n-fold axis of symmetry. The conclusions of the preceding section can be restated thus: only 1-fold, 2-fold, 3-fold, 4-fold and 6-fold axes of symmetry are permitted to crystals. In writing, these kinds of axes are recognized by the labels 1, 2, 3, 4 and 6, respectively. In illustrations, the trivial 1-fold axis is not represented by a symbol, but the others are represented by the following symbols placed normal to the axis:

2-fold: ⬯
3-fold: △
4-fold: □
6-fold: ⬡

These cases of pure angular symmetry are called proper rotation

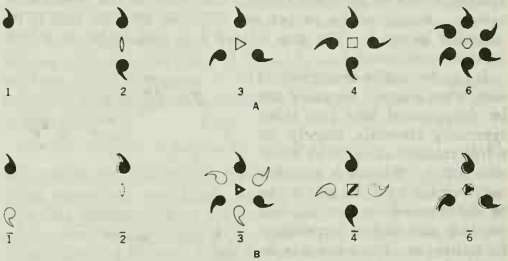

FIG. 3.—(A) PLAN VIEW OF THE REPETITIONS OF A COMMA BY AXES OF 1-, 2-, 3-, 4- AND 6-FOLD SYMMETRY; (B) PLAN VIEW OF THE REPETITIONS OF A COMMA BY AXES OF $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$ AND $\bar{6}$ SYMMETRY. SHADED COMMAS ARE ABOVE PLANE OF THE PAGE, UNSHADED ONES ARE AN EQUAL DISTANCE BELOW

axes, and are illustrated in fig. 3.

A general name for a geometrical feature which describes the symmetry of an object is symmetry element. The proper rotation axes are examples of symmetry elements, as also are the mirror, the inversion centre and the improper rotation axes introduced below.

2. Enantiomorphous Objects.—In three-dimensional space, an unsymmetrical geometrical object can assume two related shapes, ordinarily called right-handed (dextro) and left-handed (levo) shapes. These two shapes are said to be enantiomorphous with each other, and each is an enantiomorph of the other (*see* STEREOCHEMISTRY: *General Discussion of Stereoisomerism*). In three-dimensional space, two enantiomorphous shapes can be transformed into one another in only two distinct ways:

1. Reflection in a mirror (fig. 4[A]). For example, let the co-

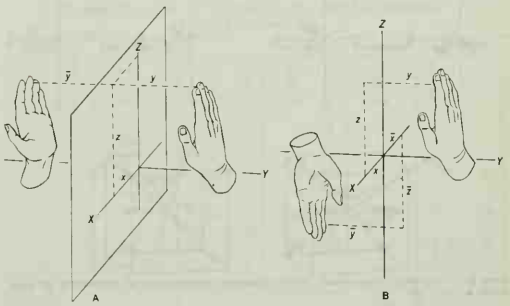

FIG. 4.—(A) REPETITION BY REFLECTION IN A MIRROR; (B) REPETITION BY INVERSION THROUGH A CENTRE

ordinates x and z be taken in the mirror, and the co-ordinate y be taken normal to it. Then if a point has co-ordinates xyz in one enantiomorph, the corresponding point has co-ordinates $x\bar{y}z$ in the other, where $\bar{y}$ is a crystallographic convention for $-y$.

2. Inversion through a point (fig. 4[B]). For example, let one enantiomorph be referred to a co-ordinate system with the origin at the point of inversion. Then if the co-ordinates of a point in one enantiomorph are xyz, the co-ordinates of the corresponding point in the other are $\bar{x}\bar{y}\bar{z}$.

3. Axes of Improper Symmetry.—If some unsymmetrical object (which may arbitrarily be designated right-handed) is taken as an original motif, repetition of it can be either of the type RRRRRR . . . or of the type RLRLRL . . . (R and L are abbreviations for "right" and "left"), and in both cases the repetition can be regarded as periodic. If the repetition is angular, the objects RRRR . . . are related by a proper rotation axis, discussed above. If the sequence is RLRL . . . , the objects are said to be related by an improper rotation axis. An improper axis, $\bar{n}$, can be described as a rotation through $2\pi/n$ (to produce the rotation) combined with an inversion through the centre of the co-ordinate system. Repetition by proper and improper rotation axes is illustrated in fig. 3. The axis labeled $\bar{n}$ is said to be an n-fold rotoinversion axis.

It can be readily demonstrated that, when n is odd, an axis $\bar{n}$ can be decomposed into two other symmetry elements, namely, an n-fold rotation axis plus an inversion centre. When n is even but not divisible by 4, an axis $\bar{n}$ can be decomposed into an $n/2$-fold rotation axis plus a perpendicular mirror, m. But when n is divisible by 4, an axis $\bar{n}$ cannot be decomposed into simpler symmetry elements.

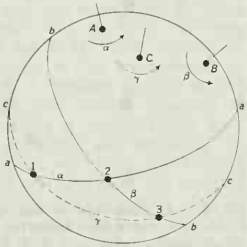

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FIG. 5.—RESULT OF COMBINING A ROTATION THROUGH ANGLE α ABOUT A WITH A ROTATION THROUGH ANGLE β ABOUT B. THE EQUATOR OF AXIS A IS aa, THAT OF B IS bb AND THAT OF C IS cc

4. Angular Combinations of Rotation Axes.—An initial motif can evidently be repeated by an n-fold axis A, as already discussed. It can simultaneously be repeated by another axis B, which makes an angle with A, as shown in fig. 5. But the illustration shows that a rotation about A followed by a rotation about B is equivalent to a rotation about some third axis C. If the angular periods about A, B and C are α, β and γ respectively, the angle $A \wedge B$ is given by

$$\cos A \wedge B = \frac{\cos\frac{\gamma}{2} + \cos\frac{\alpha}{2}\cos\frac{\beta}{2}}{\sin\frac{\alpha}{2}\sin\frac{\beta}{2}} \qquad (4)$$

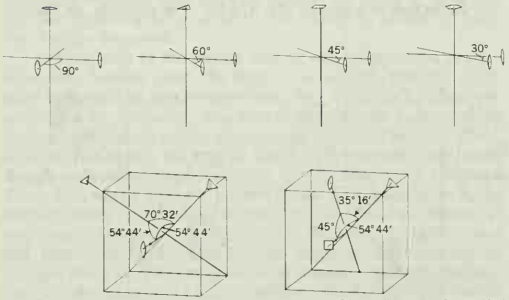

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FIG. 6.—THE SIX PERMISSIBLE NONTRIVIAL CRYSTALLOGRAPHIC COMBINATIONS OF ROTATIONS

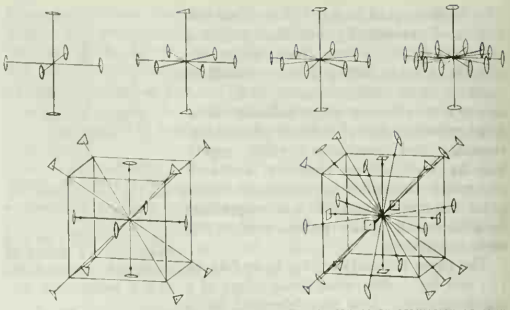

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FIG. 7.—THE SIX CRYSTALLOGRAPHIC AXIAL SYMMETRIES BASED UPON THE COMBINATIONS IN FIG. 6

Now for crystals, α, β and γ can only be $2\pi/n$, where n is 1, 2, 3, 4 or 6, as noted previously. If all these values are used systematically in (4), only six distinct nontrivial solutions are found. These are shown in fig. 6. When each of the axes in fig. 6 is allowed to repeat the others, the six sets of axes shown in fig. 7 are formed. If all rotational symmetries are tabulated, they are shown to contain the 11 combinations of axes given in Table I. It will be noted that there are two different combinations containing only 2-fold and 3-fold axes. In the customary label for the combination 322, the second 2 is omitted, giving 32, because it turns out that in this kind of combination the first and second 2 are transformed into one another by the other (odd-fold) axis. In the other combination, a somewhat similar degeneracy occurs, leaving only two symbols. The two combinations are conventionally distinguished by the order of the symbols, 32 and 23.

TABLE I.—*Possible Crystallographic Symmetries With Respect to Proper Rotation Axes*

Uncombined axes	Permissible combinations
1	
2	2 2 2
3	3 2 2 (called 3 2)
4	4 2 2
6	6 2 2
	2 3 3 (called 2 3)
	4 3 2

If improper axes are permitted in combinations such as discussed above, it can be readily shown that the only permissible simple combinations are those which contain an even number of improper axes. The only permissible combinations therefore conform to the type PPP (already discussed), PII, IPI or IIP (where P stands for a proper rotation axis and I for an improper one). Furthermore, a proper and improper axis of the same frequency n may be parallel: the symbol for this is written as a fraction, namely, $\frac{n}{\bar{n}}$. If all these combinations are examined, the 21 new permissible combinations shown in Table II are found.

5. The 32 Crystal Classes.—Table I lists the 11 symmetries involving only repetitions that are permissible to crystals not having enantiomorphous features; Table II lists the additional 21 symmetries permissible to crystals with enantiomorphous features. These $11 + 21 = 32$ symmetries are the only ones permitted to crystals in which rotational symmetries are involved. In 1830 Johann Friedrich Christian Hessel proved that crystals could have 32 kinds of symmetry, although only a few of these symmetries had been observed at that time.

Although these 32 symmetries constitute an intermediate result of symmetry theory, they are valuable in classifying crystals. The reason for this is that, while crystals contain translational repetitions as well as rotational ones, the translations are too small to be seen by eye. On the other hand, rotational symmetries are observable in the external appearances of crystals, as noted in

TABLE II.—*Permissible Crystallographic Symmetries Involving Improper Rotation Axes*

Uncombined axes	Combinations conforming to the type: $\frac{n}{\bar{n}}$	PII	IPI	IIP	PPP III
$\bar{1}$	$\left(\frac{1}{\bar{1}} = \bar{1}\right)$				
$\bar{2} = m$	$\frac{2}{2} = \frac{2}{m}$	$2\,\bar{2}\,\bar{2} = 2mm$			$\frac{2}{2}\,\frac{2}{\bar{2}}\,\frac{2}{\bar{2}} = \frac{2}{m}\,\frac{2}{m}\,\frac{2}{m}$
$\bar{3}$	$\left(\frac{3}{\bar{3}} = \bar{3}\right)$	$3\,\bar{2}(\bar{2}) = 3m$			$\frac{3}{3}\,\frac{2}{\bar{2}}\left(\frac{2}{\bar{2}}\right) = \bar{3}\,\frac{2}{m}$
$\bar{4}$	$\frac{4}{\bar{4}} = \frac{4}{m}$	$4\,\bar{2}\,\bar{2} = 4mm$	$\widehat{\bar{4}\,2\,\bar{2}} = \bar{4}\,2m$		$\frac{4}{\bar{4}}\,\frac{2}{\bar{2}}\,\frac{2}{\bar{2}} = \frac{4}{m}\,\frac{2}{m}\,\frac{2}{m}$
$\bar{6}$	$\frac{6}{\bar{6}} = \frac{6}{m}$	$6\,\bar{2}\,\bar{2} = 6mm$	$\widehat{6\,2\,\bar{2}} = \bar{6}\,2m$		$\frac{6}{\bar{6}}\,\frac{2}{\bar{2}}\,\frac{2}{\bar{2}} = \frac{6}{m}\,\frac{2}{m}\,\frac{2}{m}$
		$2\,\bar{3}\,(\bar{3}) \rightarrow 2\,\frac{3}{\bar{3}} \rightarrow \frac{2}{m}\bar{3}$			$\left(\frac{2}{2}\,\frac{3}{\bar{3}}\left(\frac{3}{\bar{3}}\right) = \frac{2}{m}\bar{3}\right)$
		$4\,\bar{3}\,\bar{2} = 4\,\frac{3}{\bar{3}}\,\frac{2}{m} \rightarrow \frac{4}{m}\,\bar{3}\,\frac{2}{m}$	$\bar{4}\,3\,\bar{2} = \bar{4}\,3m$	$\left(\bar{4}\,\bar{3}\,2 \rightarrow \bar{4}\,\frac{3}{\bar{3}}m = \frac{4}{m}\bar{3}\,\frac{2}{m}\right)$	

some detail below. Therefore the 32 rotational symmetries of crystals comprise a natural classification for the visible appearance of crystals, and hence are often called the 32 *crystal classes*. These symmetries can be studied by the mathematical theory of groups, and in this connotation they are referred to as the 32 *point groups*. The "point" in this nomenclature is the intersection of all the axes, which, because it is on each and every axis, is not repeated by the axis. These are thus the 32 crystallographic symmetries about a point.

TABLE III.—*The 32 Crystallographic Point Symmetries (International Symbols)*

Triclinic	Monoclinic	Orthorhombic	Tetragonal	Hexagonal	Isometric
$\bar{1}$	2	$2\,2\,2$	4	6	
1	$(2 =)\,m$	$2mm$	$\bar{4}$	$\bar{6}$	
	$\frac{2}{m}$	$\frac{2}{m}\,\frac{2}{m}\,\frac{2}{m}$	$\frac{4}{m}$	$\frac{6}{m}$	
	3	$3\,2$	$4\,2\,2$	$6\,2\,2$	$2\,3,\ 4\,3\,2$
	$\bar{3}$	$3m$	$4mm$	$6mm$	
	$\left(\frac{3}{m} = \bar{6}\right)$	$\bar{3}\frac{2}{m}$	$\bar{4}\,2m$	$\bar{6}\,2m$	$\bar{4}\,3m$
			$\frac{4}{m}\,\frac{2}{m}\,\frac{2}{m}$	$\frac{6}{m}\,\frac{2}{m}\,\frac{2}{m}$	$\frac{2}{m}\bar{3},\ \frac{4}{m}\bar{3}\frac{2}{m}$

The 32 crystallographic point symmetries of Tables I and II are shown in a different arrangement in Table III. Table IV shows an alternative set of symbols, known as the Schoenflies symbols, for the point groups. The Schoenflies notation is commonly employed in molecular spectroscopy.

IV. SYMMETRY-SPECIALIZED SPACE LATTICES

It has already been noted that the presence of translational repetition in crystals limits the angular repetitions to rotation axes with frequencies 1, 2, 3, 4 and 6. Conversely, these axes and their combinations restrict the translations to certain specialized types of space lattices. These were first investigated in 1842 by M. L. Frankenheim, who found 15 types. In 1850 Auguste Bravais investigated them more rigorously and showed that there are only 14 types. These 14 space lattices are commonly referred to as the Bravais space lattices.

The general nature of the deduction of these lattice types is as follows. In fig. 1(B) it is evident that any space lattice can be regarded as a periodic repetition by a translation $\mathbf{t}_3$ of two-dimensional lattice whose translation repetitions are $\mathbf{t}_1$ and $\mathbf{t}_2$. Thus a space lattice is a stack of plane lattices whose periodic displacement is $\mathbf{t}_3$. Now suppose that it is desired to deduce the space-lattice types consistent with a 4-fold axis. The plane lattice perpendicular to the 4-fold axis must have points arranged on the corners of a square; that is, it can be referred to a square cell. But the square-celled lattice is consistent with a perpendicular 4-fold axis either through a cell vertex or through a cell centre. The first and second layers of the space lattice can be pierced by the 4-fold axis in the same place (fig. 8[A]), or one can be pierced through a cell vertex and the other through a cell centre (fig. 9[A]). The first alternative has $\mathbf{t}_3$ perpendicular to the plane of $\mathbf{t}_1$ and $\mathbf{t}_2$, giving rise to a space lattice where the cell is a square prism (fig. 8[B]). In the second alternative, the displacement $\mathbf{t}_3'$ projects on one plane as $\frac{1}{2}\mathbf{t}_1 + \frac{1}{2}\mathbf{t}_2$. If the cell based upon $\mathbf{t}_1$, $\mathbf{t}_2$ and $\mathbf{t}_3'$ were accepted, it would have $\mathbf{t}_3'$ oblique to the plane of $\mathbf{t}_1$ and $\mathbf{t}_2$, and the cell itself would not have 4-fold symmetry. A cell which has not only 4-fold symmetry but also orthogonal axes can be arranged by choosing a new $\mathbf{t}_3$ such that

$$\mathbf{t}_3 = -\mathbf{t}_1 - \mathbf{t}_2 + 2\mathbf{t}_3 \qquad (5)$$

Because of the geometrical advantage of orthogonality, the cell based upon these new edges (fig. 9[B]) is always chosen. But with this advantage goes the disadvantage that this cell has a lattice point on the centre of the "unit" cell. Therefore the cell is not primitive because it has two lattice points associated with it; it is a double cell.

The preceding discussion has been concerned with the kinds of space lattices consistent specifically with a 4-fold axis. A similar discussion can be given for every symmetry. When this is done, it is found that many symmetries permit more than one kind of lattice.

Every symmetry can be represented by a lattice in which the primitive cell has the symmetry of the lattice. Such lattices and cells are designated P (for "primitive"). In addition, many symmetries can be represented by another lattice whose primitive cell has less symmetry than the lattice. But in such cases a multiple cell can be chosen which does have the symmetry of the lattice. The various possibilities of lattices with multiple cells are shown in Table V.

A further consequence of investigating the various lattice types consistent with each symmetry is that it is found that several symmetries are consistent with exactly the same lattice types. For example, symmetry $\bar{1}$ requires the same lattice as symmetry 1, because all lattices are inherently centrosymmetrical (that is, for

TABLE IV.—*The 32 Crystallographic Point Symmetries (Schoenflies Symbols)*

Triclinic	Monoclinic	Orthorhombic	Tetragonal	Hexagonal	Isometric
C_1	C_2	D_2	C_4	C_6	
C_i	C_s	C_{2v}	S_4	C_{3h}	
	C_{2h}		C_{4h}	C_{6h}	
	D_3	D_4	D_6	T	O
	C_{3v}	C_{4v}	C_{6v}		
	D_{3d}	D_{2d}	D_{3h}		T_d
	D_{2h}	D_{4h}	D_{6h}	T_h	O_h

TABLE V.—*The General Kinds (or "Modes") of Space Lattices*

Multiplicity of cell	Label	Lattice Requirements
Single	P	Primitive cell must have symmetry of lattice
	I	Body-centred cell must display symmetry of lattice
Double	A	Cell centred on *A* or (100) face must have symmetry of lattice
	B	Cell centred on *B* or (010) face must display symmetry of lattice
	C	Cell centred on *C* or (001) face must display symmetry of lattice
Quadruple	F	Cell centred on all faces *A*, *B* and *C* must have symmetry of lattice
Single (Triple)	R	Primitive cell must have shape of rhombohedron (This lattice is more conveniently referred to a cell with $a = b \neq c$, $\beta = 120°$, but having two internal points spaced $\frac{1}{3}$ and $\frac{2}{3}$ along the long body diagonal)

every translation **t** in a lattice, there exists the reverse translation **t**).

The distribution of these general types among the different symmetries is shown in Table VI. This tabulation calls for the following remarks. In the second line, I, A and B are not distinct but merely represent alternative permissible ways of selecting a cell from the lattice points. In the third line, A, B and C are not distinct but merely represent the orientation selected for the centred cell. Finally, it will be observed that P for the 3-fold case and the P lattice for the 6-fold case have the same symmetry, as noted in the third column; therefore these two cases give the same lattice type. Taking these duplications into account, there are 14 distinct specialized space-lattice types. A unit cell of each lattice type is shown in fig. 10.

V. CRYSTALLOGRAPHIC CO-ORDINATE SYSTEMS

The edges of the unit cell of the lattice provide the units of the natural co-ordinate system of the crystal. It should be noted that in Table VI the P lattices for 3- and 6-fold axes are the same, and that in Table V the R lattice can be referred to a cell of the same external shape as P for 3- and 6-fold axes, but having two additional internal lattice points. If these two lattices are referred to the same cell edges, it can be seen that only six symmetrically distinct co-ordinate systems are required for crystals. These are called the six crystal systems. (Some authors distinguish, in different ways, a subdivision of the hexagonal system, calling it "trigonal" or "rhombohedral." Such practices lead to serious inconsistencies and should be avoided.)

Both the *32* symmetries permitted to crystals, and the 6 co-ordinate systems to which crystals can be referred, constitute ways of classifying crystals. It should be observed that the most fundamental classification is that based upon the *32* symmetries. The significance of the crystal systems can be overestimated, and the restrictions they place upon crystals are frequently misunderstood by beginners. Basically, the six crystal systems provide six convenient co-ordinate systems to which to refer the geometry of crystals. Each crystal system, shown in the fourth column of Table VI, embraces several symmetries, as shown in the first column of that table.

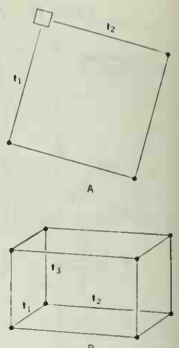

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FIG. B.—DERIVATION OF THE TETRAGONAL PRIMITIVE LATTICE

1. Axes of Systems.—Thus far, the translations of the unit cell have been labeled $\mathbf{t}_1$, $\mathbf{t}_2$ and $\mathbf{t}_3$, to stress the fact that these are translations of the lattice. Crystallographers designate the cell edges as *a*, *b* and *c*. These correspond to the units along the *X*, *Y* and *Z* axes to be used as the co-ordinate systems for the crystals. The angles between the *a*, *b* and *c* axes are labeled thus:

$$\text{angle } a \wedge b = \gamma$$
$$\text{angle } b \wedge c = \alpha$$
$$\text{angle } c \wedge a = \beta$$

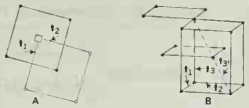
Symmetry causes the lengths of *a*, *b* and *c* and the angles between them to be specialized. This specialization is listed in the last column of Table VI. The information contained in that column is so frequently subject to misinterpretation that an attempt is made here to avoid this. The sign $\equiv$ is the mathematical one for "is identically equal to," and implies that this is true under all circumstances. In this use, the equality is required by the symmetry (noted in the first column). The sign $\neq$ means "is not generally equal to." In the present use, it does not prevent the two quantities connected by the sign from being "accidentally" equal on occasion. Thus, in the orthorhombic case, the last column of Table VI describes the relation between the lengths of the axes as $a \neq b \neq c$. This means that, in general, *a*, *b* and *c* are not required by symmetry to be identical. It should be emphasized that, although symmetry does not require identity, nothing prevents them from being equal within the precision of measurement. If, on measurement of the cell edges of a certain crystal, it turned out that *a* and *b* were, by some chance, equal within the precision of measurement, this would imply $a = b$, but not $a \equiv b$. The finding that $a = b$ dimensionally, therefore, does not place the crystal in the tetragonal system, for which the last column of Table VI gives $a \equiv b \neq c$. More generally, it

TABLE VI.—*Distribution of Space-Lattice Types Among Crystal Classes*

Symmetries	Space-lattice types permitted	Symmetry of space lattice	Crystal systems	Axes
$1, \bar{1}$	P	$\bar{1}$	triclinic	$a \neq b \neq c$ $\alpha \neq \beta \neq \gamma$*
$2, m, \frac{2}{m}$	P, I (or A or B)	$\frac{2}{m}$	monoclinic	$a \neq b \neq c$ $\gamma \neq \alpha = \beta = 90°$
$222, 2mm, \frac{2}{m}\frac{2}{m}\frac{2}{m}$	P, I, A (or B or C), F	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$	orthorhombic	$a \neq b \neq c$ $\alpha = \beta = \gamma = 90°$
$4, \bar{4}, \frac{4}{m}$ $422, 4mm, \bar{4}2m$ $\frac{4}{m}\frac{2}{m}\frac{2}{m}$	P, I	$\frac{4}{m}\frac{4}{m}\frac{4}{m}$	tetragonal	$a = b \neq c$ $\alpha = \beta = \gamma = 90°$
$3, \bar{3}$	P	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	hexagonal	$a = b \neq c$ $90° = \alpha = \beta \neq \gamma = 120°$
$32, 3m, \bar{3}\frac{2}{m}$	R	$\bar{3}\frac{2}{m}$		
$6, \bar{6}, \frac{6}{m}$ $622, 6mm, \bar{6}2m$ $\frac{6}{m}\frac{2}{m}\frac{2}{m}$	P	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$		
$23, \frac{2}{m}\bar{3}$ $432, \bar{4}3m$ $\frac{4}{m}\bar{3}\frac{2}{m}$	P, I, F	$\frac{4}{m}\bar{3}\frac{2}{m}$	isometric (also called "cubic")	$a = b = c$ $\alpha = \beta = \gamma = 90°$

*α = angle bc; β = angle ca; γ = angle ab.

should be clearly understood that the descriptions of axial dimensions in the last column of Table VI are not definitions of the crystal systems: they are merely statements of dimensional restrictions in the crystal systems. On the contrary, the first column of Table VI shows that a crystal is tetragonal if and only if its symmetry contains one axis with $n = 4$. This requires that $a = b$. (If the symmetry contained more than one axis with $n = 4$, the $a \equiv b$ requirement would place the crystal in the isometric system, where the symmetry requires $a \equiv b \equiv c$.)



FROM M. J. BUERGER, "ELEMENTARY CRYSTALLOGRAPHY"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 9.—DERIVATION OF THE TETRAGONAL BODY-CENTRED LATTICE

The specialization of axes required by symmetry, such as $a \equiv b$, implies that these axes cannot be distinguished. Under these circumstances they are called a_1 and a_2, instead of a and b, etc.

By common agreement, crystals are ordinarily drawn in a conventional orientation. The convention requires first, that c be oriented in a vertical position with $+c$ upward. Second, b is oriented approximately left and right (if $\alpha = 90°$, b becomes exactly horizontal), with $+b$ to the observer's right. This leaves a oriented approximately toward and away from the observer; it is taken as $+$ toward the observer. The resulting axial system is right-handed.

2. Special Features of Systems.—There follow some remarks about conventions and other special features of the several crystal systems.

Isometric System.—The three cell edges are orthogonal and equal, and, since they are indistinguishable, they are labeled a_1, a_2 and a_3. The axes therefore comprise the ordinary Cartesian coordinate system.

Tetragonal System.—The three cell edges are orthogonal, but two are indistinguishable and are called a_1 and a_2. The (tetragonal) axis is unique and is labeled c. It is customarily oriented vertically.

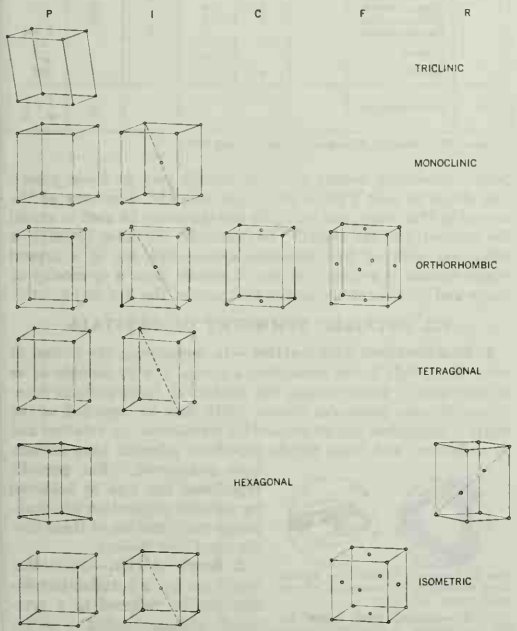


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FIG. 10.—THE SIX CRYSTAL SYSTEMS AND THEIR INCLUDED SPACE-LATTICE TYPES

Hexagonal System.—One axis corresponds to the symmetry axis with $n = 3$ (or 6). It is unique, labeled c and customarily oriented vertically. The other two axes are in a plane normal to c; they make an angle $\gamma = 120°$ with each other, are indistinguishable and are called a_1 and a_2. Neither a_1 nor a_2 can be distinguished from a third axis with which they form a set of three related by this 3-fold axis c. This unnecessary but inescapable axis is called a_3. The hexagonal system is customarily referred to four axes: $a_1 \equiv a_2 \equiv a_3 \neq c$. The indices of a plane with respect to these are, respectively, h, k, i and l. Because a_1, a_2 and a_3 are linearly dependent in their plane, the integers h, k and i are also dependent as follows:

$$h + k + i = 0 \qquad (6)$$

The indices of a plane in the hexagonal system are written fully as $(hkil)$ which, because of the linear dependence in (6), is often abbreviated $(hk\cdot l)$.

Orthorhombic System.—The three axes a, b and c are distinct but orthogonal. By universal agreement they are labeled so that $a < b$. An earlier generation of crystallographers placed no restriction on the length of c; however, it is desirable to describe newly measured crystals with the convention $a \lesssim b < c$. (Some crystallographers prefer $c < a < b$, which is much like defining 1, 2 and 3 such that $3 < 1 < 2$. No logic prevents this, but $a < b < c$ requires a minimum of arbitrary ruling.)

Monoclinic System.—If the unique axis with $n = 2$ is called c (as in the tetragonal system with unique axis $n = 4$, and the hexagonal system with unique axis $n = 3$ or 6), the monoclinic system is said to be described in the *first setting*. In this setting the 2 or $\bar{2}$ axis is called c and taken vertically, while the plane of a and b is orthogonal to c. The angle ($\gamma = ab$) is taken as obtuse. (If described in the *second setting*, b is taken as the 2 or $\bar{2}$ axis and set horizontally, and the plane of a and c is taken orthogonal to b. The second setting was usual with a past generation; however, it does not fit in with the principle of a minimum of arbitrary rulings, and therefore should be dropped.)

Triclinic System.—The three cell edges are entirely unspecialized in lengths and interaxial angles. Since there is no symmetrical specialization, there are an infinite number of ways in which the cell can be chosen from the lattice. By convention that cell is chosen which has for edges the three shortest noncoplanar edges. This cell is called the reduced cell. Such cells occur in two types: one can be described by a set of three edges surrounding a corner with three acute angles, the other by a set of three edges surrounding a corner with three obtuse angles. These are called all-acute cells or type-I cells, and all-obtuse cells or type-II cells, respectively.

All crystallographers agree with the convention of labeling the cell edges to conform with $a < b$. For reasons mentioned in the discussion of orthorhombic crystals above, it is desirable to describe newly measured crystals with the additional restriction $a < b < c$.

VI. APPLICATIONS OF POINT SYMMETRY

Under appropriate circumstances a crystal may extend its boundaries, or "grow." If allowed to grow by the addition of atoms or clusters of atoms to its free surface, this exterior surface comes to be made up of a set of plane surfaces which prove to be rational lattice planes. Without inquiring at this point why this is so, the information can be combined with the geometrical theory presented up to this point to give useful results.

1. Crystal Forms.—If the crystal grows in an environment of radial symmetry, that is, if the environment is the same in all directions, the symmetry of the crystal surface is limited only by the symmetry of the crystal pattern. For example, suppose that the crystal pattern has symmetry 4 (neglecting translations), and suppose that in growing the crystal develops a plane surface, say (100), parallel to the 4-fold axis of the pattern (fig. 11). Then the 4-fold symmetry requires that the crystal be identical along four planes like (100) and separated from the plane (100) by rotations of 90°, 180° and 270°. These additional planes have indices (010), $(\bar{1}00)$ and $(0\bar{1}0)$, respectively. The four planes

(100), (010), (001) and (010) comprise a symmetrical set with respect to the 4-fold axis. If one plane advances by growth, so must all four, because they are the same. Conversely, this set of four surface planes reveals that the pattern of the crystal contains a 4-fold axis.

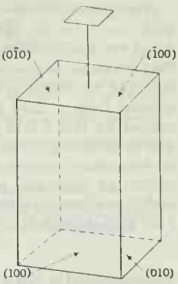


FIG. 11.—PLANE SURFACES REQUIRED BY A 4-FOLD AXIS TO BE PRESENT ON A CRYSTAL IF A SURFACE OF INDEX (1D0) IS PRESENT

A symmetrical set of planes is called a form. This designation is not a synonym for "shape" but has a technical significance. A form is symbolized by the index of any one of its faces, usually one with all positive indices. If the index of the plane is (hkl), the index of the corresponding form is written $((hkl))$, or less preferably $\{hkl\}$. The form $((hkl))$ can be regarded as the face (hkl) repeated or multiplied by the symmetry. Common forms tend to have indices composed of small integers, of which 0 and 1 are usual.

In nearly all cases a form with general indices $((hkl))$ has a different shape for each symmetry. On the other hand a form with specialized indices may be the same for several symmetries. For example, $((100))$ is the same form, a cube, for the five isometric symmetries 23, 432, $2/m\bar{3}$, $\bar{4}32$ and $4/m\bar{3}2/m$.

A crystal grown in free space normally is a polyhedron of rational plane faces, and this polyhedron can be resolved into a set of forms. Certain forms, like the cube, are known as closed forms because such a form can enclose space. Other forms are known as open forms because one cannot enclose space and can only appear on a crystal combined with other forms. There are a total of 47 different crystal forms. The occurrence of these among the point symmetries is shown in Tables VII, VIII, IX and X.

TABLE VII.—*Distribution of Forms in the Triclinic, Monoclinic and Orthorhombic Systems*

No. of faces	Name of form	Class									Unique form for
		1	$\bar{1}$	2	m	$\frac{2}{m}$	222	$2mm$	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$		
1	Pedion	+									
2	Pinacoid		+	+	+	+	+	+	+		
2	Dome			+	+			+			222
2	Sphenoid			+	+			+			$2mm$
4	Prism					+	+	+	+		
4	Bisphenoid						+				222
4	Pyramid							+			$2mm$
8	Bipyramid								+		$\frac{2}{m}\frac{2}{m}\frac{2}{m}$

Source: M. J. Buerger, *Elementary Crystallography* (1956).

TABLE VIII.—*Distribution of Forms in the Tetragonal System*

No. of faces	Name of form	Class							Unique form for
		4	$\bar{4}$	$\frac{4}{m}$	422	$4mm$	$\bar{4}2m$	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$	
1	Pedion	+							
2	Pinacoid		+	+	+	+	+	+	
4	Tetragonal prism	+	+	+	+	+	+	+	
4	Tetragonal pyramid	+				+			
4	Tetragonal bisphenoid		+				+		422
8	Ditetragonal prism			+	+	+	+	+	$\bar{4}2m$
8	Tetragonal bipyramid			+	+		+	+	$4mm$
8	Tetragonal trapezohedron			+					
8	Tetragonal scalenohedron						+		
8	Ditetragonal pyramid					+			
16	Ditetragonal bipyramid							+	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$

Source: M. J. Buerger, *Elementary Crystallography* (1956).

2. Dissolution of Crystals.—When a crystal is placed in contact with a solvent, it dissolves in such a way as to be consistent with its symmetry. For example, if a sphere is cut from a quartz crystal and if this sphere is permitted to be partly dissolved by hydrofluoric acid, the resulting shape has the symmetry of quartz, namely 32. An example is shown in fig. 12. This is known as a dissolution form.

If the solvent is weak, or permitted to act only briefly, it is often observed that it attacks the crystal at a number of isolated points, producing minute pits, called etch pits, at these points. The shape of such a pit is consistent with the symmetry of the crystal at that point, and etch pits can therefore be used to reveal the symmetry of the crystal. For example, the cube, $((100))$, is consistent with all five isometric symmetries, but if a crystal whose surface is a cube is etched, it should show a symmetry of shape and placement consistent with one of the five in fig. 13.

TABLE IX.—*Distribution of Forms in the Hexagonal System*

No. of faces	Name of form	Class												Unique form for
		3	$\bar{3}$	32	$3m$	$\bar{3}\frac{2}{m}$	6	$\bar{6}=\frac{3}{m}$	$\frac{6}{m}$	622	$6mm$	$\bar{6}m2=\frac{\bar{3}}{m}m2$	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	
1	Pedion	+			+		+				+			
2	Pinacoid		+	+		+		+	+	+		+	+	
3	Trigonal prism	+		+	+			+				+		
3	Trigonal pyramid	+			+									
6	Ditrigonal prism			+	+							+		
6	Hexagonal prism		+	+	+	+	+		+	+	+	+	+	
6	Trigonal bipyramid			+				+				+		
6	Rhombohedron		+	+		+								
6	Trigonal trapezohedron			+										32
6	Ditrigonal pyramid				+									$3m$
6	Hexagonal pyramid				+		+				+			
12	Hexagonal bipyramid					+			+	+		+	+	
12	Hexagonal scalenohedron					+								$\bar{3}\frac{2}{m}$
12	Dihexagonal prism					+				+	+		+	
12	Ditrigonal bipyramid											+		$\bar{6}m2$
12	Hexagonal trapezohedron									+				$\bar{6}22$
12	Dihexagonal pyramid										+			$6mm$
24	Dihexagonal bipyramid												+	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$

Source: M. J. Buerger, *Elementary Crystallography* (1956).

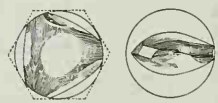
TABLE X.—*Distribution of Forms in the Isometric System*

No. of faces	Name of form	Class					Unique form for
		23	432	$\frac{2}{m}3$	$\bar{4}\,3m$	$\frac{4}{m}\bar{3}\frac{2}{m}$	
4	Tetrahedron	+			+		
6	Cube	+	+	+	+	+	
8	Octahedron		+	+		+	
12	Dodecahedron	+	+	+	+	+	
	Pyritohedron	+		+			
	Tristetrahedron	+			+		
	Deltohedron	+			+		
	Tetartoid	+					23
24	Tetrahexahedron		+		+	+	
	Trapezohedron		+	+		+	
	Trisoctahedron		+	+		+	
	Hextetrahedron				+		$\bar{4}\,3m$
	Diploid			+			$\frac{2}{m}\bar{3}$
	Gyroid		+				432
48	Hexoctahedron					+	$\frac{4}{m}\bar{3}\frac{2}{m}$

Source: M. J. Buerger, *Elementary Crystallography* (1956).

VII. DETAILED SYMMETRY OF CRYSTALS

1. Combination Symmetries.—In introducing the notion of order in crystals it was noted that a crystal can be thought of as an aggregate of atom clusters, the clusters all being periodic repetitions of some particular cluster which may be regarded as the motif. Repetition can be defined by translation, by rotation and by reflection, and these simple repetition schemes have already been considered. But periodic repetitions can also be achieved by periodic application of appropriate combinations of these simple repetition devices.

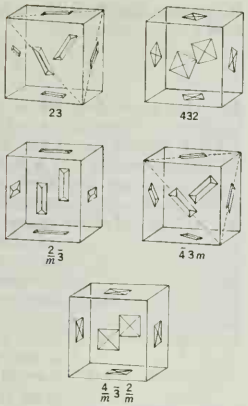


FROM E. S. OANA, "TEXTBOOK OF MINERALOGY"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 12.—DISSOLUTION FORM RESULTING FROM ETCHING A QUARTZ SPHERE WITH HYDROFLUORIC ACID. THE DISSOLUTION FORM SHOWS SYMMETRY 32

2. Screw Axes.—Periodic repetition by a rotation-translation can be referred to a symmetry element called a screw axis, in which the rotation component is the n of the rotation axis, and the translation compo-

nent τ is the pitch of the screw. If a point is repeated periodically by screw motion, the repetition must eventually bring the repeated point to translation equivalence with the original point in order that the collection of points may have the pure translational order characteristic of all crystals. This condition restricts the possible kinds of screw axes by requiring that $n\tau = mt$, so that $\tau = (m/n)t$, where m is an integer and t is one of the translations of the lattice. A screw axis is designated by the frequency of the axis, n, and the frequency of the pitch, m, in the form n_m. The possible values of n and m give rise to the screw axes shown in fig. 14; the manner in which the screw axes repeat a point is also shown in this figure.

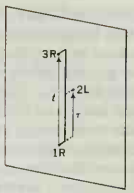


FROM M. J. BUERGER, "ELEMENTARY CRYSTALLOGRAPHY"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 13.—TYPICAL ETCH-FIGURE APPEARANCES ON ISOMETRIC CRYSTALS

3. Glide Planes. Periodic repetition by a reflection-translation can be referred to a symmetry element called a glide plane, in which the translation component is τ and the reflection component is m. This is illustrated in fig. 15. Glide planes are restricted by the requirement that $2\tau = t$. A glide plane is labeled according to the lattice translation t to which the translation component τ is parallel. These designations are shown in Table XI.

4. Space Groups.—In the same general way that the possible rotation and rotoinversion axes can be combined, combinations can be formed which include screw axes, glide planes and translations (that is, the lattices). When these combinations are systematically made, there turn out to be 230 cases, a conclusion reached nearly simultaneously in the 1890s by E. S. Federow (a Russian), A. Schoenflies (a German) and W. Barlow (an Englishman). These cases are known as space groups, because in each case all the operations of the symmetry elements leave three-dimensional space unmoved.



FROM M. J. BUERGER, "ELEMENTARY CRYSTALLOGRAPHY"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 15.—REPETITION OF A POINT BY A GLIDE REFLECTION

Space groups are related to point groups in a way which can be understood by considering how crystal faces related by screw axes or glide planes would appear to the eye. The translation component of each of these symmetry elements is a fraction of a cell translation, that is, of the order of atomic dimension, and so cannot be detected by eye. Two crystal faces related by a screw axis n_m, therefore, appear to be related by a pure rotation axis n. The screw axis n_m and the rotation axis n are said to be isogonal because they relate faces separated by the same angle. In more sophisticated language, implying an understanding of the mathematical theory of groups (*q.v.*), they are also said to be isomorphic (or isomorphous, a term which may be confused with isomorphous replacement of one atom by another).

TABLE XI.—*Designations of Glide Planes*

Type	Label	Value of translation component
Axial glides	a	τ is parallel to a and is equal to the vector $\frac{1}{2}a$
	b	τ is parallel to b and is equal to the vector $\frac{1}{2}b$
	c	τ is parallel to c and is equal to the vector $\frac{1}{2}c$
Diagonal glide	n	τ is parallel to the face diagonal of a cell, and is equal to the vector $\frac{1}{2}a + \frac{1}{2}b$ or $\frac{1}{2}b + \frac{1}{2}c$ or $\frac{1}{2}c + \frac{1}{2}a$
Diamond glide	d	τ is parallel to the face diagonal of a F cell and is equal to the vector $\frac{1}{4}a + \frac{1}{4}b$ or $\frac{1}{4}b + \frac{1}{4}c$ or $\frac{1}{4}c + \frac{1}{4}a$

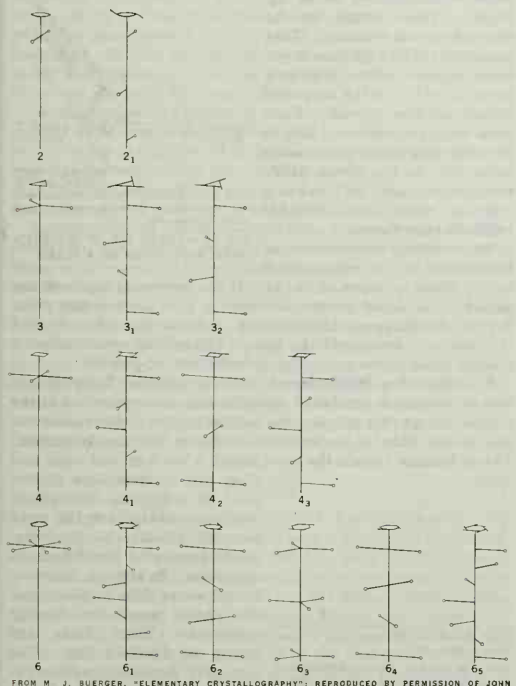


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FIG. 14.—THE REPETITION OF A POINT BY THE POSSIBLE CRYSTALLOGRAPHIC SCREW AXES

If all translations are removed from the symmetry elements of a space group, it degenerates into a point group. In general, many space groups would degenerate into the same point group. Conversely, to every point group there correspond several space groups. The several space groups corresponding to a given point group differ by (1) being based upon alternative permissible lattices of fig. 10; (2) replacement of the rotation axes of the point group with isogonal rotation axes or screw axes; and (3) replacement of the mirrors of the point group with isogonal mirrors or glide planes. If a crystal is found to have external symmetry corresponding to a given point group, it can have an internal symmetry corresponding to any one of the space groups isogonal with that point group.

The various space groups corresponding to a given point group differ from one another by lattice translations or by translation components of screw axes and glide planes. Information on space groups can be obtained by any observation which provides a way of measuring the spacings between equivalent planes in a crystal; *e.g.*, by X-ray and other diffraction methods. Certain observations of morphology, although they are not measurements, also provide information on relative spacings. These observations are discussed later. Such observations lead to the finding of translations characteristic of the space groups isogonal with a given point group.

VIII. DIFFRACTION BY CRYSTALS

An arrangement of points capable of scattering radiation can be studied with the aid of the scattered radiation. If the distance between scattering centres is of the order of magnitude of the wave length of the radiation, interference effects are observed between the scattered rays, and the resulting phenomenon becomes

diffraction (*see* LIGHT: *Diffraction*).

1. Laue Equations.—When the scattering centres are regularly arranged, as in a crystal, they constitute a three-dimensional diffraction grating whose diffraction effects are concentrated into very sharp maxima. These maxima are controlled by a set of three equations known as the Laue equations. Each equation gives the condition under which radiation of wave length λ, striking a line of translation-equivalent scattering points at angle $\bar{\mu}$, is in phase as it leaves the line at angle $\bar{\nu}$. If the three translations are a, b and c, as in a crystal, the three Laue equations are

$$\cos\bar{\nu}_1 = \cos\bar{\mu}_1 + \frac{h'}{a}\lambda$$

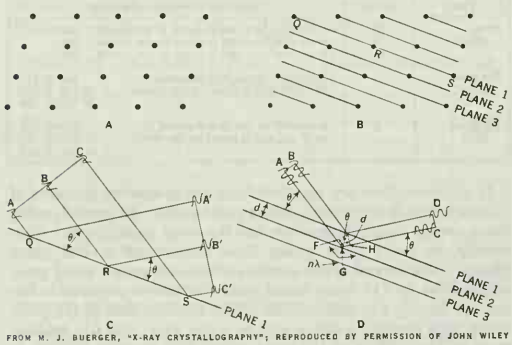
$$\cos\bar{\nu}_2 = \cos\bar{\mu}_2 + \frac{k'}{b}\lambda$$

$$\cos\bar{\nu}_3 = \cos\bar{\mu}_3 + \frac{l'}{c}\lambda \qquad (7)$$

where h', k' and l' are integers.

In most modern experimental work, λ is held constant; that is, monochromatic X-rays are used. These three equations are then not simultaneously satisfied except when $\bar{\nu}_1$, $\bar{\nu}_2$ and $\bar{\nu}_3$ are given special values, which implies that the crystal is given a special orientation with respect to the beam of incoming radiation. In experimental work, the radiation is most commonly X-rays, but it may be a beam of electrons or neutrons (*see* ELECTRON DIFFRACTION; SPECTROSCOPY, X-RAY; X-RAYS).

2. Bragg's Law.—The diffraction maxima can also be interpreted in another manner developed by Sir Lawrence Bragg (illustrated in fig. 16). The periodic nature of the crystal, fig. 16(A),



FROM M. J. BUERGER, "X-RAY CRYSTALLOGRAPHY"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 16.—(A) SET OF POINTS IN LATTICE ARRAY; (B) SIMPLE STRUCTURE OF (A) RESOLVED INTO A STACK OF PLANES; (C) REFLECTION FROM A SINGLE PLANE. WAVE FRONT ABC OF X-RAY BEAM IS SCATTERED BY ATOMS Q, R AND S, RESULTING IN WAVE FRONT A'B'C'; (D) REFLECTION BY A STACK OF PLANES. IN ORDER FOR ALL WAVES REFLECTED FROM PLANES 1 AND 2 TO BE IN PHASE ALONG WAVE FRONT DC, THE ADDITIONAL PATH LENGTH FGH OFFERED TO THE X-RAYS BY PLANE 2 MUST EQUAL AN INTEGRAL NUMBER OF WAVE LENGTHS

can be thought of as resolved into planes whose indices are (hkl), fig. 16(B). Each plane scatters the radiation as if it were reflecting the rays, fig. 16(C). The condition that the reflected rays from adjacent planes of the stack be in phase, fig. 16(D), is given by Bragg's law,

$$n\lambda = 2d_{hkl}\sin\theta, \qquad (8)$$

where n is an integer giving the number of wave lengths of phase lag between rays scattered by adjacent planes.

Bragg's law can also be written

$$\sin\theta = \frac{\lambda}{2}\frac{1}{d_{hkl/n}} \qquad (9)$$

$$= \frac{\lambda}{2}\frac{1}{d_{nh,\,nk,\,nl}} \qquad (10)$$

It develops that the integers in (7), (8), (9) and (10) are related by

$$\begin{aligned} h' &= nh \\ k' &= nk \\ l' &= nl \end{aligned} \qquad (11)$$

The triple of numbers, nh nk nl, written without parentheses or brackets are known as the indices of the reflection.

For a selected d_{hkl} of (9) there are several discrete values of the glancing angle θ. If n is also fixed, there is only one value of θ. Conversely, any X-ray method which measures θ permits determination of the corresponding spacing d of the particular set of planes hkl of the lattice.

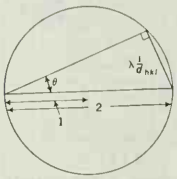


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FIG. 17.—GEOMETRICAL REPRESENTATION OF BRAGG'S LAW

3. The Reciprocal Lattice.—The explanation of many diffraction experiments is simplified if (10) is given the geometrical interpretation shown in fig. 17. The sine of θ is represented there by the ratio $(\lambda/d):2$. This is always true for a circle of unit radius. This geometrical construction can be extended to the meanings given in fig. 18. It will be noted that σ is a vector normal to the crystal plane, and that it is always equal in length to $\lambda\frac{1}{d_{hkl}}$ for a given set of planes.

The quantity $1/d_{hkl}$ occurs in a mathematical device known as the reciprocal lattice. This is illustrated in two dimensions for an orthogonal lattice in fig. 19. If any plane (hkl) is drawn in the lattice of fig. 19(A), a spacing d_{hkl} is determined. If a line is drawn in fig. 19(B) from an origin, parallel to d_{hkl} but equal in length to its reciprocal, $1/d_{hkl}$, a point P_{hkl} is reached. If this is done for all planes (hkl) of the cell of fig. 19(A) a collection of points is determined as in fig. 19(B). These points can be shown to lie on a lattice. Thus the set of $1/d$'s of a lattice determines another lattice. This new lattice is said to be the reciprocal lattice of the crystal. Each point with co-ordinates $[hkl]$ in the reciprocal lattice corresponds to a plane in the direct lattice whose indices are (hkl) and to a reflection whose indices are hkl (without parentheses).

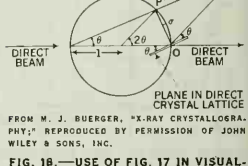

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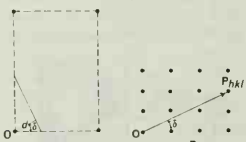
FIG. 18.—USE OF FIG. 17 IN VISUALIZING REFLECTION BY A PLANE

An interesting interpretation of Bragg's law for the entire crystal can be given as shown in fig. 18. If the reciprocal lattice is imagined to be placed so that its origin is at O, then if any point P_{hkl} of the reciprocal lattice comes to lie on the sphere (called the sphere of reflection) the plane (hkl) of the crystal reflects, causing a diffraction maximum, or reflection, labeled hkl.

4. Diffraction Methods.—A properly designed X-ray-diffraction experiment is capable of revealing the point symmetry of the crystal, except that all point symmetries appear to have an inversion centre added if an inversion centre is not already present. This is because (unless the wave length λ has a critical value and gives rise to anomalous dispersion) the reflections from planes (hkl) and $(\bar{h}\bar{k}\bar{l})$ have the same intensity, which is the only measurable feature of the diffraction maximum. In general, these reflected waves differ in phase, but the phase cannot be directly measured. These facts are known as Friedel's law. The symmetry displayed by the crystal is usually called Laue symmetry, but would better be called Friedel symmetry.



FROM M. J. BUERGER, "X-RAY CRYSTALLOGRAPHY;" REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 19.—(A) TWO-DIMENSIONAL EQUIVALENT OF A PLANE WITH INDICES hkl· (B) RECIPROCAL LATTICE BUILT UP OF POINTS AT THE ENDS OF VECTORS $1/d$ OF (A)

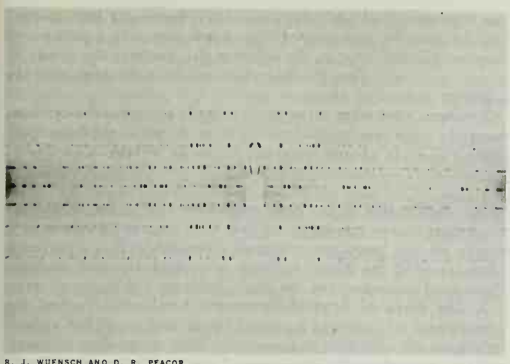


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FIG. 20.—ROTATING CRYSTAL PHOTOGRAPH: TOURMALINE, $NaMg_3Al_6B_3Si_6O_{31}H_4$. ROTATED ABOUT THE *c* AXIS

Appropriate diffraction methods enable the investigator to distinguish between the space groups isogonal with a particular crystal class. This can be done because screw axes and glide planes involve glide components, while pure rotation axes and mirrors do not. These translation components can be detected because they introduce new, interleaved planes between the planes of certain index types, and in so doing, cause these types of reflections to be extinguished. These characteristic absences are called space-group extinctions. Unfortunately the crystal class may be unknown. In this event the Friedel symmetry prevents distinguishing all 230 space groups, but, with extinctions, there still may be distinguished 122 *diffraction groups*, as shown by M. J. Buerger in 1935. In 63 of these diffraction groups there is only one space group (or enantiomorphic pair), which is therefore uniquely distinguished. In 1946 Buerger further showed that all space groups, except enantiomorphic pairs, can be distinguished with the aid of Patterson synthesis, discussed later.

Various methods of arranging and examining the diffraction by crystals have been devised which make use of photographic film for recording the diffracted radiation. These methods differ in regard to the information they yield about the crystal. The principal methods are outlined below. In all but the Laue method, monochromatic X-radiation is employed.

Rotating-Crystal Method.—Each Laue equation, (7), gives the conditions under which radiation of wave length λ is scattered in phase with respect to a particular translation of the lattice. In the rotating-crystal method, derived independently by E. Schiebold and by M. Polanyi and K. Weissenberg about 1920–22, one such translation is held in a fixed direction perpendicular to the incoming beam of X-rays. In (7) let this translation be *a*, for example: then $\bar{\mu}_1 = 90°$. If the crystal is rotated about *a*, then $\bar{\mu}_1$ stays constant while $\bar{\mu}_2$ and $\bar{\mu}_3$ vary during the rotation. This permits all planes to pass through reflecting conditions except those normal to *a*. The resulting reflections must satisfy the first Laue equation which, with $\bar{\mu}_1 = 90°$, becomes

$$\cos \bar{\nu}_1 = \frac{h'\lambda}{a} \qquad (12)$$

Thus all reflections for a given value of h′ have the same $\bar{\nu}_1$; that is, they lie on a cone (called a Laue cone, fig. 19[B]) whose half-open angle is $\bar{\nu}_1$. In the rotating-crystal method, all reflections are recorded on a photographic film placed on the surface of a cylinder coaxial with the rotation axis. When the film is developed, the reflections are found to be confined to straight lines called layer lines. In fig. 23 the *n*'s are the *h*'s of (12), so that this integer is determined. From the geometry of the film and the location of the layer line, $\bar{\nu}_1$ of (12) can be determined, so that only *a* of (12) is unknown and can thus be calculated. In this way, the translation along any rational direction in a crystal can be determined from an appropriate rotating-crystal photograph. The photograph, fig. 20, unfortunately gives no symmetry information.

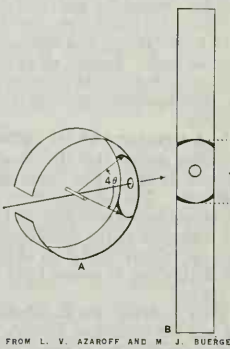
Oscillating-Crystal Method.—If the rotation range of the crystal is limited between fixed values, the reflection can be more readily assigned indices *hkl*. The resulting oscillating-crystal method gives a certain amount of symmetry information, but is now little used because of the greater convenience and utility of the Weissenberg and precession methods, both of which involve motion of the photographic film in addition to rotation of the crystal.

Weissenberg Method.—Since the various reflections arise at different azimuths, ω, of the crystal rotation, it is possible to separate the reflections of one plane and spread them over a photographic film by moving the film in synchronism with the rotation. The resulting photograph is called a Weissenberg photograph. Each spot on such a photograph is the record of a specific reflection *h′k′l′*; it is characterized by two angles, ω and one other, and all reflections can be indexed if the cell dimensions are known (for example, from rotating-crystal photographs). From a set of Weissenberg photographs the Friedel symmetry of the crystal can be completely determined.

De Jong-Bouman Method.—The collection of spots on a Weissenberg photograph can be regarded as a transformation of the points occurring on a plane of the reciprocal lattice. In 1938 W. F. de Jong and J. Bouman showed how to make a distortionless photograph of such a plane. The requirement is that the photographic film be placed and moved so that it is an enlargement of the plane of the reciprocal lattice being recorded.

Precession Method.—The precession method has a motion differing from those of other methods. The axis of a Laue cone is inclined at a constant angle with the X-ray beam, and is caused to precess about the beam. The resulting photograph is an undistorted photograph of a plane of the reciprocal lattice, because the De Jong-Bouman principle is utilized. The Friedel symmetry of the crystal can be perfectly determined from precession photographs, as can the cells of both reciprocal and crystal lattices. The precession method, as well as the two other moving-film methods outlined above, are discussed in detail in M. J. Buerger's *X-Ray Crystallography* (1942).

Powder Method.—If a single crystal is not available, a substance can be examined in the form of a powder, in which the particles preferably pass a screen of 200 meshes per inch. The powder method was developed independently and almost simultaneously in 1917 by P. Debye and P. Scherrer in Germany and by A. W. Hull in the United States. If a powder sample is placed in an X-ray beam, fig. 21, the beam passes through so many powder particles that some particles are present in every orientation θ for all Bragg reflections *hkl* of (8)—(10). The locus of constant θ is the surface of a cone which intersects a cylindrical film in an arc, fig. 21. The resulting photograph is called a powder photograph, fig. 22. For every arc an angle θ can be determined, and through this a $d_{nh,nk,nl}$ of (10) can be computed. Thus a powder photograph yields a set of *d*'s for the crystal, but no symmetry information is directly available. If the powder is a pure substance the distribution of *d*'s can sometimes be analyzed for the unit-cell



FROM L. V. AZAROFF AND M. J. BUERGER, "THE POWDER METHOD"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC., 1958

FIG. 21.—RELATION BETWEEN X-RAY BEAM, SAMPLE AND PHOTOGRAPH FILM IN THE POWDER METHOD: (A) FILM IN POSITION FOR EXPOSURE; (B) EXPOSED FILM

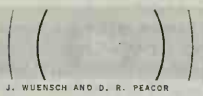


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FIG. 22.—POWDER PHOTOGRAPH OF MgO

dimensions. But powder photographs are chiefly used in an empirical manner as "fingerprints" of a substance.

Laue Method.—Equation (9) shows that if λ is allowed to be variable, a fixed value of d gives a particular solution for θ. Therefore, if a beam of polychromatic X-rays is passed through a single crystal, each reflection occurs at a characteristic angle θ, and this information can be recorded on a photographic film, fig. 23. The result is called a Laue photograph. This method gives information on the Friedel symmetry, but no direct unit cell and space-group information. The Laue method was the one used in 1913 by Laue's collaborators W. Friedrich and P. Knipping, when they discovered the diffraction of X-rays by crystals.

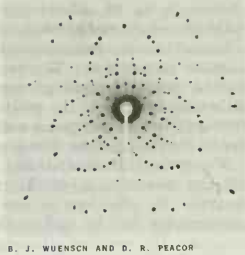

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FIG. 23.—LAUE PHOTOGRAPH OF QUARTZ, SiO_2. THE X-RAY BEAM WAS DIRECTED ALONG THE c AXIS OF THE CRYSTAL

IX. CRYSTAL-STRUCTURE ANALYSIS

Crystal-structure analysis started in 1913 with Max Laue's surmise that, since X-rays probably had wave lengths of the order of magnitude of the distances between atoms in a crystal, they should be diffracted by crystals. The experiments of Friedrich and Knipping proved he was right (*see* X-RAYS: *Historical Background*).

Crystal-structure analysis has made known the arrangements of atoms in crystals of many thousands of compounds. This information has formed the basis of crystal chemistry. Through crystal chemistry the entire structure of chemistry has been affected, and with it, metallurgy and mineralogy have been placed on a more rational basis. Indeed, all of the present-day science concerned with the structure and properties of solid matter has been placed on a firm foundation through the contributions of crystal-structure analysis.

1. A Grating and Its Diffraction.—It was explained in the preceding section that the symmetry of a crystal and the dimensions of its cell can be found by relatively simple diffraction experiments. The cell dimensions are determined by the position of the diffraction maxima and the Friedel symmetry is determined by the symmetry of the distribution of the maxima. In addition to this, the relative intensities of the reflections *hkl* are governed by the distribution of matter (that is, by the arrangement of atoms) in the cell.

More generally, the distribution of scattering matter in a grating and the diffraction it produces are related. If everything is known about either of these, the other is completely determined, and can be computed through a mathematical device known as the Fourier transform. Let

hkl = the indices of a reflection
$f_{j,hkl}$ = the scattering power of atom j for reflection hkl
F_{hkl} = the amplitude of the radiation scattered in reflection hkl
xyz = the co-ordinates of a point in the unit cell
ρ_{xyz} = the electron density at co-ordinates xyz
V = the volume of the unit cell

Then the relation between the distribution of matter in a crystal and the diffraction it produces is given by the two Fourier transforms

$$F_{hkl} = \sum_j f_{j,hkl}\, e^{i2\pi(hx+ky+lz)} \tag{13}$$

$$\rho_{xyz} = \frac{1}{V}\sum_h\sum_k\sum_l F_{hkl}\, e^{-i2\pi(hx+ky+lz)} \tag{14}$$

The scattering powers, $f_{j,hkl}$, of the various atoms are known, so that the amplitude diffracted by any crystal in reflection hkl can be computed by (13). In general this amplitude F_{hkl} is complex; that is, it has both magnitude $|F_{hkl}|$, and phase ϕ_{hkl}. When the crystal has a centre of symmetry and this is chosen as origin, the exponentials of both (13) and (14) degenerate into cosines, and the complex character of F_{hkl} degenerates into a positive or negative number; that is, the phase of F_{hkl} assumes the nature of a sign, + or −. Thus the diffraction can be easily computed for a known pattern of atoms.

Problems arise when an attempt is made to derive the arrangement of matter in a crystal by (14) from the measured diffraction. Since F_{hkl} is, in general, complex, it can be written

$$F_{hkl} = |F_{hkl}|\, e^{i\phi_{hkl}} \tag{15}$$

which implies that it has both magnitude and phase. Only the magnitude can be measured, so that (14) cannot be solved as a simple routine based on measured quantities. This constitutes what is called the *phase problem* of crystal-structure analysis. Ways used to circumvent the phase problem will be noted later.

2. The Data of Crystal-Structure Analysis.—To find the arrangement of atoms in a crystal the intensities of the various reflections *hkl* must first be measured. This can be done by measuring or estimating the blackness of the spots corresponding to each reflection as they appear on the photographs made by one of the methods outlined earlier. For this purpose the precession and Weissenberg methods are preferred, since they resolve all reflections. The oscillating-crystal, rotating-crystal and power photographs are sometimes employed, but their use involves difficulties because, in that order, they give increasingly less resolution of reflections and increasingly less symmetry information. The Laue method is not currently used because the reflections come from a spectrum of wave lengths of varying but unknown intensities.

More quantitative measures of the diffraction intensities can be made by using a single-crystal diffractometer. Such instruments are designed to allow the crystal to be set in the orientation to produce any desired reflection, *hkl*, and to allow a quantum counter (*e.g.*, a Geiger counter) to be placed in such a position as to receive the reflection. The number of quanta registered by the counter is then recorded as the crystal is uniformly rotated through the desired reflection. This provides a measure known as the integrated reflection.

The integrated reflection must be corrected for several factors known as the Lorentz, polarization and absorption factors, and possibly for primary- and secondary-extinction effects. The first two are routine geometrical corrections, but the remainder cause technical difficulties. When the corrections have been made, the resulting numbers are proportional to $|F_{hkl}|^2$, that is, to the squares of the magnitudes of the amplitudes, from which the $|F_{hkl}|$'s of (15) can be easily derived.

3. Circumventing the Phase Problem.—With a full set of $|F_{hkl}|$'s available, (14) still cannot be solved because $e^{i\phi hkl}$ of (15) is unknown. There are a number of ways of finding this factor or its equivalent, but many of the methods apply only to relatively simple structures in which there are a comparatively small number of atoms per unit cell.

Trial Models.—For crystals of some substances, the small size of the cell together with a knowledge of crystal chemistry (or in organic substances, the known structure and shape of the molecule) may permit the general packing of molecules or groups of atoms in the cell to be guessed. In such instances the guess constitutes a rough model for which the expected diffraction can be computed by (13). These calculated ϕ's may then be combined with the observed $|F_{hkl}|$'s with the aid of (15) to give a set of hybrid F_{hkl}'s which can then be used to compute (14). If the guessed model was essentially correct, its more exact distribution of electron density is then provided by this use of (14). This distribution of the electron density should essentially duplicate the arrangement of atoms in the trial model, and should also meet certain technical criteria. If it does not, the trial model is discarded for another. But if it does, the positions of the atoms are found to have been improved over those of the trial model. From this first improved model, new phases ϕ of (15) can be computed, using (13), and then (14) can be computed again. In this way the method of successive Fourier syntheses ultimately gives the correct location of atoms.

Heavy-Atom Method.—The various f's in the summation of

(13) are the scattering powers of the several atoms in the unit cell, and these, in turn, are roughly proportional to the atomic numbers, Z, of these atoms. If the cell contains one heavy atom, or a symmetry-equivalent set of them, these contribute the largest f's to the summation and tend to dominate the sum. The few heavy atoms can often be located, because they must occur in such small numbers that they can only be on symmetry-fixed locations of the space group. Alternatively they can be located by the Patterson synthesis, discussed later. Since the heavy atoms dominate (13), their contribution alone can be used to compute approximate values for (13). This determines rough values of ϕ in (15), and these permit (14) to be computed. This preliminary computation of the electron density not only reveals the heavy atoms, but other lighter atoms as well. From this point forward, the structure is refined by the method of successive Fourier syntheses.

Many complicated crystal structures have been solved by this method. Most such crystals are those of organic compounds in which a heavy atom has been deliberately attached to the organic molecule.

Replaceable-Atom Method.—Phases can be computed directly for the scattering of the entire cell provided that two crystals are available which have the same structure except for one (or a few) symmetry-equivalent set of atoms, which can be located. For example, the compounds $Mg_2(OH)_3Cl \cdot 4H_2O$ and $Mg_2(OH)_3Br \cdot 4H_2O$ have the same structure but differ by replacement of Cl by Br. That they have the same structure is judged by the fact that the crystals have similar cells, symmetry and other properties. In such cases, when the location of the replaceable atom is found (as in the heavy-atom case), the magnitudes and phases scattered by this atom can be determined, and this information can be combined with the measured magnitudes to provide the missing phases in (15). Thus (14) can be computed and the electron density found.

Direct Fourier Methods.—The methods noted so far are useful only in certain special cases. Fortunately there have been discovered a number of direct methods which are based upon the realization that, in a set of diffraction amplitudes scattered by matter concentrated in discrete atoms, the set of phases is not independent of the set of magnitudes. Now, it has been noted that for crystals containing inversion centres, the phases of the F's can be expressed as signs of these F's in (14). In making use of the relations of magnitudes and signs, it is convenient to normalize each F_{hkl} in such a way that it would be unity if all atoms scattered in phase for this reflection. Such normalized F's are called unitary structure factors and are labeled U's.

Using this kind of diffraction amplitude, David Harker and J. S. Kasper were able to demonstrate that the signs of the U's are subject to the following restriction:

$$|U_{hkl}|^2 < \frac{1}{2} + \frac{1}{2} U_{2h\ 2k\ 2l} \qquad (16)$$

The left side does not involve a phase, and therefore it can be measured. If it is greater than 1/2, (16) can only be satisfied if $U_{2h\ 2k\ 2l}$ is positive. (No conclusion can be drawn if the left side is less than 1/2.) There are many relations like (16) that are based upon the presence of various symmetry elements in the crystal.

Another, more useful, relation, due to D. Sayre, W. H. Zachariasen and others, is:

$$S_{h+h'k+k'l+l'} = S(S_{hkl}S_{h'k'l'}) \qquad (17)$$

This says that if the signs ("S") of the two reflections, hkl and $h'k'l'$ are known, the sign of the product of their signs is the same as the sign of the reflection $h + h'\ k + k'\ l + l'$. This relation holds well when hkl and $h'k'l'$ are strong reflections. It has also been shown to hold if the product is averaged over signs for sets of reflections such that $h + h'$, $k + k'$ and $l + l'$ is constant. These relations are useful in establishing the signs of some reflections if the signs of some others have been found. In addition there are other more complicated statistical relations known.

Vector-Space Methods.—Since the phases of the complex F's are not directly available for a complete determination of the electron density by (14), the question arises as to just what *is* determined by the bare magnitudes, $|F_{hkl}|$, of the diffraction amplitudes. This question was answered by A. L. Patterson, who deduced a new summation known as the Patterson function or Patterson synthesis:

$$P_{uvw} = \sum_h \sum_k \sum_l |F_{hkl}|^2 \cos 2\pi(hu + kv + lw). \qquad (18)$$

In this summation the squares of the magnitudes of the diffraction amplitudes alone enter, and these are entirely observable. This synthesis has the property that it has maxima at the ends of vectors radiating from the origin which correspond to interatomic vectors in the crystal. Thus the diffraction magnitudes enable the vectors between atoms in the structure to be determined, but do not directly provide the locations of the atoms of that structure. The relation is similar to have the individual pieces of a structure like a bridge, but not having a plan of how they are attached to one another.

The Patterson peak locations have been tabulated for one set of symmetry-equivalent atoms for every space group. Furthermore, the Patterson function exaggerates the peak locations representing vectors between heavy atoms. These two circumstances make it possible to use the Patterson function to locate the heavy atoms for the heavy-atom method, and in this way the Patterson function has contributed to the solution of many crystal structures.

The space in which the Patterson synthesis may be said to occur (or be plotted) is called vector space. A detailed study of the relations between crystal space and vector space has resulted in the development of a number of ways of transforming the Patterson synthesis into a map of the approximate electron density. The basis of this is called image theory. The Patterson synthesis can be regarded as the image of the crystal structure as seen from one atom, but summed over all atoms of the structure. Solution of the Patterson synthesis consists of isolating one image from the others. This is done by the use of mathematical devices known as image-seeking functions. Many crystal structures of moderate complexity have been solved by these methods.

4. Refinement of Structures.—The chief barrier in crystal-structure analysis is that concerned with the determination of the approximate location of the atoms. Once this barrier has been surmounted, a number of methods are available for increasing the accuracy of the atom locations. The method of successive Fourier synthesis has already been mentioned. In another method, the electron density is, in effect, computed twice, once using observed magnitudes and the second time using magnitudes predicted by the first model. The difference between the two (called a difference synthesis) should be featureless if the model is the same as the actual structure. If not, the synthesis displays anomalies which indicate which way the atoms should be shifted in order to cause the model to become the same as the true structure. A third method utilizes the method of least squares, and reveals what shifts of atom co-ordinates are required to give a better fit of computed intensities with observed intensities. This method also permits estimation of the thermal motions of the atoms. There are several other refinement methods in use.

The course of a refinement is usually followed by an estimate of the average error by which the diffraction amplitudes computed from the model fail to duplicate those actually measured. There are a number of particular measures of this sort in use; a common one is the average residual

$$R = \frac{\Sigma\ (|\ F_{\text{observed}}\ | - |\ F_{\text{computed}}\ |)}{\Sigma\ |\ F_{\text{observed}}\ |}. \qquad (19)$$

(M. J. Bu.)

X. OPTICAL CRYSTALLOGRAPHY

The optical properties of crystals are not only of considerable interest theoretically, but are of the greatest practical importance. Crystals of calcite (Iceland spar) are employed in producing polarized light. The science of petrology is largely based on the study of the appearance of thin sections of rocks in a microscope

fitted with two polarizing calcite prisms (*see* MICROSCOPE: *Illumination: Polarized Light*). In the absence of external crystalline form, as with a faceted gem stone, or with the minerals constituting a rock (thin, transparent sections of which can be examined in the polarizing microscope), a mineral may often be readily identified by the determination of some of its optical properties.

According to their action on transmitted plane-polarized light (*see* LIGHT: *Polarization and Electromagnetic Theory*), all crystals may be referred to one or another of the five groups enumerated below. These groups correspond with the six systems of crystallization (in the second group two systems are included together). The several symmetry classes of each system are optically the same, except in the rare cases of substances which are circularly polarizing.

1. Optically isotropic crystals—corresponding with the cubic system.

2. Optically uniaxial crystals—corresponding with the tetragonal and hexagonal systems.

3. Optically biaxial crystals in which the three principal optical directions coincide with the three crystallographic axes—corresponding with the orthorhombic system.

4. Optically biaxial crystals in which only one of the three principal optical directions coincides with a crystallographic axis—corresponding with the monoclinic system.

5. Optically biaxial crystals in which there is no fixed and definite relation between the optical and crystallographic directions—corresponding with the triclinic system.

1. Optically Isotropic Crystals.—These belong to the cubic system and, like all other optically isotropic bodies, have only one index of refraction for light of each colour. They have no action on polarized light (except in crystals which are circularly polarizing); and when examined in the polariscope or polarizing microscope they remain dark between crossed Nicols or Polaroids, and cannot be distinguished optically from amorphous substances such as glass.

2. Optically Uniaxial Crystals.—These belong to the tetragonal and hexagonal (including rhombohedral) systems, and between crystals of these systems there is no optical distinction. Such crystals are anisotropic or doubly refracting (*see* LIGHT: *Refraction and Double Refraction*), but for light traveling through them in a certain, single direction they are singly refracting. This direction, which is called the optic axis, is the same for light of all colours and at all temperatures; it coincides in direction with the principal crystallographic axis, which in tetragonal crystals is a 4-fold (or $\bar{4}$) axis of symmetry, and in the hexagonal system a 3-fold or 6-fold axis.

For light of each colour there are two indices of refraction; namely, the ordinary index (ω) corresponding with the ordinary ray, which vibrates perpendicular to the optic axis; and the extraordinary index (ϵ) corresponding with the extraordinary ray, which vibrates parallel to the optic axis. If the ordinary index of refraction is greater than the extraordinary index, the crystal is said to be optically negative, while if less the crystal is optically positive. The difference between the two indices is a measure of the strength of the double refraction or birefringence. Thus in calcite, for sodium (D) light, $\omega = 1.6585$ and $\epsilon = 1.4863$; hence this substance is optically negative with a relatively high double refraction of $\omega - \epsilon = 0.1722$. For sodium light in quartz, $\omega = 1.5442$, $\epsilon = 1.5533$ and $\epsilon - \omega = 0.0091$; this mineral is therefore optically positive with low double refraction. The indices of refraction vary not only for light of different colours but also slightly with the temperature.

The optical characteristics of uniaxial crystals are symmetrical not only with respect to the full number of planes and axes of symmetry of tetragonal and hexagonal crystals, but also with respect to all vertical planes; *i.e.*, all planes containing the optic axis. A surface expressing the optical relations of such crystals is thus an ellipsoid of revolution about the optic axis. (In cubic crystals the corresponding surface is a sphere.) The optical indicatrix, or index ellipsoid, is the surface obtained by plotting the value of the refractive index in each principal direction for a linearly polarized light vector lying in that direction. In the optical indicatrix the length of the principal axis, or axis of rotation, is proportional to the index of refraction (*i.e.*, inversely proportional to the velocity) of the extraordinary rays, which vibrate along this axis and are transmitted in directions perpendicular thereto; the equatorial diameters are proportional to the index of refraction of the ordinary rays, which vibrate perpendicular to the optic axis. For positive uniaxial crystals the indicatrix is thus a prolate spheroid (lemon-shaped), and for negative crystals an oblate spheroid (doorknob-shaped).

In uniaxial crystals the ray surface, or wave surface, which represents the distances traversed by the rays during a given interval of time in various directions from a point of origin within the crystal, consists of two sheets; namely, a sphere, corresponding to the ordinary rays, and an ellipsoid of revolution, corresponding to the extraordinary rays. The difference in form of the ray surface for positive and negative crystals is shown in fig. 24.

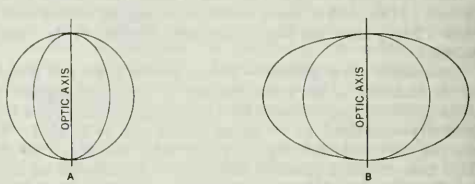

FIG. 24.—RAY-SURFACE SECTION OF (A) POSITIVE UNIAXIAL CRYSTAL AND (B) NEGATIVE UNIAXIAL CRYSTAL

When a uniaxial crystal is examined in a polariscope or polarizing microscope between crossed Nicols (*i.e.*, with the principal planes of the polarizer or analyzer at right angles, and so producing a dark field of view), its optical behaviour differs according to the direction in which the light travels through the crystal, to the position of the crystal with respect to the principal planes of the Nicols, and according to whether convergent or parallel polarized light is employed. A tetragonal or hexagonal crystal viewed in parallel light, along the principal axis will remain dark as it is rotated between crossed Nicols, and will thus not differ in its behaviour from a cubic crystal or other isotropic body. If, however, the crystal is viewed in any other direction (for example, through a prism face), it will, except in certain positions, have an action on the polarized light. A plane-polarized ray entering the crystal will be resolved into two polarized rays having their directions of vibration parallel to the vibration directions in the crystal. These two rays on leaving the crystal will be combined again in the analyzer, and a portion of the light will be transmitted through the instrument; the crystal will then show up brightly against the dark field. Furthermore, because of interference of these two rays in the analyzer, the light will be brilliantly coloured, especially if the crystal is thin, or if a thin section of a crystal is examined. The particular colour seen will depend on the strength of the double refraction, on the orientation of the crystal or section, and on its thickness. If, now, the crystal is rotated with the stage of the microscope, the Nicols remaining fixed in position, the light transmitted through the instrument will vary in intensity and in certain positions will be cut out altogether. The latter happens when the vibration directions of the crystal are parallel to the vibration directions of the Nicols (these being indicated by cross hairs in the microscope). The crystal, now being dark, is said to be in position of extinction, and as it is turned through a complete rotation of 360° it will extinguish four times. If the crystal is viewed through a prism face, it will be seen that, when the crystal is in a position of extinction, the cross hairs of the microscope are parallel to the edges of the prism; the crystal is then said to give straight extinction or parallel extinction.

In convergent light, a very different phenomenon is observed when a uniaxial crystal, or section of such a crystal, is placed between crossed Nicols with its optic axis coincident with the axis of the microscope. The rays of light, being convergent, do not travel in the direction of the optic axis and are therefore doubly refracted in the crystal; in the analyzer the vibrations will

be reduced to the same plane and there will be interference of the two sets of rays. The result is an interference figure (fig. 25) consisting of a number of brilliantly coloured concentric rings, each showing the colours of the spectrum of white light; intersecting the rings is a black cross, the arms of which are parallel to the principal planes of the Nicols. If monochromatic light is used instead of white light, the rings will be alternately light and dark. The number and distance apart of the rings depend on the strength of the double refraction and on the thickness of the crystal. By observing the effect produced on such a uniaxial interference figure when a quartz wedge, a gypsum plate or a mica plate is superposed on the crystal, it may be at once decided whether the crystal is optically positive or negative. Such a simple test may, for example, be applied for distinguishing certain faceted gem stones: thus zircon and phenacite are optically positive, while corundum (ruby and sapphire) and beryl (emerald) are optically negative.

FIG. 25.—INTERFERENCE FIGURE OF A UNIAXIAL CRYSTAL

3. Optically Biaxial Crystals.—In these crystals there are three principal indices of refraction, denoted by α, β and γ; of these, γ is the greatest and α the least ($\alpha < \beta < \gamma$). The three principal vibration directions corresponding to these indices are at right angles to each other, and are the directions of the three rectangular axes of the optical indicatrix. The indicatrix (fig. 26) is an ellipsoid with the lengths of its axes proportional to the refractive indices; $OC:\gamma$, $OB:\beta$, $OA:\alpha$, where $OC > OB > OA$. The figure is symmetrical with respect to the principal planes OAB, OAC, OBC.

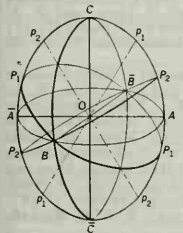

FIG. 26.—OPTICAL INDICATRIX OF A BIAXIAL CRYSTAL

The ray surface (represented in fig. 27 by its sections in the three principal planes) is derived from the indicatrix in the following manner. A ray of light entering the crystal and traveling in the direction OA is resolved into polarized rays vibrating parallel to OB and OC, and therefore propagated with the velocities $1/\beta$ and $1/\gamma$ respectively (with the velocity of light in vacuum taken to be unity): distances Ob and Oc (fig. 27) proportional to these velocities are marked off in the direction OA. Similarly, rays traveling along OC have the velocities $1/\alpha$ and $1/\beta$, and those along OB the velocities $1/\alpha$ and $1/\gamma$. In the two directions Op_1 and Op_2 (fig. 26) perpendicular to the two circular sections P_1P_1 and P_2P_2 of the indicatrix, the two rays will be transmitted with the same velocity $1/\beta$. These two directions are called the optic axes (primary optic axes), although they do not have all the properties associated with the optic axis of a uniaxial crystal. They have very nearly the same direction as the lines Os_1 and Os_2 in fig. 27, which are distinguished as the secondary optic axes. In most crystals the primary and secondary optic axes are inclined to each other at not more than a few minutes, so that for practical purposes there is no distinction between them.

The angle between Op_1 and Op_2 is called the optic axial angle, and the plane OAC in which these lines lie is called the optic axial plane. The angles between the optic axes are bisected by the vibration directions OA and OC, the line which bisects the acute angle being called the acute bisectrix and the other the obtuse bisectrix. When the acute bisectrix coincides with the greatest axis OC of the indicatrix, *i.e.*, the vibration direction corresponding with the refractive index γ (as in fig. 26 and 27), the crystal is described as being optically positive; and when the acute bisectrix coincides with OA, the vibration direction for the index α, the crystal is negative.

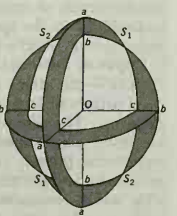

FIG. 27.—RAY SURFACE OF A BIAXIAL CRYSTAL

The distinction between positive and negative biaxial crystals thus depends on the relative magnitude of the three principal indices of refraction; in positive crystals β is nearer to α than to γ while in negative crystals the reverse is the case. Thus in topaz, which is optically positive, the refractive indices for sodium light are $\alpha = 1.6120$, $\beta = 1.6150$, $\gamma = 1.6224$; and for orthoclase, which is optically negative, $\alpha = 1.5190$, $\beta = 1.5237$, $\gamma = 1.5260$. The difference $\gamma - \alpha$ represents the strength of the double refraction.

Since the refractive indices vary both with the colour of the light and with the temperature, there will be for each colour and temperature slight differences in the form of both the indicatrix and the ray surface; consequently there will be variations in the positions of the optic axes and in the size of the optic axial angle. This phenomenon is known as the dispersion of the optic axes. When the axial angle is greater for red light than for blue the character of the dispersion is expressed by $r > v$ and when less by $r < v$. In some crystals, *e.g.*, brookite, the optic axes for red light and for blue light may be, at certain temperatures, in planes at right angles. The type of interference figure exhibited by a biaxial crystal in convergent polarized light between crossed Nicol prisms is represented in fig. 28. The crystal must be viewed along the acute bisectrix, and for this purpose it is often necessary to cut a plate from the crystal perpendicular to this direction; sometimes, however, as in mica and topaz, a cleavage flake will be perpendicular to the acute bisectrix. When the crystal is viewed in white light, there are around each optic axis a series of brilliantly coloured ovals, which at the centre join to form an 8-shaped loop, while farther from the centre the curvature of the rings is approximately that of lemniscates. In the position shown in fig. 28(A) the vibration directions in the crystal are parallel to those of the Nicols, and the figure is intersected by two black bands or brushes forming a cross. When the crystal is rotated with the stage of the microscope, the cross breaks up into the two branches of a hyperbola, and when the vibration directions of the crystal are inclined at 45° to those of the Nicols the interference figure is as shown in fig. 28(B). Points of emergence of the optic axes are at the middle of the hyperbolic brushes when the crystal is in the diagonal position, and the size of the optic axial angle can therefore be directly measured with considerable accuracy.

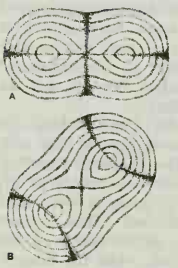

FIG. 28.—INTERFERENCE FIGURES OF A BIAXIAL CRYSTAL

In orthorhombic crystals the three principal vibration directions coincide with the three crystallographic axes, and therefore have fixed positions in the crystal which are the same for light of all colours and at all temperatures. The optical orientation of an orthorhombic crystal is completely defined by stating to which crystallographic planes the optic axial plane and the acute bisectrix are respectively parallel and perpendicular. When examined in parallel light between crossed Nicols, such a crystal extinguishes parallel to the crystallographic axes, which are often parallel to the edges of a face or section; there is thus usually straight extinction. The interference figure seen in convergent polarized light is symmetrical about two lines at right angles.

In monoclinic crystals only one vibration direction has a fixed position within the crystal; it is parallel to the 2 or $\bar{2}$ axis. The other two vibration directions lie in a plane perpendicular to this axis, but they may vary in position for light of different colours and at different temperatures. Thus, in crystals of this system, in addition to dispersion of the optic axes there may also be dispersion of the bisectrices. The latter may be of one or another of three kinds, depending on which of the three vibration directions coincides with the 2 or $\bar{2}$ axis of the crystal. When the acute bisectrix is fixed in position, the optic axial planes for different colours may be crossed, and the interference figure will then be symmetrical with respect to a point only (crossed dispersion). When the obtuse bisectrix is fixed, the axial planes may be inclined to one another, and the interference figure is symmetrical only about a line which is perpendicular to the axial planes (horizontal

dispersion). Finally, when the vibration direction corresponding to the refractive index β has a fixed position, the optic axial plane lies perpendicular to the 2 or $\bar{2}$ axis, but the acute bisectrix may vary in position in this plane; the interference figure will then be symmetrical only about a line joining the optic axes (inclined dispersion). Examples of substances exhibiting these three kinds of dispersion are borax, orthoclase and gypsum, respectively. In orthoclase and gypsum, however, the optic axial angle gradually diminishes as the crystals are heated, and after passing through a uniaxial position the angle opens out in a plane at right angles to the one it previously occupied; the character of the dispersion thus becomes reversed in the two examples quoted. When examined in parallel light between crossed Nicols, monoclinic crystals will give straight extinction only in faces and sections which are parallel to the 2 or $\bar{2}$ axis; in all other faces and sections the extinction directions will be inclined to the edges of the crystal. The angles between these directions and edges are readily measured and, being dependent on the optical orientation of the crystal, they are often characteristic constants of the substance.

In triclinic crystals there is no relation between the optical and crystallographic directions, and the exact determination of the optical orientation is often a matter of very considerable difficulty. The character of the dispersion of the bisectrices and optic axes is more complex than in monoclinic crystals, and the interference figures are devoid of symmetry.

4. Absorption of Light in Crystals; Pleochroism.—In crystals other than those of the cubic system, rays of light with different vibration directions will, as a rule, be differently absorbed, and the polarized rays on emerging from the crystal may be of different intensities and (if the observation is made in white light and the crystal is coloured) differently coloured. Thus in tourmaline the ordinary ray, which vibrates perpendicular to the principal axis, is almost completely absorbed, while the extraordinary ray is allowed to pass through the crystal. A plate of tourmaline cut parallel to the principal axis may therefore be used for producing a beam of polarized light, and two such plates placed in crossed position form the polarizer or analyzer of tourmaline tongs, with the aid of which the interference figures of crystals may be simply shown.

Uniaxial (tetragonal and hexagonal) crystals that show perceptible differences in colour for the ordinary and extraordinary rays are said to be dichroic. In biaxial (orthorhombic, monoclinic and triclinic) crystals, rays vibrating along each of the three principal vibration directions may be differently absorbed and, in coloured crystals, differently coloured; such crystals are therefore said to be trichroic or in general pleochroic (from *pleon,* more, and *chros,* colour).

The directions of maximum absorption in biaxial crystals have, however, no necessary relation with the axes of the indicatrix, unless these have fixed crystallographic directions, as is the case with the orthorhombic system and with the 2 or $\bar{2}$ axis in the monoclinic system. In epidote it has been shown that the two directions of maximum absorption which lie in the plane of symmetry are not even at right angles. The characteristic absorption bands in the spectrum of white light which has been transmitted through certain crystals, particularly those of salts of the cerium metals, will, of course, be different according to the direction of vibration of the rays.

The pleochroism of some crystals is so strong that when they are viewed through in different directions they exhibit marked differences in colour. Thus a crystal of the mineral cordierite (also called dichroite because of its strong pleochroism) will be seen to be dark blue, pale blue or pale yellow according to which of three perpendicular directions is viewed. The face colours seen directly in this way result, however, from the mixture of two axial colours belonging to rays vibrating in two directions. In order to see the axial colours separately the crystal must be examined with a dichroscope, or in a polarizing microscope from which the analyzer has been removed. The dichroscope consists of a cleavage rhombohedron of calcite, on the ends of which glass prisms are cemented: the lens is focused on a small square aperture in the tube of the instrument. The eye of the observer will see two images of the square aperture, and if a pleochroic crystal is placed in front of this aperture the two images will be differently coloured. On rotating this crystal with respect to the instrument the maximum difference in the colours will be obtained when the vibration directions in the crystal coincide with those in the calcite. Such a simple instrument is especially useful for the examination of faceted gem stones even when they are mounted in their settings. A single glance suffices to distinguish between a ruby and a spinel ruby, since the former is dichroic and the latter isotropic and therefore not dichroic.

See also references under "Crystallography" in the Index volume. (L. J. S.; J. D. H. D.; M. J. Bu.)

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CRYSTALS, DISLOCATION OF. Few things in nature are more perfect than a crystal, in which immense numbers of atoms or molecules are stacked in perfect alignment. Rarely is even one atom in a thousand out of line. Yet, surprisingly, many of the most important properties of a crystal are due to the few odd places where the crystal structure goes wrong. Many crystals could not have grown at all without having imperfections in them. Gemstones mostly owe their colours to imperfections. Luminescence, and the special electrical properties of semi-conducting materials such as germanium, are due to them. Imperfections enable atoms to move about and chemical reactions to take place inside crystals. Imperfections at the surfaces of crystals are prone to chemical attack, which is turned to advantage in chemical catalysts but is a source of trouble in corrosion-resistant metals and alloys. Most important of all, engineering metals, which are conglomerates of crystals, owe their great strength, toughness and malleability to the special properties of a certain type of crystal imperfection called a dislocation.

Types of Dislocations.—A crystal is an assembly of identical "bricks"—the atoms or molecules—built into a certain architectural pattern or lattice, and a dislocation is an imperfection in that pattern. The simplest patterns, from which perfect crystals are built, are formed by the intersections of three families of equidistant planes; such patterns are also used in the simplest rectilinear architecture. But more complicated patterns are possible which enable one to build curved architectural structures, such as arches, from the same bricks. This is done by matching $n + 1$ bricks in one layer against n in the next layer, where the

number n depends on the curvature required, as shown in fig. 1. In the architecture of a crystal this particular pattern is called an edge dislocation. Plastically bent crystals such as are obtained when a soft metal wire is sharply bent, contain edge dislocations and these are the sources of their curvature.

Another type of dislocation, the screw dislocation, has a different architectural property. It enables a three-dimensional structure to be made out of a single flat sheet of material. This sheet is wound about a central axis—the dislocation—like a spiral staircase so that each successive layer of the sheet rests on the one below, as in fig. 2. In crystallography this is equivalent to replacing one of the families of planes in the lattice by a single spiral surface, or helicoid.

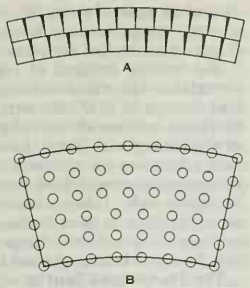

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FIG. 1.—(A) EDGE DISLOCATION IN A CURVED BRICK ARCH; (B) EDGE DISLOCATION IN ATOMIC STRUCTURE OF A SIMPLE CURVED CRYSTAL (CIRCLES REPRESENT ATOMS) (*see* TEXT)

Crystal Growth and Growth Steps.—This property of a screw dislocation is important for the growth of crystals. When a crystal is exposed to a supersaturated vapour or solution of its own substance, atoms or molecules condense on to its surface and move about on it until they meet one another and begin to form new layers of the crystal on top of the existing ones. A difficulty occurs when the vapour or solution is only slightly supersaturated. The rate of arrival of atoms or molecules on the surface is then so low that one that has arrived is most likely to evaporate off the surface again before it manages to meet others and so begin forming a new layer. Only when a partly grown layer already exists on the surface is such an atom likely to become a permanent part of the crystal, by attaching itself to the "growth step" at the edge of that layer. If the crystal is architecturally perfect, however, a smooth crystal face is produced as this layer grows to the edges of the crystal. It then becomes almost impossible for the crystal to grow further unless the supersaturation is increased to the level at which new layers can form on existing smooth ones. This conclusion is based on sound thermodynamic arguments but is in striking disagreement with the observed fact that most crystals grow easily under the smallest supersaturations. It was pointed out by F. C. Frank in 1949 that such crystals probably contain screw dislocations and grow in the manner suggested by the arrow in fig. 2, by adding more turns to the spiral through the attachment of atoms or molecules to the ledge between the top "stair" and the layer beneath it. The problem of creating new growth steps then disappears because the screw dislocation provides a self-perpetuating growth step on the surface. The addition of atoms or molecules to this step does not produce a smooth crystal face but causes the step instead to wind up into a growth spiral on the surface, as in fig. 3. Many crystals have now been observed to grow by this process and the demonstrated existence of such growth spirals has strongly confirmed this aspect of the theory of dislocations. Again there is an architectural analogy in the ziggurats, the spiral pyramids of Mesopotamia.

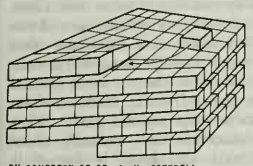

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FIG. 2.—BUILDING OF A CRYSTAL BY THE ADDITION OF LATTICE BLOCKS TO THE ENDS OF A SINGLE SPIRAL SHEET AROUND A SCREW DISLOCATION

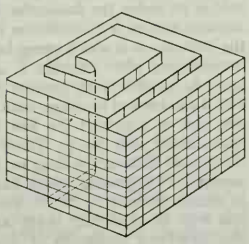

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FIG. 3.—GROWTH SPIRAL CENTRED ON A SCREW DISLOCATION

"Whisker Crystals."—In the presence of a solvent or corroding agent the process of fig. 3 can operate in reverse, the point of emergence of the dislocation on the crystal surface being a centre for the dissolution of the crystal. Instead of a growth hill, a depression or etch pit is formed on the crystal face. Etch pits are troublesome in corrosion-resistant materials but useful as a means of locating dislocations in crystals. Atoms or molecules of foreign substances are important in both the growth and dissolution of crystals. By attaching themselves to the growth steps they can block the flow of matter to and from the steps and so obstruct or "poison" the processes. The more slowly a growth step moves across a crystal face the more time there is for other impurities to condense on to that face and slow down the growth still more. This leads to "bunching," in which large numbers of growth steps pile up closely behind a heavily contaminated one and produce steep-sided growth hills and etch pits. In extreme cases it provides one mechanism for the growth of remarkable "whisker crystals"; *i.e.*, crystalline fibres which are typically about 1 cm. long but only about 0.0001–0.001 cm. thick. Fig. 4 shows how the poisoning of a growth step can lead to the formation of a whisker. Practically all crystalline substances have now been observed to grow as whiskers under favourable conditions and the process just described is only one of several by which they are formed. Some materials, *e.g.*, cellulose and asbestos, grow as fibres because their molecules are shaped in that form. In others, particularly the metals, the whiskers often grow from their bases, not their tips, by processes occurring inside the bulk material.

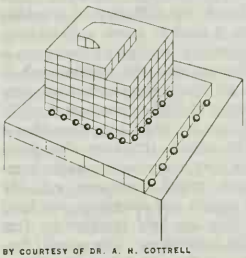

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FIG. 4.—GROWTH OF CRYSTAL IN WHISKER FORM DUE TO "POISONING" OF THE GROWTH STEP AT ITS BASE BY ADSORBED IMPURITY ATOMS

Slip.—The idea of dislocations in crystals was introduced in 1934 by G. I. Taylor, E. Orowan and M. Polanyi to explain the plastic deformation of crystals. Experiments made between 1920 and 1930 had already shown that when a crystal is stretched or bent plastically its crystal structure is not destroyed, and that the deformation occurs by the process of slip, as in fig. 5, in which one slab of the crystal slides past another along a surface within the crystal that is commonly one of the main crystallographic planes, called a slip plane, and along a direction in that surface that is always one of the main crystallographic axes, called a slip direction. The coherence and continuity of the crystal across the surface is not destroyed by slip and the atoms come to rest in perfect alignment after having slipped. In some cases the deformation occurs uniformly on a thick packet of such planes and rotates the crystal axes of the material within the packet into a position of mirror symmetry relative to the original axes; it is then called deformation twinning.

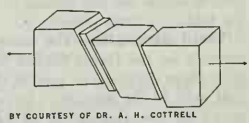

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FIG. 5.—DEFORMATION PRODUCED BY THE PROCESS OF SLIP IN A STRETCHED CRYSTAL

It is scarcely possible for all the millions of atoms on a slip plane to ride up simultaneously over their neighbours on the opposite face of the plane. The smallest variation in the distribution of applied force on the plane and the natural vibrations of the crystal lattice itself must cause one part to slip before the rest. The slip can then spread outward from this part over the rest of the plane, like a wave spreading over the surface of a pond. The front of this wave, *i.e.*, the boundary line between the slipped and unslipped areas, is the dislocation line. Where this line is parallel to the slip direction the dislocation is a screw and where it is perpendicular the dislocation is an edge. Where it is curved the dislocation is partly a screw and partly an edge. In fig. 3 the line of the screw dislocation is shown as a broken line running

vertically down the centre of the crystal. Fig. 1 (B) may be regarded as a section through the line of the edge dislocation.

Slip dislocations are thus able to move or glide across their slip planes and, in doing this, to cause the material above the slip plane to slide over that below it. This important property of dislocations is illustrated in fig. 6. At each stage during slip the atoms behind the dislocation have completed their movement along the slip plane from one lattice site to the next and those ahead of the dislocation have hardly begun to move. Those at the centre of the dislocation have slipped halfway; as they complete their slip they push the next row of atoms along the dislocation line into the half-slipped position. In this way the dislocation moves forward and the crystal slips.

The ability of a dislocation to glide depends on the forces between atoms at its centre. In simple metals the atoms, which may be pictured as small spheres, are not joined directly by chemical bonds but are pulled together by free electrons that move through the spaces between them. It is not difficult for these atoms to slide over each other in a dislocation, since no chemical bonds have to be broken; and so the dislocation is mobile. But in a nonmetallic crystal such as diamond or quartz in which the atoms are joined directly by chemical bonds the difficulty of breaking and re-forming these bonds makes it hard to move a dislocation except at high temperatures where the heat motion of the atoms is strong enough to break bonds. This explains why a metal such as copper or aluminum is malleable at all temperatures, whereas many non-metallic crystals are brittle except at high temperatures. The free-electron structure is not sufficient by itself to ensure that a crystal is soft and malleable; the crystal structure also plays a part. This is shown by the fact that many intermetallic compounds (*q.v.*) which have complex crystal structures, *e.g.*, the compound $CuAl_2$ formed between copper and aluminum, are hard and brittle despite the fact that they are held together by free electrons and are obviously metallic substances. The special feature about the simple, malleable metals is that the slip planes in them are unusually smooth, each consisting of a densely packed sheet of atoms widely spaced from the next sheet. Because of this, when one such sheet slides over another the cohesion between them fluctuates less violently than it does in most other types of crystal. The structures of the dislocations are also altered by this effect. In gold, for example, the highly strained central region of the dislocation is spread out over a region about 30 atoms wide in the slip plane, rather as in fig. 1 (A), so that the dislocation line is really a flat "ribbon" lying in the slip plane. In certain alloys such as some of the brasses and bronzes it is possible, by plastic working, to widen the dislocations out completely across the slip planes, so producing crystallographic stacking faults on those planes.

Yield Strength.—The yield strength of a malleable crystal depends on the forces needed to create dislocations in it and to glide these dislocations against the resistance of various obstacles that exist in the material. In pure, unworked metals slip is produced by the application of extremely small forces, when the crystal lattice is sheared elastically through an angle of only about 0.001°. It is quite impossible to create dislocations in a perfect lattice by straining it as gently as this. In fact it is clear, by considering diagrams such as fig. 6 (A), that the atoms would have to be pushed forward a distance which is a large fraction of the interatomic spacing before they would consent to run on of their own accord to produce a configuration such as that of fig. 6 (C). The lattice would thus have to be sheared elastically through an angle of about 10°. From the known elastic properties of, say, copper, the shear force needed for this is about 1,000,000 lb. per square inch of slip plane area.

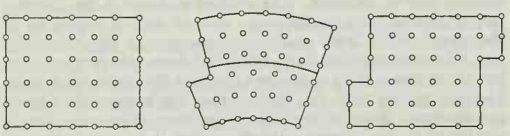

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FIG. 6.—STAGES OF SLIP PRODUCED BY THE GLIDE OF A DISLOCATION ALONG A SLIP PLANE

The exciting prospect of producing materials with such high strengths as this stimulated much research. C. Herring and J. K. Galt showed in 1952 that pure tin, normally one of the softest of metals, becomes stronger than steel when prepared in the form of whisker crystals. Since then it has been shown that whiskers of most substances are extremely strong; iron and graphite whiskers for example have withstood stresses of 1,700,000 and 3,000,000 lb. per square inch. It seems that such whiskers have either no dislocations in them or none in those configurations that enable large amounts of slip to form. Large perfect crystals free from dislocations have also been grown and these again are extremely strong.

The Frank-Read Source.—The softness of ordinary malleable crystals is due to dislocations already present in them or to other imperfections from which dislocations are easily created. As explained above, under certain conditions crystals will not grow unless they contain dislocations. Dislocations can also be created by thermal shrinkage strains, particularly around specks of foreign substances included in the crystal, as well as by the impact of grit on the surface. Several methods for observing dislocations inside crystals have been developed. In 1953 J. M. Hedges and J. W. Mitchell succeeded in revealing dislocation lines inside silver bromide crystals by "decorating" them with specks of metallic silver. In 1956 P. B. Hirsch, using a transmission technique with an electron microscope, succeeded in filming dislocations in motion inside thin aluminum foil. His method has been applied widely to the study of dislocations in metals and other crystals. Later developments, due mainly to J. W. Menter, have enabled the atomic structure of dislocations to be resolved in some substances.

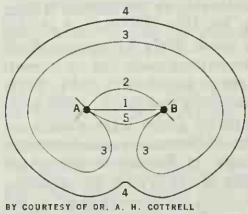

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FIG. 7.—PLAN VIEW OF A SLIP PLANE IN WHICH A FRANK-READ SOURCE PRODUCES A DISLOCATION RING BY EXPANDING THROUGH A SEQUENCE OF POSITIONS 1, 2, 3, 4–5 ABOUT ITS NODES (A) AND (B)

Such observations have shown that dislocation lines are often linked together in networks reminiscent of the networks formed in a soap froth by the lines where three soap bubbles meet. Each dislocation line, typically about 0.0001 cm. long, is joined to others at "nodes" in the network and so is constrained from moving completely independently of them. As a result, the network as a whole has a mechanical stability analogous to that of a soap froth. This is why it is almost impossible, once dislocations have been formed in a crystal, to eliminate them completely at any temperature below the melting point of the material.

A remarkable geometrical property of such networks, discovered in 1950 by F. C. Frank and W. T. Read, is that large numbers of dislocations can be created from certain places in a network by the application of small forces. Fig. 7 represents a plan view of a slip plane containing a Frank-Read source; *i.e.*, the dislocation line 1 lying between the fixed nodes A and B. A shear force applied to the plane causes this dislocation to glide across it. Being held at its nodes, the dislocation line must bend into approximately circular shapes, *e.g.*, positions 2 and 3, as it glides. Eventually the branches of it which sweep behind the nodes meet and coalesce, immediately after position 3, and produce a closed dislocation ring, 4, together with another line, 5, bridging the nodes. The ring 4 can expand to sweep over the whole slip plane, so producing one unit of slip, and the line 5 can repeat the entire sequence that started with line 1. There is thus a virtually unlimited production of dislocation rings on the slip plane of the Frank-Read source. This process, which has been confirmed by observations in silicon crystals by W. C. Dash (1956), is widely accepted as one way in which slip bands are formed; *i.e.*, bands of intense slip, involving thousands of dislocations, formed on certain slip planes in a plastically deformed crystal. It is not always necessary that dislocations be linked in a network for slip bands to

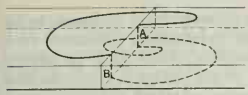

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FIG. 9.—MULTIPLICATION OF SLIP DISLOCATIONS BY THE CROSS-SLIP OF PART OF AN EXPANDING DISLOCATION RING, FIRST ONTO A PLANE (AB) AND THEN ONTO ANOTHER PLANE PARALLEL TO ITS ORIGINAL SLIP PLANE

form and in certain cases a single dislocation line is sufficient. Such a process, first discussed by J. S. Koehler (1952) and E. Orowan (1954) and since confirmed in lithium fluoride crystals by W. G. Johnston and J. J. Gilman (1960), is illustrated in fig. 8. It depends upon the fact that a screw dislocation can cross-slip from one slip plane to another, provided all such planes are parallel to the slip direction. As shown in the figure, an expanding dislocation ring may, by double cross-slip, transfer part of itself to a nearby parallel plane. A type of Frank-Read source is then created on both planes. This process, occurring repeatedly along a slip plane, produces a broad slip band dense with dislocations.

Work Hardening.—Most metals owe their plastic strength to obstacles which oppose the movement of dislocations. A great deal of metallurgical research is aimed at exploiting this principle. Among the more important of such obstacles are the dislocations themselves, which obstruct one another. This leads to the paradoxical fact that, although a metal is severely weakened by the first few dislocations formed in it, its strength improves again as more dislocations are added. As in road transport, dense traffic moves slowly. The simplest way to increase the density of dislocations in malleable solids is by plastic deformation, which generates dislocations by processes such as those of fig. 7 and 8. This leads to the well-known work hardening, an important means of strengthening many industrial metals and alloys by rolling, drawing and other processes of mechanical working. Yield strengths exceeding 300,000 lb. per square inch are produced in some steels by cold working. Experiments on single crystals of metals have shown that, provided slip occurs on only one family of parallel planes, there is not much work hardening. It is thus possible to stretch a single crystal of, say, cadmium to more than ten times its original length easily between the fingers. Work hardening occurs intensely when slip takes place simultaneously in different directions on two or more intersecting families of planes. Because of their cubic crystal structures metals such as copper, iron and aluminum commonly deform in this manner. Dislocations gliding in such planes interfere with and obstruct one another in several ways when they meet at the intersections. They may either attract or repel one another through the mutual effects of their elastic strain fields. They may lie across one another's paths, so that one dislocation line cannot advance without cutting through the line of the other. When these lines touch they may unite to form networks and new types of dislocations geometrically incapable of gliding. The general result is that the dislocations at such intersections become mutually locked together. Only at temperatures above about one-half of the absolute melting point, where the intense heat motion enables atoms to move about individually inside the crystal and anneals the obstacles, is it possible to reduce this work hardening substantially. At such temperatures the highly dislocated crystals are rapidly replaced by new, soft ones in a process of recrystallization and the material remains soft even while it is being plastically deformed. This is exploited in the industrial process of hot working. Pure lead and tin recrystallize even at room temperature, which is why they are so soft.

A basic process involved in the annealing of cold-worked crystals is the climb of edge dislocations, illustrated in fig. 9. Atoms jump onto the edge of the "half-plane" of the dislocation and raise it from one glide plane to the next. The atomic-sized holes or vacancies left by these atoms migrate into the crystal through the movements of other atoms into them and are eventually annihilated on the edges of other dislocations or at the surface.

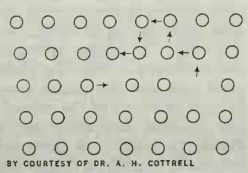

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FIG. 9.—CLIMB OF AN EDGE DISLOCATION BY THE CAPTURE OF NEIGHBOURING ATOMS, LEADING TO THE CREATION OF LATTICE VACANCIES

If two nearby dislocations have half planes which extend in from opposite sides of the crystal, the edges of these half-planes may climb toward each other and eventually coalesce, so producing one whole plane and a perfect crystal in a region where two half-planes and two edge dislocations previously existed. This is one way in which the density of dislocations is reduced by atomic movements during annealing. Another process, which occurs in plastically bent regions of the crystal where all the half-planes extend in from the same side, is shown in fig. 10. By both climbing and gliding, the dislocations can align themselves systematically into a vertical wall or boundary. The plastic curvature is then removed from most of the crystal, becoming concentrated in the boundary across which there is a sharp change in the direction of the crystal axes.

The study of this polygonization process and of dislocation boundaries provided some of the earliest evidence in support of the theory of dislocations (R. W. Cahn, 1947; W. T. Read and W. Shockley, 1950; J. Washburn and E. R. Parker, 1952). The dislocation structure is clearly discernible in boundaries across which the crystal axes are rotated through small angles. At angles greater than about 10°, however, the dislocations lie so closely together in the boundary that they produce a practically continuous layer of misfitting atoms along the boundary, analogous to a monolayer of liquid between the two crystals. This is the structure of typical grain boundaries such as are found in polycrystalline metals and alloys as ordinarily used in industry. Grain boundaries obstruct slip dislocations very strongly but the direct hardening caused by them is small because they are widely spaced obstacles, judged on the scale of most dislocation processes. The crystal grains in a typical industrial metal, for example, are about 0.01 cm. across. The main effect of grain boundaries is an indirect one; the plastically deformed grains are forced to slip on several intersecting glide planes in order to continue adhering together across their boundaries.

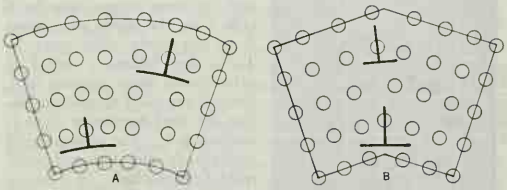

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FIG. 10.—FORMATION OF CRYSTALLITES IN A PLASTICALLY BENT CRYSTAL BY THE REARRANGEMENT OF EDGE DISLOCATIONS

Alloying.—The most important method of hardening metals is by alloying; that is, by adding other substances to them, either dispersed atomically through the crystal lattice or grouped into precipitates or small grains embedded in the main crystal grains. Most foreign atoms contained in a crystal are generally slightly too large or too small, by about 10% or so, for the atomic sites they occupy and are thus centres of lattice strain. Such atoms can fit better into atomic sites near the centre of an edge dislocation because the distorted lattice which exists there, as shown in fig. 9 (B), provides sites both larger and smaller than average. It follows that foreign atoms which expand the crystal are attracted to the expanded side of the dislocation, and vice versa. This attraction causes foreign atoms to segregate to dislocations at temperatures at which such atoms are able to migrate through crystals.

The effect is particularly important in mild steel because the carbon and nitrogen atoms in this material exist in the interstices between the metal atoms and can move through the crystal unusually rapidly along these interstitial channels. At room temperature, for example, such an atom makes about one jump per second from one interstitial site to the next. This means that, whenever a dislocation rests for a few minutes or hours at room temperature,

a swarm of carbon and nitrogen atoms move into it and take up positions of best fit near its centre. This is the process known usually as strain-age hardening or strain ageing. During the initial stages of ageing the interstitial atoms are distributed diffusely, forming an "atmosphere," along the dislocation lines. More prolonged ageing, particularly at a higher temperature, such as 200° C., causes the atmosphere to become so dense with segregated interstitial atoms that precipitation takes place and the dislocation lines then become decorated with small specks of iron carbide and other precipitated particles strung along them like beads on a necklace.

The mechanical properties of mild steel are profoundly affected by carbon and nitrogen ageing. A dislocation which is embedded in a swarm of interstitial atoms, whether as an atmosphere or a precipitate, is firmly locked in position by them and strong applied forces are needed to drag it away. On the other hand, as soon as it has moved a few atomic spacings away, it enters comparatively "clean" regions of the crystal and the force needed to continue its motion then falls spectacularly. This locking of dislocations by ageing, and unlocking only at high stresses, leads to many characteristic properties of steel. Until really large forces are applied the dislocations are so completely anchored by the interstitial atoms as to make aged steel one of the most perfectly elastic of all the malleable metals. The deviations from true elasticity which many other metals show under applied forces below their yield strengths, due to small movements of free lengths of dislocations between widely dispersed obstacles, can be completely suppressed. This is important in connection with the use of steel for springs and for wires in pre-stressed concrete. It may also account for the fact that steel, unlike other common metals, possesses a definite fatigue limit under oscillating forces. When a sufficiently large force is applied to aged steel the yield point is eventually reached. At this point free dislocations are produced which move and multiply rapidly, so producing a sudden burst of plastic deformation. As shown in fig. 11, the metal becomes softer when yielding occurs, due to the rapid multiplication of mobile dislocations inside it, and the force supportable by it falls from the upper yield point A to the lower yield point B. There then follows a period of deformation under constant load, through the yield elongation, before the work-hardening curve is reached at C. The original yield strength is not regained until point D is reached. In a tensile bar, for instance, the plastic elongation needed to reach this point amounts typically to about 2%. It follows that, when such a bar is made to support a constant load at the level of the upper yield point, once one section of the bar begins to yield it must continue to do so until it reaches the point D in order to continue supporting the load on it. The plastic deformation of yielding steel is thus extremely non-uniform. Completely unyielded sections can exist next to other sections that have yielded and strained plastically by some 2%. Bands of differently deformed material, known as Lüders bands or lines, or stretcher strains, form across the material and are made clearly visible by changes in surface level caused by the difference in strain between them. These irregular bands of deformation are a source of trouble in the pressing of steel sheet and various steps are taken to avoid them. One method, known as temper rolling (a term sometimes also applied to cold rolling to stiffen a sheet) or leveler rolling, involves pre-straining the metal before pressing, to overcome the yield point everywhere in it. If the pressing is then made quickly afterward, before strain ageing has caused the yield point to return, a smoothly pressed sheet can be produced: various non-ageing steels are also made. In general carbon is less soluble in iron than is nitrogen and can be made relatively unimportant in strain ageing by precipitating it in large particles during a preliminary heat-treatment. Nitrogen, being more soluble, is dealt with differently, by adding substances such as aluminum, manganese and vanadium, which have an affinity for it and "fix" it in the lattice, so preventing it from reaching the dislocations during strain ageing. At higher temperatures, *e.g.*, 400° C.–600° C., these metallic alloying elements become mobile and able to migrate themselves, with the carbon and nitrogen, to dislocations. Strain ageing due to the precipitation of alloy carbides and nitrides in dislocations thus appears in many steels of this type at elevated temperatures. The metal then retains or even improves its strength at such temperatures. This is the principle underlying some types of creep-resistant alloy steels, notably those containing 0.5% molybdenum which are used for superheater tubes and pipes in steam power plants. Niobium, which forms precipitates of niobium carbide on dislocation lines, has been added to high-alloy steels to improve their strength at high temperatures.

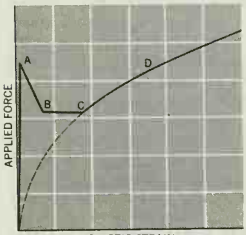

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FIG. 11.—YIELD POINT OF AGED STEEL

Many alloys, including the age-hardening aluminum alloys, are hardened by the formation of large numbers of finely precipitated particles dispersed throughout the crystal grains. Some of these particles are precipitated on dislocation lines but most are distributed randomly throughout the crystal lattice. The hardening in this case is due to the difficulty the dislocations have in moving past the many precipitates they meet as they glide in their slip planes. Since this is a dispersed form of hardening which opposes a dislocation throughout its entire glide motion, the material does not become markedly softer at the instant of yielding. N. F. Mott and F. R. N. Nabarro first explained, in 1947, how precipitation hardening could originate from localized stress fields around the precipitated particles, which oppose the stress field acting on the dislocations from the applied force. A. Kelly (1959) and R. B. Nicholson (1959) have shown that dislocation lines actually cut through the very fine precipitates and that an important contribution to precipitation hardening comes from the resistance these particles offer to cutting. If the precipitation process is allowed to proceed too far, as in over-aging, the numerous fine precipitates are then replaced by a smaller number of coarse ones and the spacing between these becomes sufficiently large to allow the dislocation lines to pass between them. The material is then soft. This over-ageing is important in those creep-resistant alloys that depend for their strength on finely dispersed particles, since at high temperatures atoms migrate rapidly in the crystal structure and can readily cause the particles to coarsen. One of the aims in such alloys is to form particles that remain stable at high temperatures; *e.g.*, aluminum oxide in aluminum, a nickel-titanium-aluminum compound in nickel, and alloy carbides in cobalt and high-alloy steels.

Fractures.—Although dislocations generally prevent malleable solids from fracturing by making them soft, they also contribute in several ways to processes of fracture. Highly ductile materials fracture under tensile forces when the dislocations in them cannot produce any more work hardening; the material then has no further protection against the enlargement, by localized plastic flow, of holes or other geometrical irregularities in it. In more brittle crystals fracture is sometimes caused by the rapid "piling-up" of dislocations at intersections of their own slip planes with grain boundaries or other slip planes. Examples of such fractures have been observed in ionic crystals such as magnesium oxide. There is evidence to suggest that the brittleness of some steels at low temperatures is due to similar processes, related in this case to the interstitial locking of dislocations and to the creation of deformation twins. In fatigue deformation the dislocations glide forward and backward in their slip planes with the oscillations of the applied load and this causes sandwiches of material in slip planes to slide in or out of the crystal. At the surface of the specimen this material may move out, to form an "extrusion" standing above the surface, or move in, to leave a groove behind which eventually becomes a fatigue crack.

See also ALLOYS; HEAT-TREATMENT; METALLURGY: *Heat Treatment;* IRON AND STEEL INDUSTRY: *Steel Metallurgy;* MATERIALS, STRENGTH OF: *Testing of Materials;* SOLID STATE PHYSICS: *Physical Properties of Solids.*

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(A. H. CL.)

CSÁRDÁS or CZARDAS, Hungarian national dance in $\frac{4}{4}$ or $\frac{2}{4}$ time, in two parts: slow (*lassu*), played andante maestoso, and quick (*friss*), played allegro vivace. A ballroom dance adapted from the csárdás is popular in eastern Europe. As a character dance in ballet, the csárdás is danced with complicated, theatricalized Slavic and Hungarian folk dance steps, as in Delibes' *Coppélia* and Tschaikovsky's *Swan Lake*. (LN. ME.)

CSOKONAI VITÉZ, MIHÁLY (1773–1805), born in Debrecen, Nov. 17, 1773, was the most outstanding Hungarian poet of the 18th century. Throughout his life, he had to contend with uncommon difficulties. First an assistant master in his own old Calvinist college at Debrecen, he was soon dismissed, and lived thereafter as a wandering poet. For the sake of a wealthy girl (the "Lilla" of his poems) he tried to secure a permanent post, but by the time he had obtained a deputy mastership in a small town she had already married. Csokonai returned to Debrecen a poor man and a consumptive, and died there (Jan. 28, 1805) without having seen his poems published.

Csokonai had a great interest in form; he was one of the first Hungarian theorists of prosody, and the first to unite with ease Hungarian forms and the rhymed metrical ones of western Europe. His poetry breathes the spirit of the Enlightenment, of the abortive Hungarian Jacobinism. It is vigorous, often ironical, sometimes sentimental. His poems have a graceful musical charm and often also the savour and humour of peasant songs. He was also the author of plays, and of the first Hungarian comic epic, *Dorottya* (1804), a work influenced by Pope but nevertheless Hungarian in form and content.

Csokonai's collected works were edited by I. Harsányi and J. Gulyás, 3 vol. (1922). (N. KI.)

CSOMA DE KŐRÖS, ALEXANDER (1784–1842), or, as the name is written in Hungarian, KŐRÖSI CSOMA SÁNDOR, Hungarian traveler and philologist, was born April 4, 1784, at Kőrös in Transylvania to a poverty-stricken noble family. He was educated at Nagyenyed and at Göttingen. In 1820 he set out for the east to investigate the origin of the Magyars. He visited Egypt and then disguising himself as an Armenian he crossed central Asia to Tibet, where he spent four years in a Buddhist monastery studying the language and the Buddhist literature. His knowledge of Tibetan obtained him employment in the library of the Asiatic society of Bengal, which possessed more than 1,000 volumes in Tibetan; and he was afterward supported by the government of Bengal while he published a Tibetan-English dictionary and a Tibetan grammar (1834). He also published an analysis of the Buddhist sacred books, the *Kanjur* (*bKah-hgyur*). The Hungarian government granted him a pension which he devoted to the purchase of books for Indian libraries. He spent some time in Calcutta studying Sanskrit and several other languages; but, early in 1842, he commenced his second attempt to discover the origin of the Magyars. He died at Darjeeling on April 11, 1842. An oration was delivered in his honour before the Hungarian academy by József Eötvös, the novelist.

CTENOPHORA, a phylum of unusual marine animals that look like small, clear, ovoid balls of jelly. They are commonly known as comb jellies, sea gooseberries, sea walnuts or cat's eyes. *See* COMB JELLY.

CTESIAS (fl. early 4th century B.C.), Greek physician and historian, was the author of *Persica*, a history of Assyria and Persia, based on Persian authorities. Born at Cnidus in Caria, he was in early life physician to Artaxerxes Mnemon, whom he accompanied (401) on his expedition against his brother Cyrus the Younger. Ctesias was also the author of treatises on rivers and on the Persian revenues, and of an account of India. The *Persica*, written in the Ionic dialect, was professedly founded on the Persian royal archives. The first six books treated of the history of Assyria and Babylon to the foundation of the Persian empire; the remaining 17 went down to the year 398. Of the two histories there are abridgements by Photius, and fragments in Athenaeus, Plutarch and Diodorus Siculus, whose second book owes much to Ctesias.

As to the worth of the *Persica* there has been much controversy. Being based upon Persian authorities, it was naturally looked upon with suspicion by the Greeks and regarded as untrustworthy, a view which, even when allowance is made for the condensation of Photius, seems likely to be right.

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(G. T. GH.)

CTESIPHON (TUSBUN, TAYSAFUN), an ancient city on the Tigris river, 20 mi. S.E. of Baghdad, in central Iraq. Winter capital of the Arsacid (Parthian), later often of the Sasanian empire (*see* PERSIAN HISTORY), the site is famous for remains of a gigantic vaulted hall, the Taq-e Kisra, traditionally regarded as the palace of Khosrau I, though Shapur I also undertook work on the site. First mentioned by Polybius in 221 B.C., Ctesiphon was originally a Greek army camp on the east bank of the Tigris opposite Seleucia. Air survey shows that in modern times the course of the river has shifted, no longer flowing between the cities but dividing the site of Ctesiphon. When in 129 B.C. the Arsacids finally annexed Babylonia, they found Ctesiphon a convenient residence and cantonment. As this royal suburb of Seleucia grew, the two came to form a twin city, a status symbolized by coins issued soon after 31 B.C. showing two city-goddesses joining hands over an altar. Ammianus' statement that Ctesiphon was "founded" by a king Vardanes, then enlarged and fortified by Pacorus, is of uncertain interpretation; yet its typically Parthian circular plan contrasts with the rectangular layout of Greek Seleucia. Roman occupations of the twin capitals began with the emperor Trajan in A.D. 116. In the sack of both by the Roman general Avidius Cassius in A.D. 165, the Arsacid palace of Ctesiphon was destroyed and Seleucia depopulated, an event which extinguished local Greek culture. Septimius Severus, entering Ctesiphon in A.D. 197, found Seleucia abandoned. As late as A.D. 283 Ctesiphon was briefly occupied by the emperor Carus. The Sasanian monarchy finally replacing the Arsacid in A.D. 228 greatly favoured Ctesiphon, though Ardashir I also resettled the west bank to found Veh Ardashir (Arabic, Bahurasir). Farther east Asfanabr, site of the Taq-e Kisra, and Veh-Andiokh-Khosrau (Arabic, Al Rumiya), a settlement for the Roman captives of Khosrau I, were other Sasanian suburbs.

The Arabs in A.D. 637 conquered this city-complex, called by them Al Mada'in (the capitals), obtaining immense booty. At first they used the Taq-e Kisra as an improvised mosque. Its splendid murals survived until the 9th century A.D. It was at Al Rumiya that the caliph al-Mansur executed his lieutenant Abu Muslim, but when in 763 he founded Baghdad; Ctesiphon was deserted except as a quarry for building material.

During World War I a battle, preceding the siege of Kut, took place on the site of Ctesiphon between British and Turkish armies (1915). (A. D. H. B.)

CUANZA: *see* KWANZA.

CUANZA NORTE, a district of the Portuguese overseas province of Angola, west Africa, is divided from Cuanza Sul district by the Cuanza river. Pop. (1960) 263,101. Area 12,050 sq.mi. The district has five *concelhos* (counties); the capital is Vila Salazar. Cuanza Norte is rich in mining and agriculture. Manganese ore (Cazengo and Golungo Alto), iron ore (M'Bassa, near Zenza do Itombe) and bituminous coal are extracted. Agricultural production is varied but the main products are coffee, sisal, palm oil, palm kernels, peanuts, castor beans, tobacco, cotton, broad beans and cereals. There are also minor industries: the preparation of coffee, cotton and sisal, the extraction of oils and the making of soap. At Cambambe a dam was begun, designed to produce 1,300,000,000 kw. of electric power. The region has a remarkable beauty of landscape. The railway and road from Luanda to Malanje pass through the south of the district.
(A. A. G. P.)

CUANZA SUL, a coastal district in the Portuguese overseas province of Angola, west Africa. Pop. (1960) 405,012. Area 17,317 sq.mi. The district (capital, Novo Redondo) has seven *concelhos* (counties). There is profitable fishing at Porto Amboim and Novo Redondo. The main agricultural products are coffee, cotton, sisal, palm oil, palm kernels, peanuts, sesame and castor beans, tobacco, crude rubber, broad beans and cereals. Stock is intensively bred. Land is exploited chiefly by big companies, although cereals, cotton and some of the coffee are produced by Africans. Industries include the preparation of coffee, cotton and sisal; the production of fish oil and meal; the extraction of vegetable oils; milling; the production of soap and ceramics; dairying and meat preserving. Porto Amboim is served by a railway to Gabela (80 mi.) which carries the products of the interior.

(A. A. G. P.)

CUBA, the largest and most populous island in the Antilles, more commonly called the West Indies. Together with the Isla de Pinos (1,182 sq.mi.) and more than 1,600 offshore islets and keys which are included in the national territory, Cuba's total area is 44,218 sq.mi. This represents more than half the area of the entire Antillean chain. The shape of the main island is long and narrow, resembling an irregular crescent convex to the north. Its length along an east-west axis from Cape Maisí to Cape San Antonio measures about 746 mi.; its breadth averages about 62 mi. but varies from a minimum of 22 mi. to a maximum of 124 mi.

Cuba is strategically located at the entrance to the Gulf of Mexico, between the parallels 19° 49′ and 23° 15′ N., and the meridians 74° 8′ and 84° 57′ W. This location has been significant in both the historical and the economic development of the island. During the colonial period, Cuba's commanding position at the entrance to the Gulf and Caribbean astride the sea lanes to Mexico, the Isthmus of Panama and other important points made the island so valuable that the Spaniards referred to it as the "key to the new world." After its independence, Cuba's proximity to the great population centres and markets of the eastern United States was a major factor in its economic growth. Since 1960, its alignment with the Soviet Union has changed its economic orientation.

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I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—The geological history of the physical features of Cuba is a complicated one. The foundation of the island is composed of metamorphic and igneous rocks such as schist, slate, marble and granite of pre-Cretaceous Age. Several periods of crustal disturbance occurred from Late Jurassic time. Periods of more or less intense folding and uplift alternated with periods of subsidence of the island, accompanied by the deposition of several thousands of feet of strata. A period of intense folding along approximately 350 mi. of the northern coast occurred in the Late Cretaceous, accompanied by a considerable amount of volcanic activity that resulted in thick series of tuffs, volcanic breccia and flows. The folding of the Eocene was the most intensive, as well as the most widespread, of the periods of deformation. Thrusts and overturned folds occurred in western, central and eastern Cuba, and basaltic flows in the east.

The last period of folding occurred after the deposition of the Middle Miocene, about 20,000,000 years ago, and developed along the structural lines of the earlier foldings. Cuba was raised above sea level and was united with the other Antilles. Following the last folding a sharp uplift resulted in widespread faulting. The most striking fault zone was that of the large fault block of the Sierra Maestra of southeastern Cuba, which was tilted toward the north and was separated from the islands to the southeast by the very deep Bartlett trough.

Later, in the Pliocene period, erosion reduced a large part of Cuba almost to a plain. A slow, irregular emergence in the Pleistocene caused marine terraces that now mark the island's coast line, especially at the eastern end. The Recent period, which includes the last 50,000 years, has been characterized by slight coastal emergence in some areas and submergence in others. Most of the pouch-shaped embayments, which make excellent harbours, were formed during this period, when slight submergence inundated the mouths of rivers.

Cuba is still subject to some crustal instability, and several destructive earthquakes have been recorded, such as at Santiago de Cuba in 1578 and 1678. The zone of maximum instability is along the northern escarpment of Bartlett trough, where the Sierra Maestra rises abruptly from the sea, and light seismic disturbances are felt every year.

The general structure of Cuba is broadly anticlinal with several systems of folding superposed on the broad arch. The southern flank is wider and gentler in dip than the northern one. A chain of low anticlines runs in echelon through the island along trends of structural weakness that are roughly parallel to the west-east axis of the island itself.

Most of the soils have been derived from limestone and have a high clay content. Typical of these is the famous Matanzas red clay, the leading soil used for sugar cane. Alluvial soils are extremely fertile but are confined to narrow flood plains of the streams.

2. Physiography.—Most of Cuba consists of gentle slopes and rolling land. Mountains cover about one-fourth of the total area and are widely spread from one end of the country to the other, with large plains areas between mountain concentrations. The fact that nearly three-quarters of its terrain consists of relatively level land is significant for agricultural utility, particularly in facilitating cultivation and transportation.

The characteristics of the present relief of Cuba are the result of the interaction of two groups of forces. The constructive, or orogenic, forces have determined the structure and alignment of the land forms, while the destructive, or erosive, forces, such as water, winds and waves, have sculptured the original structure into the present forms.

The alignment of Cuban land forms consists of four principal wings arranged in echelon, like a series of steps. The northernmost wing is a long, asymmetrical folding, much worked by erosion, which extends from western Pinar del Río into the northern sections of Havana and Matanzas provinces. The Havana-Matanzas section consists of two low anticlines separated by a syncline—all arranged in an east-west direction. The Pinar del Río section, however, has had such pressures applied that folds were overturned and old rocks rest on top of younger rocks in places. The second wing, at the centre of the island, is a complex system of igneous intrusions in the centre of Las Villas and of overturned folds in

the southern part. The third wing, from Camagüey into northern Oriente, consists of folded structures and serpentine intrusions, but most of the region has been reduced by erosion to the condition of a peneplain (almost plain). The fourth or southernmost wing is a complex area of folding, large domal intrusions and plateau structure in the extreme east, and the great fault block of the Sierra Maestra rising sharply out of the sea.

The average elevation of Cuba is reported to be about 325 ft. above sea level. The highest elevation is 6,578 ft. at Pico Turquino in the Sierra Maestra, and a considerable part of the mountainous region of extreme southeastern Cuba lies above 2,000 ft. Highest elevations in Camagüey are just over 1,000 ft. In the Trinidad mountains of southern Las Villas the highest peak is 3,800 ft. The highest elevation in Pinar del Río is 2,389 ft., near the north coast.

More than 200 rivers drain the surface of Cuba. Most of these run toward the north or toward the south, dividing approximately along the axis of the island. Many of the rivers empty into wide, deep estuaries that allow navigation for a short distance from the coast line. Because of the narrow width of the island, almost all of the rivers are short. The largest is the Cauto, 155 mi. in length, which runs parallel to the Sierra Maestra through the wide plain of western Oriente.

Cuba's coast line of approximately 2,200 mi. has an extraordinarily large number of good harbours, chief of which are the pouch-shaped or bottlenecked harbours, which have narrow entrances but commodious anchorage. The main bays of this type are Honda, Cabañas, Mariel, Havana, Nuevitas, Puerto Padre, Nipe and Tánamo on the north coast and Guantánamo, Santiago de Cuba and Cienfuegos on the south coast. The principal open bays are Matanzas and Cárdenas.

3. Climate.—Cuba's insular position near the northern limit of the tropics results in a climate that can be described as maritime subtropical, but variations from this type are common. The fact that no place is far from the sea has a moderating effect on the temperature, but the effects of elevation and of exposure to predominant winds are also felt.

The fundamental characteristic of the temperature is its relative uniformity during the year and from year to year. Mean temperatures range from 70° F. in January and February to 81° in July and August, decreasing, of course, with elevation. Extremes are greatest in the interior. Maximum temperatures above 90° are rare; minimum temperatures below 50° are equally rare except in the mountains, where freezing temperatures are occasionally recorded. Coastal areas are moderated noticeably by the trade winds, which are steady throughout the year, blowing from the northeast in the winter and from the east to southeast in the summer. Occasional masses of cold air from the continental United States in the winter affect the northern coast of Cuba.

Since temperature is a relatively uniform characteristic of the climate, rainfall is the most important climatic element in Cuba. Rainfall is abundant, averaging 54 in. annually for the island as a whole. The wettest part of the island, averaging more than 65 in., is the mountainous section of Pinar del Río. The driest place, averaging less than 30 in., is in the basin of Guantánamo on the leeward, southern coast of Oriente. Throughout Cuba there are two seasons: the rainy season and the dry season. The rainy season, corresponding to the high-sun period of intense convection, extends from May to November, during which about three-fourths of the yearly rain falls. Actually, two distinct maxima are evident during the rainy season. The June maximum is caused by the daily thunderstorms of the period of vertical sun; the September maximum is related to the hurricanes.

Cuba is situated in a zone frequented by tropical cyclones, or hurricanes. Such storms may occur at any time from June to November but are commonest in September and October. Seldom does a decade pass without hurricanes of at least local severity. Since they measure as much as 400 mi. in diameter, their effects are felt widely. High wind velocities and heavy rainfall, as well as wind-driven waves, may destroy houses, crops, shipping and even human life. The probability of hurricanes increases from east to west, being highest in Pinar del Río and lowest in Oriente.

4. Vegetation.—Climatic and soil conditions of Cuba make possible a flora of splendid richness, comprising characteristic species of the West Indies, southern Florida, Mexico and Central America. The total number of native flowering species has been estimated at between 5,000 and 6,000. In addition, much of the original vegetation cover has been replaced by many exotic cultivated plants, particularly sugar cane, coffee, cacao and bananas.

Large forests of valuable woods covered the fertile plains of Cuba before the extension of agriculture. Almost all of the forests of the plains have disappeared, while much has been preserved in the mountain districts. As a result of the distinct seasonal nature of the rainfall, true tropical rain forests are found only in a small section of the eastern coast near Baracoa, where windward exposure to trade winds results in fairly well-distributed rainfall. Elsewhere, forests exhibit varying degrees of semi-deciduous formations. The principal zones of forest remaining are the mountains of Pinar del Río, Trinidad mountains, Sierra Maestra and the highlands of Baracoa and Nipe. Pine forests are fairly extensive in Pinar del Río, Isla de Pinos and the Nipe mountains of northern Oriente. The chief species that have been left standing in the heavily deforested plains are the royal palm and the ceiba. The stately royal palm (*Roystonea regia*), considered the national tree, attains a height of 50 to 75 ft. and sometimes of more than 100 ft., and every portion, from roots to leaves, serves some useful purpose. The beautiful ceiba (*Ceiba pentandra*), or silk-cotton tree, often grows to a height of 100 to 150 ft., with enormous girth and wide-spreading branches, and is an object of reverent fear to many rural inhabitants.

In addition to the pine and cedar, there are at least 40 choice cabinet and building woods, including oaks, mahogany, lignum vitae, ebony, granadilla, ácana and sabicu. Many species of woods are rich in gums and resins; others are oleaginous; and many are medicinal. There are also various dyewoods. More than 30 species of palms, including the coconut palm, are common features of the landscape.

Savannas, signifying a tropical landscape with few trees, originally covered about one-fourth of Cuba. The sparse vegetation is not the result of lack of rainfall but rather of the soils that are unable to retain sufficient moisture for a richer vegetation. Fairly large areas of sandy soils in southern Pinar del Río, western Las Villas and much of Camagüey are covered with poor grass, palms and woody shrubs.

Mangrove forests cover much of the extensive coastal areas, especially along the inundated southern coast.

Among the common fruits are custard apples (*Annona reticulata*), sweetsops (*A. squamosa*), soursops (*A. muricata*), star apples (*Chrysophyllum cainito*), papayas (*Carica papaya*), mammee apples (*Mammea americana*) and avocados (*Persea gratissima*).

5. Animal Life.—The main characteristics of Cuban fauna are (1) great richness and variety of species and varieties; (2) paucity of vertebrates; (3) profusion of lower species; (4) existence of species of small size; and (5) localization of species. Some species are limited or localized to a very small range.

Indigenous mammals include 23 species of bats, 6 species of rodents and 2 species of insectivores. The predominance of bats over land mammals is a phenomenon opposite to that which occurs on continents. Although some bats live in abandoned buildings and attics, the most numerous are those that inhabit the innumerable caves of the limestone regions and furnish valuable guano. The largest bat (*Noctilio leporinus mastivus*) feeds on small fish; the smallest is called the butterfly bat, subgenus of *Natalus: Nyctiellus lepidus*. Three species of large rats, one of which is in part arboreal (*Capromys prehensilis*), inhabit forested areas and are now relegated chiefly to the mountains. The *Solenodon cubanus* is a peculiar and very rare insectivorous mammal nearly two feet long. The manatee or sea cow frequents the mouths of rivers.

Birds recorded in Cuba number about 297 forms (species and subspecies). Only about 70 are indigenous. Many are familiar North American migrants, resident in the West Indies in winter. One of the most striking of the native types, the Cuban macaw, is extinct as a result of deforestation and agricultural expansion. The

distinctively American group of hummingbirds is represented by three species.

Reptiles and amphibians are few as compared with the Central American region, but there are numerous species of frogs and of lizards. The largest lizard is the iguana (*Cyclura macleayi*). There are two species of crocodile, one known as the cayman, the other as the *cocodrilo*. There is a common fresh-water turtle. Cuba has no poisonous snakes, though there are several kinds of small boas.

The marine fishes are those of the West Indian region in general, a rich tropical fauna with many brilliantly coloured types. Marine invertebrates include more than 4,000 species of mollusks. Cuba is especially rich in land snails.

Insect life is varied and abundant; 17,000 species are said to have been described. The near extinction in 1902 of *Aëdes aegypti*, the mosquito that carries yellow fever, was one of the early triumphs of medical entomology. *See* YELLOW FEVER.

II. GEOGRAPHICAL REGIONS

The landscapes of Cuba can be grouped into four major geographical regions on the basis primarily of relief. The resultant natural divisions reflect differences not only in physiography but also in other elements of the geographical landscape, such as vegetation, soils and human activities. The four regions thus distinguished are Occidente (comprising essentially the three western provinces), Las Villas (most of the central province), Camagüey (and the northwestern part of Oriente province) and Oriente.

1. Occidente.—The region of Occidente extends from westernmost Cape San Antonio to the savannas of Manacas in western Las Villas province, encompassing all of Pinar del Río, Havana and Matanzas provinces—about 26% of the national territory and about 40% of the nation's population.

Western Cuba exhibits two main zones of folding. One is prolonged from southwest to northeast along Pinar del Río; the other extends east to west in the north-central sections of Havana and Matanzas. The backbone of the westernmost section is the Sierra de los Órganos, a strangely beautiful landscape of haystacklike, brush-covered hills separated by numerous fertile, flat-floored valleys. Toward the east is the more rounded though higher (to 2,389 ft.) Sierra del Rosario, in whose high valleys is some coffee. On both flanks of the Sierra de los Órganos are pine-covered hills. From the longitude of Havana bay eastward extend three series of parallel heights, separated by long synclinal valleys. The northernmost series is very close to the north coast.

The northern plain of Pinar del Río is a narrow strip between the mountains and the coast, whereas the southern plain is relatively wide and slopes gently to the swampy coast. For the most part the soils of the southern plain are sandy and used mostly for pasture, except in certain sections where applications of fertilizer have produced the world-famous Vuelta Abajo tobacco. Rice, by means of irrigation, has become important in places.

The red plain of southern Havana and Matanzas contains some of the best soils of Cuba. The red clay soils of great depth and of excellent permeability yield great quantities of sugar cane, rice, pineapples, plantains, vegetables and other agricultural products. A considerable part of the agricultural production, especially around Güines, is aimed at the metropolitan Havana market.

The peninsulas of Guanahacabibes and of Zapata extend southward to the Caribbean. The westernmost, Guanahacabibes, is flat, little populated, and is in part extremely rocky and in part covered by swamps and lagoons. The Zapata peninsula is also very sparsely populated, consisting of vast areas of mangrove swamps surrounding the low, rocky axis of the peninsula. The chief activity is charcoal making.

2. Las Villas.—The region of Las Villas occupies the central portion of Cuba and encompasses almost all of the province of Las Villas, except the Zapata peninsula, and includes a small part of western Camagüey. Its area is approximately 20% of the national territory, and its population is about 20% of the nation.

Rising from the southern coast of Las Villas are the Trinidad mountains, where several peaks of more than 3,000 ft. elevation are found. The complexly folded structure of the mountains is cut by an intricate system of drainage that has resulted in steep, tortuous valleys in many places. Beautiful waterfalls, such as on the Hanabanilla river, are fairly common. A few valleys are sufficiently large for intensive agricultural use. Coffee, sugar cane and tobacco are the main crops. The highlands continue east of the Agabama river as the Sancti Spíritus mountains, which are somewhat lower. To the north of the Trinidad mountains and slightly separated are the Santa Clara hills, which consist essentially of intrusions of granite and serpentine. Undulating relief and savanna-type vegetation have given rise to cattle raising and tobacco growing as the chief activities.

The northern section of Las Villas consists of a very low cordillera and a coastal plain of variable width. The hilly part is prolonged for about 125 mi. parallel to the coast and is highest at the eastern end, where it rises to 1,600 ft. The highly productive soils of the coastal plain and of the valleys of the Sagua la Grande and Sagua la Chica rivers form one of the nation's chief sugar-cane and tobacco regions.

Moderately extensive plains extend west and east of the Trinidad-Sancti Spíritus mountains. More than one-half of the fertile plain north of Cienfuegos bay is cultivated, and the density of population is very high. The sugar industry is the base of the economy. The plain extending from Sancti Spíritus to the Caribbean coast is also one of the most productive agricultural sections of Cuba. Its chief products are sugar, tobacco and dairy products.

3. Camagüey.—The region of Camagüey extends from the western part of the province to include the northwestern section of Oriente as far as Nipe bay. It contains more than one-fourth of the national territory but less than 20% of the nation's population. In general, Camagüey's relief is dominated by plains, with undulating sections and a few steep areas. Three areas of hilly relief can be distinguished. The so-called Sierra de las Cubitas in north central Camagüey consists of a large overturned fold of hard limestone formations with the most notable caves in Cuba. A low, isolated hilly section also rises southeast of Camagüey city. The third hilly section is found in the extreme eastern part of the region between the coast line and the Cauto plain.

The undulating central plain extends from the city of Camagüey to Holguín. The area is one of extensive savannas with generally gravelly and sandy soils, except around Holguín where soils are heavier. The major activity is cattle raising on the extensive pastures, which support about one-fifth of all Cuban cattle. Chromite is mined in this section. Some sugar cane is grown, and the area around Holguín is a significant producer of beans and other staple foodstuffs for the nation.

The northern and southern coastal plains of Camagüey slope gently from the slightly upraised interior toward the coasts. Good soils predominate, and the production of sugar cane is the chief economic activity, supplemented by livestock raising in parts of the southern plain. The plains were sparsely inhabited until after the beginning of the development of the sugar industry about 1900. Several huge sugar mills grind the cane, making Camagüey the nation's leading sugar province.

The section known as La Trocha plain lies completely across the width of the island in western Camagüey. Its red clay soils are among the most productive in Cuba and are cultivated intensively for sugar cane, pineapples, oranges, potatoes, rice and other crops. Although isolated by lack of transportation facilities during the colonial period, La Trocha grew rapidly after 1905.

4. Oriente.—The region of Oriente includes the greater part of Oriente province, excluding the northwestern section. It comprises about one-fourth of the nation's territory and population.

Oriente presents the most rugged relief of Cuba, particularly as represented in the Sierra Maestra, which extends along the southern coast from Cape Cruz for about 150 mi. to Guantánamo basin. The fault-block range rises steeply and majestically from the depths of the Bartlett trough to heights of more than 6,578 ft. above sea level. The southern slopes are almost uninhabited, but the northern slopes are smoother, and the valleys are used for coffee. Manganese deposits are exploited. Much of the Sierra is covered by dense forests.

The highlands of Baracoa are a jumble of mountains occupying the eastern and northeastern sections of Oriente; a few peaks of more than 3,500 ft. elevation are found. The intricate relief of the mountain masses and the restricted coastal plains have left much of the section isolated and hardly explored. The pine and other forests of the Sierra del Cristal have been set aside as a national park. Production of bananas, coffee and cacao is carried on around Baracoa.

The Nipe mountains of northern Oriente form a wide, pine-covered plateau that is essentially an intrusion of igneous rocks metamorphosed into serpentine. Most of the soils are without agricultural value. The Nipe clay soils, however, have a very high content of iron and aluminum and some manganese, chrome and nickel, which are being exploited. Pine lumbering is also an important activity.

From the productive plain around Nipe bay an extensive plain stretches westward for nearly 100 mi. to the Gulf of Guacanayabo. This wide plains area is drained by the Cauto river, the largest in Cuba. The area is not densely populated, partly because of the widespread flooding during the rainy season and also because of the extensive coastal marshes. Livestock raising is one of the principal activities, centring on Bayamo. Sugar cane is spread along the inner margins of the plains.

The Central valley and the Guantánamo basin lie between the Sierra Maestra and the northeastern mountains of Oriente. Both have good soils and are important sections in the production of sugar cane. Coffee grown on the slopes of the surrounding mountains is also very important. The small basin of Santiago is nearly squeezed into the sea by several arms of the Sierra Maestra. There is a little agriculture in the plain behind the Bay of Santiago and its important commercial city. (D. R. D.)

III. THE PEOPLE

1. Ethnic Groups.—The Cuban population is derived from countries of Europe, Africa and Asia, and from the Indians who inhabited the island at the time of its discovery by Columbus. Of least importance in the Cuban blood stream are the aborigines; there are no Indians recognizable in the population, although the precise degree of representation can never be known. Asians, mainly Chinese, make up less than 1% of the population. Of major importance are the descendants of Africans who were brought in originally as slaves. About one-eighth of the population qualified as Negro and one-seventh as mulatto, according to census enumerators. The remainder, or nearly three-fourths, is classed as white, mainly of Spanish descent. Classification according to race is left to the census enumerators to judge on the basis of physical appearance, however, and it is more than likely that the proportion of the population with some Negro ancestry is much higher than the figures indicate.

Indian.—The pre-Columbian inhabitants consisted of two main groups, the Ciboney and the Taino. There is evidence of some other cultures, or subcultures, but the above-named are generally regarded as the main ones. Of the two, the Taino, an Arawak-speaking group, had the most advanced culture and had apparently subjugated the Ciboney, whom they used as servants. The Taino occupied the eastern portion of the island, practised agriculture, lived in uniquely constructed houses called *bohios* and were expert in making pottery and highly polished stone implements.

Although by all accounts the Taino were a nonwarlike people, the conquistadors treated them with unmerciful ferocity, slaying them with slight provocation and virtually enslaving them under the system known as the encomienda. Harsh treatment, forced labour (mainly digging for gold) and exposure to disease brought in by the Spaniards resulted in their virtual extinction by the middle of the 16th century. While no physical traces of them remain, they bequeathed to modern Cubans the *bohio*, the most common dwelling of the rural areas, and the culture and utilization of a number of plants, notably tobacco and cassava.

Negro.—As previously noted, the Negro stock is very important in Cuba. Some Negroes were doubtless brought in very early, even before the Indians were extinguished. The Spanish government approved the importation of African slaves to its colonies as early as 1517, only six years after the conquest of the island by Diego Velázquez. However, there was little need for slave labour for the ensuing 250 years, since the major preoccupation of Spain was with the richer resources of the continent. New markets for sugar following the independence of the United States and the revolt of the slaves in Haiti in 1791 (which practically eliminated that country as a producer) opened the way for vast expansion in Cuba. This called for the rapid importation of slaves with the result that from about 1790 to 1850 the Negro population (not all of them slaves) exceeded the white. Although slavery was abolished officially by various treaties (1815, 1817, 1835) and by Spanish law in 1845, contraband traffic continued until around 1885.

The large number of slaves brought in during the 18th and 19th centuries was augmented in the 20th century by immigration from other Caribbean islands, notably Haiti and Jamaica. Many came originally to work during the harvest and found ways of remaining. Thus, the importance of African stock in the population is second to, and not far behind, that of the European.

Negroes have enriched Cuban life in many ways: Afro-Cuban music and dances are internationally known and enjoyed. Persons of Negro stock are among the most famous musicians of Cuban history. Nevertheless, problems of assimilation remain that require tolerance and able leadership for their solution.

Chinese.—Of considerable importance, though few in number, are the Chinese. In part, they are the descendants of coolies imported as indentured servants to take the place of the Negroes after the importation of the latter was forbidden in 1845. Usually the contracts were for eight years. Large numbers are reported to have died at sea on the miserable ships, while the mortality after arrival was also high because of conditions of work and maltreatment. In 1864 a treaty between China and Spain brought some improvement. By 1877 the number of Chinese was about 44,000, declining to fewer than 18,000 by 1953. Since the Chinese were predominantly men, it was only to be expected that they would marry Cuban women: white, Negro or mixed. They found an important niche in the Cuban economy as operators of laundries, restaurants and other small business enterprises and by producing truck crops on the fringes of the large cities. Establishment of diplomatic and trade relations with the People's Republic of China after Fidel Castro came to power in 1959 brought an influx of Chinese diplomats, technicians and others.

European.—The dominant white population, while mainly of Spanish origin, includes considerable numbers of other Europeans along with British, U.S. and Canadian elements. Cuba accepted many displaced persons during and following World War II. The ties that Castro established with the U.S.S.R. resulted in the influx of many technicians and military personnel from behind the Iron Curtain. By the same token, many North Americans and Europeans whose property was expropriated left the country.

2. Language and Religion.—The language of Cuba is Spanish, although the close economic, social and political ties with the United States and Britain have made English practically a second language.

The vast majority of Cubans are nominally Roman Catholic. However, freedom of religion is guaranteed by the constitution, and many Protestant denominations and sects are represented. The schools and churches established by such groups as the Methodists, Baptists and Presbyterians rank among the best in the country and usually enjoy community-wide support.

3. Class Structure.—The class structure is that characteristic of many of the South American countries, consisting essentially of upper and lower and marked by differences in occupation. Those who perform manual work cannot enjoy upper-class status. Within the upper class are gradations in status, certain professional categories outranking others; and a middle class—in the sense of being "middle upper"—before the revolution of the late 1950s was growing in importance. Gradations in rank appear within the lower class also. Status seems in many cases to be unrelated to income. However, it has racial overtones. Negroes in general occupy lower positions.

While in many respects race prejudice is not evident, it cannot be denied that it has an influence in determining social position.

Negroes are admitted freely to schools and the university, public restaurants and places of public assembly. Intermarriage is relatively common. Negroes are elected to congress, though usually not in proportion to their numbers. Yet they are underrepresented among professional and semiprofessional occupational groups, proprietors, managers and high officials, office workers and salesmen. They are overrepresented in proportion to numbers among skilled and unskilled workers and those providing personal services.

The revolution that brought Castro to power in 1959 has modified the class structure in at least two respects. First, the lower classes have been upgraded in the sense that the political power structure rests upon them. Second, the upper and middle upper classes have lost economic and political power, and a large proportion of them are now refugees abroad. (L. Nn.)

IV. HISTORY

Cuba, discovered by Columbus in the course of his first voyage, on Oct. 27, 1492, was one of Spain's first footholds in the new world and was the last Spanish colony in the Americas to obtain independence. Colonialism has been an important molder of the island's history.

The conquest of Cuba was begun in 1511 by Diego Velázquez with a force of about 300 men and was completed in less than two years. By 1515 the Spaniards had established small settlements at Baracoa (the landing point), Bayamo, Santiago de Cuba, Puerto Príncipe (Camagüey), Sancti Spíritus and the original Havana. Velázquez' reputation and legends of wealth drew many immigrants to the island, but it was soon realized that Cuba was not the treasure house that had been imagined. The colony's first use for the Spaniards in the 16th century was as a steppingstone for the exploration and conquest of the adjoining mainland. From Cuba went the expeditions that discovered Yucatán (1517) and explored the southern Gulf coast of Mexico, and the expeditions of Hernán Cortés for the conquest of Mexico (1519–21) and of Hernando de Soto for the exploration of Florida and the lower Mississippi valley.

1. Early Colonial Period.—Following the period of exploration, Cuba's chief function within the Spanish colonial empire was to serve as a supply and communications base for the fleet moving to and from the new world. Havana became the principal port and naval base of Hispanic America. Ships bound for Spain assembled in the port to be convoyed in the eastern crossing of the Atlantic, and fleets from Spain for the Americas often called first at Havana. An agricultural economy developed, aimed at supplying both the needs of the local population and provisions for the ships that plied between Spain and the colonies. Cassava, sweet potatoes and plantains were grown, and cattle raising was started. At first the labour force for agriculture was supplied by poor Spanish-born and Creole farmers and by Indians. The institution of a plantation economy for the production of sugar and tobacco, coupled with the rapid destruction of the Indians, created a labour shortage, however, and warranted the importation of African slave labour. The first slaves began arriving as early as 1522, and these, reinforced by many thousands more, eventually made a significant contribution to the racial composition of the Cuban population. Throughout the colonial period Cuba's economic growth was severely handicapped by Spanish mercantilist policies. The colony was considered to exist only for the good of the mother country; trade with countries other than Spain was forbidden; all the island's commerce had to be carried in Spanish ships; the colony according to law could produce nothing that would compete with production in Spain. As a result of these restrictions, smuggling became an important means of bolstering the island's commerce.

Because of its strategic location and its role as a naval base and centre of communications, Cuba became an important target for the attacks of the European sea powers disputing the Spanish hold on the West Indies. Throughout the 17th century Cuba suffered from Spain's wars with England, France and Holland. Surrounded by enemy colonies, attacked by pirates and freebooters, its line of communications with Spain threatened after the destruction of Spain's Mexico fleet near Matanzas in 1629, the island suffered widespread destruction. In 1662 the English attacked and destroyed Santiago; Remedios was sacked by the French in 1665; the English freebooter Henry Morgan attacked Puerto Príncipe in 1668. The peace of Rijswijk (1697) brought a temporary end to the attacks, but by the end of the 17th century the Cuban population numbered only 50,000, and its economy was badly strained.

Between 1700 and 1763 Cuba's plight showed little improvement. Spain's numerous wars continued to disrupt commerce and cause loss of life and property on the island; economic exploitation and monopolistic control by the mother country became worse; concentration of administrative control in the hands of the military and discrimination against Cuban-born Creoles in favour of the Spanish-born peninsulars fostered discontent. The island's misfortunes reached a culmination in 1762 when the English captured and looted Havana after a bitter siege. The city was returned to Spain the following year in exchange for the Floridas.

2. Reforms and Reactions.—Beginning in 1764 Cuba made notable progress. The strategic and economic value of the island having been proved, Cuba was given greater attention by Spain. Moreover, Spain governed the Louisiana territory, which it had acquired from France in 1763 and held until 1800, from Havana. With the arrival of competent officers, agriculture and education received a new impetus, commerce increased and age-old monopolies were suppressed. Formal establishment of commercial relations with the U.S. opened up new channels of trade. Hundreds of Spanish families migrated to Cuba from Spanish Santo Domingo when that colony was ceded to France (1795). Later, thousands of immigrants followed them from French Haiti when the Negroes revolted and assumed power. Most of these French immigrants settled in Oriente province, where their names are still found. Their coffee and sugar plantations converted the region from neglect to prosperity.

Under a succession of liberal governors at the end of the 18th century and in the first part of the 19th, when wars in Europe cut off Spain from its colony, Cuba became practically independent. Free commerce with foreigners—a fact after 1809—was definitely legalized in 1818 and confirmed in 1824. In 1810 Cuba elected deputies to the Spanish *Cortes* (parliament), and in 1817 the long-unpopular tobacco monopoly was abolished. Populations reported by the partial censuses of 1774, 1792 and 1817 were 161,670; 273,-301; and 553,033, respectively.

Despite this progress, discontent and restiveness still ruled the island. It seems reasonable to assume that if Cuba had been part of the mainland it would have struck for independence in the first quarter of the 19th century as did the other Spanish colonies. The sharp distinction between Creoles and peninsulars, the growing discontent with political conditions in Madrid and a rising sentiment of nationalism were as strong in Cuba as on the mainland. Failure to move for freedom may be explained in part by lack of effective aid from the outside and in part by disagreement among the Cubans themselves as to what was the best course for the future—independence, autonomy within the Spanish empire or annexation to the U.S. As the 19th century progressed, however, desire for independence increased, helped to a major degree by renewed repressive measures of the Spanish government. These took the form of arbitrary powers granted in 1825 to the governor of Cuba to ward off the restiveness of the Cuban population and threatened invasions from Mexico and Colombia. Gov. Miguel de Tacón (1834–38) made matters worse by suppressing the popular Spanish constitution of 1834 soon after its proclamation in Cuba in 1836. In 1837 Spain excluded Cuban deputies from the Spanish *Cortes* and declared that Cuba (and Puerto Rico) would be governed by "special laws." Since the colony had no voice in the *Cortes* and the special laws were never passed, the arbitrary rule of the governor remained supreme.

The political scene in Cuba was further complicated at this time by the desire of certain groups in the U.S. to acquire the island. U.S. proslavery elements, especially, saw in Cuba the possibility of expanding slave territory to offset the growing power of anti-slavery forces in the U.S. congress. In the mid-19th century several freebooting expeditions from the U.S. failed to free Cuba, while at the same time Presidents Franklin Pierce and James

Buchanan tried in vain to purchase the island from Spain.

Sporadic revolts increased in number until 1855. After a period of unsure peace, war broke out again in 1868. It was to be one of the longest (ten years) and bloodiest ever fought in the Americas.

3. Civil Wars.—The Ten Years' War, which brought death to more than 200,000 Cubans and Spaniards and caused much property damage, resulted from Spain's failure to bring badly needed reforms to Cuba. Proposals for the emancipation of the Negro slaves were indefinitely shelved by a committee appointed to bring about this reform. Taxes rose and the public debt soared. Military tyranny suppressed criticism of the corrupt and ineffective Spanish administration. When a junta of inquiry of Cuban and Puerto Rican delegates meeting in Madrid in 1866–67 failed completely to get action, Cuban leaders decided the time had come to strike. Some of them desired reforms only, such as the abolition of slavery; others wanted annexation to the U.S.; while a growing section wanted complete independence. The last group, headed by Carlos Manuel de Céspedes y Borja del Castillo (1819–74), a wealthy planter who proclaimed the revolution at Yara on Oct. 10, 1868, demanded the gradual emancipation of the slaves and universal suffrage.

War was confined almost wholly to the eastern provinces, but Spanish volunteers committed horrible excesses even in Havana. The rebels also burned and killed indiscriminately. Although there was agitation in the U.S. for intervention in the struggle on behalf of the Cubans, the movement was not successful, perhaps because the U.S. had just emerged from a bloody civil war itself and was busy healing its wounds. Thirty years later the U.S. would intervene and obtain the independence of Cuba, but many changes had to take place in the U.S. in the meantime to bring about the necessary shift in public opinion.

War ended in 1878 when Spain by the convention of El Zanjón promised sweeping government reforms, an amnesty to political prisoners, liberty for rebel slaves and the abolition of slavery. Spain gave Cuba direct representation in the *Cortes* and later abolished slavery (gradual abolition in 1880 and definitive abolition in 1886).

But the armistice proved short lived. Spain expected the Cubans to pay for the property damage resulting from the war and soon forgot about political reforms. Royal officials even began to choose members of the provincial assemblies and town councils. With sentiment for independence again sweeping the island, the government began to rule as despotically as before.

Spain's forgotten promises of reform were not the only cause for the war to the death that began in 1895. A severe financial crisis in the United States and the repeal of the tariff act favouring importation of Cuban sugar into the U.S. were bringing widespread unemployment and economic hardship to the Cubans. Sugar plantations were idle, and sugar cane was Cuba's main crop.

When Spain suspended constitutional guarantees in Feb. 1895, the leading chiefs of the Ten Years' War—Máximo Gómez y Báez, Antonio Maceo y Grajales, José Martí, Calixto García Iñiguez and others—again took to the field. Martí (1853–95), a famous poet who dedicated his life to Cuban independence, unified the movement through the Cuban Revolutionary party founded in the U.S. in 1892. These patriots drew up a constitution for a republic and appointed a governing council headed by Salvador Cisneros y Betancourt.

This war also began in the east but spread rapidly to the western provinces. Spain sent more than 200,000 troops and used the severest measures to crush the rebellion. The rebels retaliated with a scorched-earth policy, burning especially the plantations, on the grounds that Spain would never give up the island unless it was not worth having. The Spanish attempted to isolate their foes with entrenchments, barbed-wire fences, lines of blockhouses across the narrow parts of the island and noncombatant detention camps. The last measure produced much suffering and death among the civilians who were forced into the camps by the thousands. Widespread condemnation of the policy forced Spain to abandon it. A newly appointed liberal premier, Práxedes Mateo Sagasta, abolished the system, recalled the general who had established it and promised Cuba an autonomous regime, proclaimed in Oct. 1897. But again final authority rested in the Spanish governor. Moreover, the rebels by then would accept nothing but complete independence, and so the plan was not put to a test.

At this point, Pres. William McKinley asked Spain for permission to mediate the conflict. Spain, although willing to accept some of McKinley's terms, was unwilling to have him serve as arbiter in case peace were not re-established by Oct. 1, 1898. In Feb. 1898 the U.S. battleship "Maine" was blown up in Havana harbour. U.S. public opinion demanded war with Spain.

4. U.S. Occupation.—The war, beginning in April, was over in a few months. (*See* SPANISH-AMERICAN WAR.) A U.S. blockading force destroyed a Spanish squadron seeking to escape from Santiago harbour on July 3, and within two weeks Santiago surrendered after its capture by land forces. Other operations in Cuba were slight. By the treaty of Paris, Dec. 10, 1898, Spain "relinquished" the island to the United States in trust for its inhabitants. The temporary character of U.S. occupation was evident throughout the treaty, in accordance with the terms of the U.S. declaration of war in which the U.S. had disclaimed any intention of controlling the island except for its pacification and had expressed the determination to leave the island thereupon to the control of its people.

Spanish rule ceased on Jan. 1, 1899, and was followed by U.S. military rule from Jan. 1, 1899, to May 20, 1902. During these years the majority of offices were filled by Cubans. Much was done for public works, sanitation, education and public administration. Most notable of all, yellow fever was eradicated where it had been endemic for centuries. A constitutional convention met at Havana from Nov. 5, 1900, to Feb. 21, 1901. The constitution finally adopted contained certain provisions known as the Platt amendment, imposed by the U.S. as a condition for accepting the constitution and approved by Cuba on June 12, 1901. By these provisions Cuba promised not to incur debts its current revenues would not bear; to continue the sanitary administration undertaken by the U.S. military government; to lease naval stations to the U.S.; and, if necessary, to permit the U.S. to intervene in order to preserve Cuban independence and a government adequate to protect life and property. The status of the Isle of Pines was left for future adjustment by treaty, and in March 1925 the U.S. senate by treaty recognized it as a part of Cuba.

5. The Republic.—The first Cuban congress met on May 5, 1902, and took over the government from the U.S. military authorities on May 20. Tomás Estrada Palma (1835–1908) became the first president of the new republic. During his administration material prosperity came to Cuba thanks to a reciprocal trade treaty which had been requested earlier by the outgoing U.S. authorities permitting more Cuban sugar to enter the U.S. Sugar again became the basis for Cuban prosperity. A U.S. naval base was established at Guantánamo (*q.v.*) in 1903.

Palma's administration, although attempting to continue the progressive measures of the U.S. occupation with the surplus in the treasury brought by increased sugar production and the tariff reduction on sugar entering the U.S., was plagued by corruption as well as by the demands of veterans for pensions. Pension frauds and failure to bring about the governmental reforms demanded by the Cubans brought revolution against Palma in July 1906. The revolutionaries, the Liberals, denounced the Moderates in power, accusing them of stealing in the elections of Dec. 1905 and March 1906. Insurrection spread rapidly, and Palma requested intervention by the U.S., which sent commissioners to mediate.

Mediation failed. The president resigned and congress adjourned without naming a successor. As an alternative to anarchy the U.S., on Sept. 29, 1906, proclaimed a provisional government, to last "long enough to restore order and peace and public confidence." Government was maintained under the Cuban flag; the regular constitutional forms remained outwardly unchanged. The insurrectionists promptly disbanded. U.S. administration ceased on Jan. 28, 1909, and the republic was inaugurated a second time, with Gen. José Miguel Gómez (1858–1921) as

president and Alfredo Zayas y Alfonso as vice-president. Both were Liberals. The U.S. troops were withdrawn April 1, 1909.

Three presidents governed Cuba from 1909 to 1925 with little distinction and much corruption. They were Gómez (1909–13), Mario García Menocal (1913–21) and Zayas (1921–25). In this period the U.S. intervened twice in Cuba and threatened to intervene several more times. During Gómez' administration the country prospered, but charges of corruption in the government soon rose, culminating in a bloody race war in 1912 in which thousands lost their lives. The government was accused of giving few offices to Negroes and also of favouring those who had supported the Spanish cause in the war for independence. Zayas and Gómez split and in the election of 1912 the conservative candidate, Menocal, won.

Menocal's administration saw much material progress. With prosperity, however, came new charges of corruption against his government, including that of nepotism. But Menocal won re-election in 1916 by employing fraud and violence. As a result, war broke out against him (Feb. 1917), but he was able to defeat the rebels and enter upon his second term. The rebels hoped for intervention by the U.S., which, however, was too occupied with the European situation. Menocal's government declared war on Germany on April 7, 1917, the day after the U.S. entered the war.

In anticipation of the elections of 1920, Gen. Enoch H. Crowder of the U.S. army was invited in 1919 to draw up a new election law. But the law was flagrantly disregarded in the elections. Menocal now backed Zayas, the Liberal candidate in 1916, in a Conservative-Popular alliance against Gómez, who was nominated by the Liberals. When Zayas was declared elected, Gómez protested. Crowder suggested new elections but while preparations were being made to hold them, Gómez withdrew and Zayas was elected easily.

Until 1919 Cuba enjoyed phenomenal prosperity, thanks to the high price of sugar. By 1920, however, a severe financial crisis had struck the country. Despite a moratorium many banks and other business concerns had gone bankrupt by 1921. At the suggestion of the U.S. government Zayas introduced financial reforms and was given a $50,000,000 loan by the U.S. (Jan. 1923). The economic situation rapidly improved, the year 1922–23 closing with a surplus. But with the return of prosperity Zayas' administration was accused of corruption, and revolts broke out against him, led in part by war veterans who were not receiving their pensions. When Zayas tried to get himself renominated, he ran into stiff opposition in his own party. He therefore made a pact with the Liberal candidate, Gen. Gerardo Machado y Morales, against Menocal, who ran as the Conservative candidate in the election of 1924. Machado was elected overwhelmingly and assumed office on May 20, 1925. In 1928 he was elected to a second term.

Machado became Cuba's first full-fledged dictator. Pledged to a program of reform, he made good only a few of his promises during his first term. With his second term a rule of terror began. Martial law was proclaimed, and congress allowed him to suspend freedom of speech, press and assembly. Political opposition, allayed by an adroit distribution of patronage in 1928, revived against Machado as the economic depression of the early 1930s hit Cuba. An attempt to stabilize the price of sugar, always the mainstay of Cuba's economy, failed, and no substantial relief came from a public-works program. As the opposition increased, Machado adopted increasingly harsher methods against it. Cuban exiles swarmed to the U.S. Machado's rule seemed fastened on the island for life, since the U.S. did not want to intervene, but when a violent outbreak occurred the U.S. offered to mediate. Its offer was accepted. An amnesty was declared and constitutional and political reforms promised. With the economic crisis deepening and with Machado apparently determined to stay in office in spite of promises to resign, a general strike broke out forcing him to flee the country in Aug. 1933.

Cuba had many presidents in the following years, but they were usually made and unmade by Fulgencio Batista y Zaldívar, a sergeant who gained control of the army at the time of Machado's downfall. Carlos Manuel de Céspedes y Quesada, son of the 19th-century leader of the Cuban separationists, was the first president serving on a provisional basis. He set aside the constitution and tried to bring about a few reforms. But the university people feared that he was too closely allied to the U.S., and with the rank and file of the army they overthrew him after a few months and put Ramón Grau San Martín in his place. Grau San Martín's attempts at reform were also short lived. His four months in office were characterized by bloody strife. A military junta, headed by Batista, then conferred the office on Col. Carlos Mendieta, who seemed to have the approval of most factions. The U.S. and other countries granted him prompt recognition. Under him a treaty was signed with the United States (June 1934) abrogating the Platt amendment. This famous document, issued to preserve peace, had had the opposite effect, since discontented factions had frequently risen against Cuban governments in order to bring about U.S. intervention. It had also been used by such leaders as Zayas to get the people to support them as champions of Cuban liberty against U.S. aggression.

Disorder and strikes continued, but provisional President Mendieta and his chief of staff, Batista, frankly used dictatorial measures and postponed elections until Dec. 1935. Batista continued to rule Cuba through a succession of presidents (José Barnet y Vinageras, Dec. 1935–May 1936; Miguel Mariano Gómez y Arias, May–Dec. 1936; Federico Laredo Bru, Dec. 1936–Oct. 1940).

Finally, in 1940 Batista, then a colonel, presented his own candidacy, defeating Grau San Martín. During his full term, 1940–44, Cuba entered World War II on the side of the Allies and established diplomatic relations with the U.S.S.R. Batista's candidate, Carlos Saladrigas y Zayas, ran in 1944 but was defeated by Grau San Martín and Batista soon left the country. Grau San Martín's administration began with much emphasis on "political house cleaning."

In foreign affairs, Cuba joined the United Nations, and its capital served as the site of the international trade conference of 1947, which produced the Havana charter. In domestic affairs, the administration took an active part in disputes between labour and capital and appeared to lean toward collectivist political and social ideas.

Carlos Prío Socarrás became president in 1948. As a result of violent political agitation and charges of corruption, Batista, who had returned to Cuba, overthrew the government in March 1952 without bloodshed. He closed congress and called for elections in 1954. He was elected president without opposition for a four-year term beginning Feb. 24, 1955. He declared the 1940 constitution, containing many liberal prolabour reforms, again the law of the land and tried to return the country to normalcy. But strong opposition developed against him. Anti-Batista elements denied the validity of the election and organized a campaign of harassment and sabotage in the provinces. Cuba was in a state of virtual civil war after 1957 as a well-armed force of revolutionaries led by Fidel Castro (*q.v.*) carried on widespread guerrilla warfare from the mountain fastness of Oriente province.

6. The Castro Regime.—Batista resigned and fled the country on Jan. 1, 1959. In a provisional government Castro took the position of premier and designated Manuel Urrutia Lleo president. With opposition to the new government forbidden, trials and executions of Batista followers and other opponents of Castro's government numbered around 700 by early 1961. Many thousands languished in jail, while additional thousands fled the country. Castro resigned as premier July 17, but resumed office after Urrutia resigned as president. Osvaldo Dorticós Torrado was appointed president.

Castro's government soon embarked on a violent propaganda campaign blaming the ills of Cuba on the United States. At the same time warm friendship was expressed for the communist countries and closer economic ties were established with them. In July 1960 the U.S. congress authorized the reallocation to other countries of the Cuban sugar quota. By the end of 1960, U.S. investments in Cuba amounting to approximately $1,000,000,000 had been seized. Following a continuous campaign of vilification against the U.S. government, including a charge that it planned

an imminent invasion of Cuba and a demand that the staff of the U.S. embassy in Havana be drastically cut, the U.S. government broke diplomatic relations with the Castro government on Jan. 3, 1961. The following month a reorganization of the Cuban government along the lines of the governments of the communist countries centralized even more the means of production of the island in the hands of a few procommunist followers of Castro. The avowed reason for this action was to hasten the industrialization of Cuba. In April 1961, José Miró Cardona, president of the Revolutionary Council of Cuban Refugees, announced that troops were being landed in Cuba to overthrow the Castro regime. The invading force was defeated and forced to surrender. U.S. participation in the organizational phase of the invasion caused serious repercussions throughout the world.

The foreign ministers of the Organization of American States, meeting at Punta del Este, Urug., in Jan. 1962 excluded Cuba "from participation in the inter-American system" because of the Castro regime's adherence to communism. This action was designed to exclude Cuba from O.A.S. activities but not to deprive Cuba of its O.A.S. membership. At the same time the foreign ministers imposed an arms embargo against Cuba and excluded it from membership on the Inter-American Defense board.

Evidence that the communist nations were sending military weapons and armed forces to Cuba led to an international crisis in late 1962. On Oct. 22 the U.S. accused the Soviet Union of establishing offensive missile bases in Cuba, declaring that these bases constituted an immediate danger to the western hemisphere. President Kennedy demanded the prompt removal of the missiles and also ordered the U.S. navy to search all ships en route to Cuba and to prevent them from delivering to Cuba additional weapons that could be considered as offensive. In the next few days several ships were stopped but then allowed to proceed when no offensive weapons were found. On Oct. 28 the Soviet Union agreed to the U.S. demand and ordered the dismantling of the missile bases. By mid-November U.S. aerial reconnaissance showed that all such bases had been dismantled, though Cuba continued to maintain an extensive arsenal of communist-supplied defensive weapons. In Dec. 1962 Premier Castro released 1,179 prisoners taken in the invasion of April 1961 in exchange for about $50,000,000 worth of food and medicine, supplied mostly by U.S. industrial firms. (F. L. Hn.; X.)

In July 1964 the foreign ministers of the O.A.S. met in Washington, D.C., at the request of Venezuela, which had discovered that Cuba had been supplying weapons to Venezuelan revolutionary groups. By a vote of 15–4 the ministers approved a resolution condemning Cuba for its actions against Venezuela and also agreed to sever diplomatic relations with Cuba; suspend all trade with it except for foodstuffs, medicines and medical equipment; and cut off all sea transportation to and from the country.

V. POPULATION

After the wars of independence Cuba's population grew very rapidly, both from natural increase and from immigration. By 1953, the latest census, the total was 5,829,253, a 20% increase over 1943. A population of about 7,022,350 was estimated for the mid-1960s. The revolution of the late 1950s affected population growth and distribution, but no precise measure of the change is available.

In line with world-wide trends, Cuba's population is steadily becoming more urbanized. In the 1953 census 57% of the people were classed as urban, compared with 51% in 1931. (A slight change in definition of urban in 1953 enlarged the figure for that year but does not alter the trend.) Havana province, with 89% urban, ranks first, and Oriente, with 28%,,lowest among the six provinces. The largest cities were Havana, Marianao, Santiago de Cuba, Camagüey and Santa Clara.

The announced birth rate in 1953 of 25.1 per 1,000 and the death rate of 6.5 per 1,000 were both considerably under the true figure. A better indication of the vitality of the population was the ratio of children under 5 years per 1,000 women 14–49. This ratio by comparison with the United States (which also had a birth rate of 25 per 1,000) was much higher. Oriente province had the highest index of fertility and Havana the lowest. Cuba had nearly 105 males per 100 females, a ratio which in 1953 was about the same as that for 1943. (L. Nn.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Government.—The United States-influenced constitution of 1901 provided for a unitary state with separation of powers and checks and balances. Corruption, inefficiency, ruthless disregard for individual liberty and freedom and irresponsible executive dictatorship characterized one Cuban government after another under this constitution. When the Platt amendment (*see* above, *History*) was abrogated in 1934, therefore, the Cubans immediately began preparations for governmental change. The constitution of 1935, which never went into effect, largely rejected United States influence. When the constituent assembly met in 1939 to draft a new constitution, practically no one present wanted to continue with separation of powers and presidential government. The constitution of 1940 established a semiparliamentary system. Suffrage was made universal, equal, secret and obligatory for both sexes over 20 years of age; elaborate safeguards against fraud were devised in the electoral code of 1943; parties could be formed by petition of 2% of the voters in the last electoral census; and a system of proportional representation was used for allocating seats in the senate. The two-house legislature was continued. (The size of the senate was increased from 54 to 72 and that of the house of representatives from 130 to 195 in 1956.) The president, elected directly for a four-year term, was made responsible to the legislature by provisions which permitted either house to force his cabinet ministers to appear and be subjected to questioning or interpellation (formal questioning of ministerial policy or actions). If either house should vote lack of confidence, the minister was obligated to resign within 48 hours. The greatest procedural weakness of the new system was the requirement of a majority of the votes of all members of the legislative chamber concerned to initiate interpellation and vote of confidence, instead of a simple majority of the members present, assuming a quorum.

Batista, elected president in 1940, gave the semiparliamentary system his co-operation. He appointed a distinguished man of the highest ability and integrity, Carlos Saladrigas y Zayas, to be his prime minister. The legislature interpellated a number of the cabinet ministers in May 1942. Informed opinion agreed that the semiparliamentary system was off to a good start. However, the "liberal" Grau San Martín, elected president in 1944, crippled the system and established the pattern that was later followed. The crucial event was the interpellation of Grau San Martín's minister of commerce, Alberto Inocente Alvarez, in the house of representatives in Oct. 1945 for alleged fraud in handling exchanges of Cuban sugar for Argentine fats. The house voted lack of confidence in Alvarez on Oct. 9 by a vote of 79-13. Grau San Martín immediately thwarted the purpose of the semiparliamentary system by appointing Alvarez (Oct. 11) minister of state. On Oct. 20 Prime Minister Prío Socarrás informed the legislature that the president did not feel that he should be bound by majority votes in the legislature. After that the semiparliamentary system was little more than a form. Cuba continued in practice to have strong, centralized, executive government. Batista, who seized power by force on March 10, 1952, governed by decree under a constitutional code of 275 articles until he could win a *candidato único* (single candidate) election on Nov. 1, 1954. With his inauguration on Feb. 24, 1955, the constitution of 1940 was restored. After 1952, however, there were repeated efforts to oust Batista from power by force, and as a result the president governed by *estado de sitio* (state of siege) a good deal of the time until he was forced to resign on Jan. 1, 1959.

In addition to the attempt to replace omnipotent executive power by a semiparliamentary system, the constitution of 1940 followed the trend of all recent Central and South American constitutions in providing for the "interventionist" or welfare state. The central government was given great power to direct, regulate and control the economy. Individuals were given practically all the material benefits of welfare and social security that any country in the world made available. Organized labour was protected

by the government. Although Cuba is a rich country and the government collects large sums of money through taxes, the politicians failed to use the public's money to provide more than a small part of the welfare benefits which the constitution theoretically guaranteed. Governments after 1940 were generally "labour" governments, which supported labour's demands for higher wages, fewer hours for the same pay, lower production and price controls. Although some unions undoubtedly derived special benefit from such demands, it was at the expense of lower efficiency and reduced production, which adversely affected material standards of living for the people as a whole.

After Fidel Castro seized power by force on Jan. 1, 1959, he established a political dictatorship. Although Castro had promised that he would hold elections and guarantee constitutional government, it was announced on Jan. 6, 1959, that his administration would rule by decree for at least 18 months, later extended to 4–5 years. In 1960 and 1961 Castro made clear that his government intended to maintain dictatorial power indefinitely. The evidence of dictatorial government was seen in Castro's charismatic leadership; the execution of political enemies after military trials; the provision that civil courts could impose the death sentence and long prison terms for all counterrevolutionary activities with persons so accused refused bail and held incommunicado; the imprisonment of many thousands of Cubans; the elimination of all political parties except the communist (called the Popular Socialist party); the abolition of all press opposition (by Jan.–Feb. 1960); the establishment of centralized government control of all media of communication; the increasingly vitriolic attacks on the Roman Catholic Church; and the repudiation of friendship with the United States in favour of ties with the Soviet Union, Communist China, Czechoslovakia and other communist satellites. The Castro-appointed president and council of ministers enacted a fundamental law on Feb. 7, 1959, under which the council was given authority to represent the sovereign power of the state. In theory the council could govern by decree in any field whatever, unrestricted by constitution, law or courts. In fact, however, the council of ministers did not formulate important policy. That was done by Castro himself; by his brother Raúl, chief of the armed forces; Ernesto ("Che") Guevara, head of the National bank and a communist since his university days in Buenos Aires; Osvaldo Dorticós Torrado, president and long-time communist; and Antonio Núñez Jiménez of the National Agrarian Reform institute (INRA), also a long-time communist. In a speech on May 1, 1961, Castro proclaimed the official establishment of Cuba as a socialist state. In Dec. 1961 Castro announced in another speech that he had been a convinced Marxist-Leninist since his student days but had concealed the fact until he could gain power. In 1962, Castro began the organization of a single all-powerful party (the United Party of the Socialist Revolution), which would perform a role similar to that of the party in other Communist countries.

Prior to the Castro regime justice was administered through the Roman law system of codes, most of which were either copies of Spanish or other Central and South American codes or were influenced strongly by such sources. The court system was highly centralized and included the usual categories of special courts, courts of original jurisdiction and appellate jurisdiction and a supreme court. Cuba copied Colombia's system under which any person could challenge the constitutionality of any law or decree by presenting a petition of unconstitutionality directly to the supreme court. This principle, which is somewhat similar to judicial review, acted as a check on executive and legislative power in Colombia, where about 50 important laws were declared unconstitutional. It never acted as a check on the powerful executive in Cuba, however. Under the Castro government most judicial functions were handled by revolutionary tribunals which had practically summary jurisdiction.

Cuba being a highly centralized state, the central government naturally spends most of the revenues derived from taxation, appoints most governmental personnel, formulates important policy and administers the major functions of government. The central government definitely overshadows the local and provincial governments. After 1940 the municipalities were able to have a form of local charter. They had the mayor-council system and elected their own officials, who could not legally be removed by the provincial or central authorities. The voters elected a governor for each of the six provinces, and the alcaldes (mayors) of the cities and towns made up provincial councils. Even the officials of the capital city of Havana were elected locally, in contrast to the usual practice in Central and South America. The mayor of Havana was considered second in importance politically only to the president of the country. In the Castro revolutionary government, however, power was highly centralized in the revolutionary group and even the president became a figurehead, with the real authority embodied in Castro.

2. Education, Health and Social Welfare.—Cuba undoubtedly has had one of the most distinguished records of any of the Central and South American countries in education, health and social welfare. In part, this has derived from the fact that the government, particularly at mid-20th century, has had a relatively large amount of money to spend. In addition, education has high prestige value in Cuba, and all levels of government are dedicated to improving and expanding it. The law states that education is compulsory and free for all children from 7 to 14 years of age. Usually more than 22% of the budget of the central government is allotted to education, and many schools have been constructed and teachers hired. Official statistics claim that only about 22% of the population over 15 is illiterate. Since 1959 the government of Fidel Castro has claimed virtually to have eliminated illiteracy in Cuba. The population of the urban centres is growing, on an average, about twice as fast as the rural population, and among the Central and South American countries only Uruguay, Argentina and Chile are more urbanized than Cuba. This has sometimes been cited as justification for using most of the education budget for the construction of new schools and facilities in the cities rather than in the country. When politicians permitted rural schools to be constructed, they frequently had them built, it has been said, near the public highways to impress voters, rather than in the interior where the rural children could more easily reach them. The University of Havana is the largest of four universities. Both students and faculty are active in politics and use or permit the use of armed violence. As a result, the universities have been shut down by order of the government from time to time. Health facilities are unusually good in the urban centres of Cuba in comparison with other Central and South American countries. The U.S. occupation is credited with initiating such measures as water purification and sanitation. In the rural areas the water is likely to be contaminated, and the people suffer from amoebic dysentery and other intestinal disorders. Cuba has a network of hospitals, clinics and other services which provide subsidized care.

(W. S. Ss.)

VII. THE ECONOMY

1. Production.—The economy of Cuba since 1900 has been based primarily on the growing and grinding of sugar cane, although efforts toward economic diversification have been undertaken. Sugar is grown throughout the country, but the heaviest concentrations are in the eastern half of the island in Oriente and Camagüey provinces. Sugar cane is ground into raw (brown) sugar in about 160 sugar mills (called *centrales*), and blackstrap molasses is produced as a by-product. Very little sugar refining, however, occurs in Cuba. The production pattern became uncertain, or at least harder for an outsider to evaluate, after the advent of the Castro regime in 1959. In 1960 sugar imports from Cuba were embargoed by the United States.

The modern sugar era began in Cuba about 1900 and was facilitated by major expansion of the United States market. Subsequently the industry became the victim of violent price fluctuations. Extremely prosperous 1920, called the year of "the dance of the millions," was followed by a disastrous price slump in 1921 and the pattern has been repeated many times. In consequence the sugar industry has always been subject to extensive regulation. After the establishment of the Castro regime, much of the agricultural land was expropriated (if not confiscated) and a major

effort was made to establish an extensive system of agricultural co-operatives. The responsible agency was the INRA.

Other agricultural activities consist of livestock raising and the growing of tobacco, food crops and fruits, such as bananas, pineapples and papayas. Cuban tobacco, which is widely used in cigars, is grown chiefly in Pinar del Río, in the west. The only fibre commercially produced in Cuba has been henequen. The production of ambary (*kenaf*), another fibre, was in the experimental stage in the mid-1960s. Direct investment by the United States in the agricultural sector of the Cuban economy declined considerably from a peak of 575,000,000 pesos in the 1920s to an estimated book value of 276,000,000 pesos at the end of 1955, and in 1959–60 nearly all U.S. holdings in Cuban agriculture were confiscated by the Castro government.

Cuba was once an important producer of hardwoods. By the second half of the 20th century, however, the principal woods formerly exported, mahogany, Spanish cedar and sabicu, were under export embargo.

Cuba has a fairly important mining industry. There is a large copper deposit in Pinar del Río, at Matahambre. Large deposits of low-grade iron ore (especially laterite) exist, principally in Oriente province; however, they have not been extensively developed. There is also nickel in the Moa bay region. Much of the mining industry was nationalized by the Castro government.

Cuba's considerable fishing resources have not been extensively developed. The annual catch averages between 50,000,000 and 60,000,000 lb.—not enough to fill all the country's consumption requirements. The principal varieties caught are grouper, snapper, yellowtail, mackerel, muttonfish and sardines. Sponge fishing, once an important export industry, was in decline in the second half of the 20th century partly because of the sponge blight, which became endemic in the Cuban beds around 1939, but also because of competition from synthetic sponges and overexploitation.

Cuba has no coal. Hydroelectric potential is negligible, and known petroleum reserves are also insignificant. The chief household fuel is charcoal, which is obtained from local firewood. A sugar cane by-product called bagasse supplies much of the fuel used in the sugar industry.

The manufacture of raw sugar cane from cane is the principal industry in Cuba. Associated with the sugar industry is the manufacture of rum and of industrial alcohol from blackstrap molasses. Cuba had no heavy industry in the middle part of the 20th century. Other industrial activity included the production of tobacco products, foodstuffs, beverages and light consumer goods for domestic consumption. The government has engaged in considerable planning designed to encourage industrialization.

2. Trade and Finance.—Havana, the capital, is by far the most important as well as the largest commercial centre in Cuba. Nearly all the island's banks and insurance companies, sugar mills, manufacturing enterprises and wholesale distributing firms have their main offices there.

Sugar accounted each year for more than 80% of Cuba's total exports before the United States in 1960 banned further importation of sugar from Cuba. The Soviet Union became relatively much more important in the Cuban trade picture and the United States much less. As a consequence of devoting so much effort to the production of sugar and tobacco for export, Cuba has normally been dependent on imports to meet much of its food requirements. The chief imports of this type have been lard, rice, wheat and flour, dairy products, beans and potatoes. Petroleum products and automobiles have also been imported. In Oct. 1960 the United States announced an embargo on all exports to Cuba except medicines, medical supplies and certain foods.

The peso of 100 centavos is the country's monetary unit. On the foreign exchange market one Cuban peso in 1960 was equal in value to one U.S. dollar, but exchange control was vigorous. The National bank of Cuba carried out the functions of a central bank. It was the sole bank of issue and fiscal agent of the government.

3. Transport and Communications.—In the mid-1960s Cuba had a total of 5,000 mi. of all-weather roads and 3,200 mi. of other roads. The backbone of the highway network was the Central highway, which extended from Pinar del Río to Santiago, a total of 710 mi. The railroad network had a total of 11,250 mi. of track well distributed throughout the island. Most of the public utilities were nationalized by the Castro government.

See also references under "Cuba" in the Index. (W. C. Gn.)

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CUBE, a regular solid with six square faces; that is, a regular hexahedron (*see* Solids, Geometric). Since the volume of a cube is expressed, in terms of an edge e, as e^3, in arithmetic and algebra the third power of a quantity is called the cube of that quantity. That is, 3^3, or 27, is the cube of 3; and x^3 is the cube of x. A number of which a given number is the cube is called the cube root of the latter number (*see* Root); that is, since 27 is the cube of 3, 3 is the cube root of 27—symbolically, $3 = \sqrt[3]{27}$. A number that is not a cube is also said to have a cube root, the value being expressed approximately; that is, 4 is not a cube, but the cube root of 4 is expressed as $\sqrt[3]{4}$, the approximate value being 1.587, because 1.587^3 is approximately 4.

In Greek geometry the duplication of the cube was one of the most famous of the unsolved problems. It required the construction of a cube that should have twice the volume of a given cube. This has been proved to be impossible by the aid of the straight edge and compasses alone, but the Greeks were able to effect the

construction by the use of higher curves, notably by the cissoid of Diocles (*see* CURVES, SPECIAL). Hippocrates showed that the problem reduced to that of finding two mean proportionals between a line segment and its double; that is algebraically, to that of finding x and y in the proportion $a:x = x:y = y:2a$, from which $x^3 = 2a^3$, and hence the cube with x as an edge has twice the volume of one with a as an edge.

CUBEB (CUBEB BERRIES), the dried, unripe fruit of *Piper cubeba* (family Piperaceae), a perennial vine native to Java, Sumatra and Borneo and cultivated in Java, Sumatra, Ceylon and the West Indies. Most of the commercial supply is shipped from Jakarta and Singapore. The fruits are gathered while still unripe but fully grown, and carefully dried in the sun. Their odour is agreeable and aromatic, their taste pungent, acrid, slightly bitter and persistent. Cubeb contains about 15% of a volatile oil from which a solid known as cubeb camphor can be separated. The drug was known by Arab physicians in the 9th and 10th centuries. It was used in Europe as a spice from the 11th century and medicinally as a diuretic from the beginning of the 19th century. The berries were also crushed and smoked in cigarettes for catarrh and asthma. Since its beneficial effect is too uncertain to offset undesirable side effects, it has been replaced by more reliable remedies. (V. E.)

CUBE ROOT: *see* ROOT.

CUBISM, a revolutionary phase of the modern art movement, developed in Paris during 1907–14. The name was a scornful description by a critical public. The movement unfolded as a corollary to Fauvism (*q.v.*), to the current enthusiasm for primitive art in general and African Negro sculpture in particular and to the deep impression caused by the Paul Cézanne retrospective exhibition at the 1907 Salon d'Automne.

The most immediate of these influences was a keenly appreciative realization of Cézanne's conception of painting as "a construction after nature." This theory, exemplified by his work, was confirmed by his saying that nature should be treated in terms of the cylinder, cone and sphere. For Cézanne, the end was the discovery of a significant equivalent for the object. For the Cubists the object was the starting point: from it they abstracted elements and created compositions of imagined rather than observed forms and relationships. Cubism progressed through three phases. The first, the Cézanne phase (1907–09), was a period of assimilation and modification of Cézanne's methods and theory. The second, the analytic (1910–12), was characterized by nearly monochromatic colour, a complex fragmentation of form and the use of simultaneity (representation of several aspects of the same object). In the third, called synthetic (1912–14), colour reappeared and textural surfaces were applied in a technique of collage (the sticking of extraneous material onto the canvas).

In 1908 the Bateau-Lavoir studios in Montmartre became the rendezvous of Cubists and their supporters. Outstanding in the group were Pablo Picasso (whose "Les Demoiselles d'Avignon," of 1906–07, is regarded as the first identifiable Cubist picture), Georges Braque, André Derain, Juan Gris, Louis Marcoussis and Jean Metzinger. Other artists linked with the movement were Robert Delaunay, Albert Gleizes, Edouard Jeanneret (Le Corbusier), Fernand Léger, André Lhote, Marcel Duchamp and Jacques Villon. Though the Cubists were dispersed by the outbreak of World War I, the influence of the movement remained and was clearly discernible in the subsequent emergence of abstract painting (*see* ABSTRACT ART). *See* also PAINTING: *Modern Painting: Cubism.*

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CUCKOO, any member of the cuckoo family, Cuculidae, which comprises about 127 species of small- to moderate-sized birds (6 to 27 in. long). Superficially they could pass for perching birds (order Passeriformes) except for the arrangement of the toes: two toes are directed forward and two backward. Their internal anatomy indicates that the cuckoos form a distinct order, the Cuculiformes, with few close relatives. The Cuculidae are of nearly world-wide distribution, with most of the species occurring in the tropics; species of the temperate zones migrate to the tropics for the winter. Although without great variation in form, some cuckoos are long-winged tree birds, others are short-winged birds of the shrubbery and ground. The bill varies from moderately stout to very stout, and the pattern and colour of the plumage is very variable. Perhaps the point of greatest interest in the group is the wide variety in their nesting habits, though the young are all hatched in a helpless condition and must be cared for in the nest. The European cuckoo, *Cuculus canorus,* has long been noted for its habit of laying eggs in the nests of other kinds of birds (a condition called social parasitism).

In America the two common tree cuckoos are the black-billed cuckoo (*Coccyzus erythrophthalmus*) and the yellow-billed cuckoo (*C. americanus americanus*). They are similar in appearance, each being about a foot long, slender, long-tailed, olive-brown above and white below; the latter, however, has yellow in the bill, rust in the wing, and broad, rather than narrow, white tips to the tail feathers. Both are similar in habits. They usually stay well hidden among the leaves of trees and shrubs, make rather deliberate movements and seek out caterpillars as their favourite food. Their calls are a series of notes often written "cow-cow . . . ," but having considerable variation. Usually these birds build their own nest, a scanty platform of twigs lined with soft material. Two to four greenish-blue eggs are laid in the nest and incubated by the parent. The young, naked at hatching, soon become covered with immature plumage that is very much like that of the adult. Only occasionally does the yellow-billed cuckoo lay its eggs in the nests of other birds and leave its offspring to be raised by foster parents. In winter both species migrate to the American tropics.

The common or European cuckoo, with a wide range in Europe and Asia, migrates as far as South Africa in winter. It is about 13 in. long, with a blue-gray back and breast and barred underparts. It is a tree bird that feeds chiefly on insects. Its call, a loud "coc-coo," has given the name to the family. The bird itself has been used by poets as a herald of summer, and its call, of course, has been widely imitated in cuckoo clocks.

The most interesting thing about this bird is the adaptation for laying the eggs in the nests of other birds and leaving the offspring to be raised by the foster parents. Each female of *Cuculus* confines itself to a small area and specializes in a particular species of foster parent. Included among the 50 species of birds recorded as serving as foster parents to cuckoo young are such species as meadow pipits (*Anthus*) and sedge warbler (*Acrocephalus*). The cuckoo lays about 12 eggs, usually one to each nest. The eggs of each *Cuculus* female tend to resemble those of the chosen foster parent, an adaptation that results in great variation in egg colour within the species. The female cuckoo watches the host species build the nest and begins laying at the same general period that the foster parent does. While the host is away from the nest, the cuckoo removes one of the host's eggs and replaces it with one of its own. Contrary to much early speculation, the egg is laid directly in the chosen nest.

The young cuckoo hatches quickly, in about 12 days. It is entirely naked at this stage. Soon it disposes of its nest mates—the foster parents' eggs or newly hatched young—by getting them on its back and pushing them over the edge of the nest. Thus the young cuckoo receives all the food and care of the foster parents and is ready to leave the nest in about three weeks. It is then in immature plumage, barred above and below. A further interesting point is that the cuckoo's behaviour traits, voice and species recognition are evidently inborn, not influenced by its early

JOHN MARKHAM

HEDGE SPARROW (PRUNELLA MODULARIS) FEEDING YOUNG CUCKOO (CUCULUS CANORUS)

environment, except perhaps the recognition of its special foster parents.

The road runner, *Geococcyx californianus,* is a ground cuckoo of the arid parts of western North America. It is a long-tailed, short-winged running bird about 2 ft. long, found in open brush and cactus country. In colour its upper parts are streaked in browns, grays and black and an area of bare skin behind the eye is marked with red and blue. The road runner feeds largely on insects but also takes lizards, small snakes and mice. It makes a rather bulky nest in shrubbery and lays up to five white eggs. Since the young hatch a few days apart, a nest may have various sized young in it.

In the American tropics are several species of black cuckoos called anis, such as the smooth-billed ani (*Crotophaga ani*), about 13 in. long, with a long tail and a deep, curved bill. They spend much time in the shrubbery and feed on the ground. Their nesting is peculiar in that several females may lay eggs in one nest and may share incubation duties and care of the young. *See* also BIRD.

See H. Friedmann, "Social Parasitism in Birds," *Smithsonian Institution Report for 1929,* pp. 363–382 (1930); E. C. Stuart Baker, *Cuckoo Problems* (1942). (A. L. RD.)

CUCKOOPINT, called also lords-and-ladies (*Arum maculatum*), is a tuberous herb of the arum family (Araceae) native to southern Europe and northern Africa. Like many other aroids, cuckoopint contains a bitter, sometimes poisonous sap; the red berries, however, are particularly toxic. In England, where it is common in woods and hedgerows, it is also called wake-robin. It grows from a whitish rootstock, which sends up in the spring a few long-stalked, arrow-shaped, polished green leaves, often marked with dark blotches. These are followed by the fleshy spadix bearing in the lower part numerous tiny flowers and continued above into a purplish or yellowish appendage; the spadix is enveloped by a whitish or purplish leafy spathe, 6–10 in. long, constricted in the middle to form the flower chamber. Insects visit the plant, attracted by the fetid smell, and carry the pollen from one spathe to another. As the fruit ripens the spathe withers, and the brilliant red poisonous berries are exposed. Its counterpart in eastern North America is the jack-in-the-pulpit. *See* ARACEAE; ARUM; JACK-IN-THE-PULPIT.

CUCKOO SPIT INSECT, any insect of the family Cercopidae (order Homoptera) whose immature stages produce a frothy, whitish secretion found upon stems of various plants. They are also known as froghoppers or spittle bugs. The adult, a grayish-brown winged form with variegated markings, is a powerful leaper. The origin and formation of the froth has been much discussed. It appears that juices of the plant imbibed by the whitish nymph, when voided from the alimentary canal, become mixed with the secretion of special abdominal glands, which enables the product to maintain its foamy coherence and hold the air bubbles which are introduced through a special valve on the underside of the abdomen. Cuckoo spit is believed to protect the insects from the attacks of enemies and also from desiccation.

More than 2,000 species of this family have been described from various parts of the world. The common cuckoo spit insect of Europe is *Cercopis spumaria,* which also occurs in North America. Most of these insects are small, but in the tropical regions some are of medium size; in Africa certain species occur in enormous numbers and secrete large amounts of honey dew, which drips from the branches like rain. Such trees are called rain trees. One species, the sugar cane froghopper, *Tomaspis saccharina,* is very destructive to sugar cane in Trinidad. Another species, *Aphrophora salicis,* has been imported from Europe to North America and is sometimes a serious pest of basket and ornamental willow. In Africa, India, the east Indian islands and Australia there is a group of froghoppers which secrete small calcareous tubes of various shapes. The nymphs live inside these tubes in a mass of spittle. The tubes resemble small snail shells and curiously enough were described as species of snails by some of the earlier zoologists. (Z. P. M.)

EDWIN WAY TEALE

FROGHOPPER (CERCOPIS) NYMPH PRODUCING CUCKOO SPIT, A BUBBLE SECRETION

CUCULIDAE, a family of birds, world-wide in distribution, that includes the cuckoos, road runners and anis. *See* CUCKOO; ROAD RUNNER.

CUCUMBER (*Cucumis sativus*), a creeping plant of the family Cucurbitaceae (*q.v.*) widely cultivated for its fruit, and originated probably in northern India. It is a tender annual with a rough, succulent trailing stem and stalked hairy leaves with three to five pointed lobes; the stem bears branched tendrils by which the plant can be trained to supports. The short-stalked, yellow, bell-shaped flowers are unisexual, but staminate and pistillate ones are borne on the same plant; the latter are recognized by the swollen warty green ovary (the potential cucumber) below the rest of the flower. Flowers are insect pollinated. Hives of bees are commonly placed near plantings in frames or fields or inside greenhouses to ensure pollination and fruit setting.

In the U.S. cucumbers are widely grown as field crops and are extensively grown in home gardens. They are planted in "hills" about 5 by 5 ft. apart, with two plants per hill; or with the plants spaced singly about 2 ft. apart in rows 5 ft. apart. An excess of seed, about 2 to 3 lb. per acre, is sown, and the small plants are thinned to the number desired. In Great Britain and northern Europe the cucumber is extensively grown in frames or on trellises in greenhouses because the climate is so cool that few varieties are productive outdoors.

The heat requirement of the cucumber is one of the highest among the common vegetables. There are three groups of varieties, based on adaptability and use: (1) very large-fruited, strong-growing varieties adapted only to greenhouse or frame culture. Several English greenhouse varieties will form fruits without pollination and seed formation, and are generally much larger than those popular in the U.S.; (2) large-fruited, outdoor-grown varieties for slicing and pickling, and generally having white spines; (3) small-fruited prolific varieties grown outdoors principally for making pickles, and having black spines.

The food value of the cucumber is low but it is popular for salads and relishes. The Sikkim cucumber, *C. sativas* var. *sikkimensis,* is a large-fruited form, reaching 15 in. long by 6 in. thick, grown in the Himalayas of Sikkim and Nepal. The west India gherkin, *Cucumis anguria,* has small, slender vines, and abundant small ellipsoid green fruit covered with warts and spines. It is used for pickling. (V. R. B.; X.)

CUCUMBER TREE, the common name for *Magnolia acuminata,* a handsome ornamental tree that reaches a height of nearly 100 ft., bearing large, not very showy, greenish-yellow flowers and three- to four-inch fruits, which, when immature, resemble a small cucumber, but which ripen to a pink or red colour. Another species, *M. macrophylla,* a spreading shrub or small tree, is known as the large-leaved cucumber tree. Both are native to the southeastern United States. *See* MAGNOLIA.

CUCURBITACEAE, the gourd family of prostrate or climbing, generally annual, herbs, usually bearing tendrils and having a rapid growth. The group includes such economically important members as pumpkin, cucumber, watermelon, squash and gourd (*qq.v.*). This group of dicotyledonous plants contains about 100 genera and about 850 species, found in the temperate and warmer parts of the earth but especially developed in the tropics.

The long-stalked leaves are arranged alternately and are generally palmately lobed and veined. The flowers are borne in the leaf axils, in which a vegetative bud is also found, and at the side of the leaf stalk is a simple or branched tendril. There has been much difference of opinion as to what plant member or members the tendril represents; the most generally accepted view regards the tendril as a shoot, the lower portion representing the stem, the upper twining portion a leaf. The flowers are unisexual,

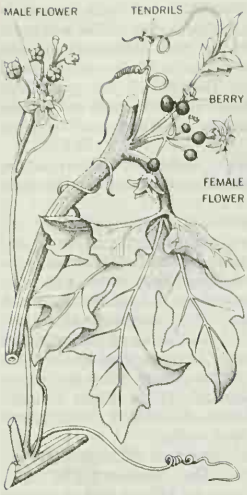

FIG. 1.—BRYONY (BRYONIA DIOICA)

and markedly epigynous (borne atop the ovary), the perianth and stamens being attached to a bell-shaped prolongation of the receptacle above the ovary. The fine narrow pointed sepals surround five petals, which are generally united to form a more or less bell-shaped corolla. There are five stamens in the male flowers; the anthers opened toward the outside, are one-celled, with the pollen sacs often elaborately twisted and variously united. The carpels, normally three in number, form an ovary with three thick, fleshy, cleft placentas bearing a large number of ovules on each side and generally filling the interior of the ovary with a juicy mass. The short, thick style has generally three branches, each bearing a fleshy, usually forked stigma. The fruit is a fleshy many-seeded berry with a tough rind (pepo), and often attains considerable size. The embryo completely fills the seed.

In North America the family is represented by a few genera comprising about 40 species, which occur chiefly in the southern parts of the United States and Mexico. Among these are the climbing wild cucumber or balsam apple (*Echinocystic lobata*) and the star cucumber (*Sicyos angulatus*), of the eastern United States and Canada; the calabazilla or mock orange (*Cucurbita foetidissima*), of the southwestern U.S. and Mexico; and the manroot (*Echinocystis fabacea*), of California. The family is represented in Britain by bryony (*q.v.; Bryonia dioica*) (fig. 1), a hedge climber, perennial by means of large fleshy tubers that send up each year a number of slender angular stems. The leaves are heart-shaped with wavy margined lobes. The flowers are greenish, ½ to ¾ in. in diameter; the fruit, a red several-seeded berry, is about ¼ in. in diameter.

HENRICKS HODGE

FIG. 2.—FRUIT OF CHOCHO OR CHAYOTE (SECHIUM EDULE)

Among the genera of economic importance are: *Cucumis* (cucumber and muskmelon); *Cucurbita* (pumpkin, squash and marrow); *Citrullus vulgaris* (watermelon), and *C. colocynthis* (colocynth). Other edible cucurbits include: *Ecballium elatarium* (squirting cucumber), which ejects its seeds with a watery fluid by the contraction of the wall of the fruit; *Sechium edule* (chocho), a tropical American species, cultivated for its fruit; it contains one large seed which germinates *in situ*. The fruits of the gourd (*Lagenaria* and others) are often used as ornaments. The fruits of *Luffa cylindrica* have closely netted vascular bundles in the pericarp, forming a loose felt which supplies the loofah or bath sponge; its fruits are edible when not fully mature.

CÚCUTA, a city of Colombia, capital of the department of Norte de Santander, adjacent to the Venezuelan border, is the gateway to Venezuela, with highway, rail, river and air connections with that country. Pop. (1961 est.) 142,230. Founded as San José de Guasimal in 1733, it became San José de Cúcuta in 1793. In 1875 Cúcuta was destroyed by an earthquake. A beautiful city and an important commercial centre emerged from the ruins. Nucleus of a livestock and agricultural zone, it has many small industries, and there are oil fields to the north. (T. E. N.)

CUDDALORE, a town in Madras state, India, headquarters of South Arcot district, is 15 mi. S. of Pondicherry. Pop. (1951) 68,456; (1959 est.) 85,843. It has two stations on the Southern railway. The town's name comes from the Tamil *kudalur*, meaning "river confluence" (of the Ponnaiyar, which reaches the sea there, and the Gadilam).

Cuddalore consists of two areas: Cuddalore New Town, with district offices and officials' residences, the ruined Ft. St. David and an ancient Hindu Siva temple; and the "old town," the market and port area, to the south. Cuddalore is a roadstead and creek port, with peanuts as the main export. Industry includes peanut-oil pressing and the weaving of coloured cloths and fabrics of silk mixed with cotton, mainly exported to Malaya. There is a large French Roman Catholic mission with a big school.

The British East India company established its Cuddalore factory in 1683. Trade increased rapidly, the warehouses were enlarged and Ft. St. David was built (rebuilt 1720). Robert Clive (*q.v.*) became governor of Cuddalore in 1756. The French took it in 1758, abandoned it in 1760, retook it in 1782 and held it till 1785 when it reverted to the British under the peace treaty. The old governor's garden house is the district collector's residence. (G. Kn.)

CUDDAPAH (Kadapa), a town in Andhra Pradesh, India, headquarters of Cuddapah district, is on the Southern railway 161 mi. N.W. of Madras. Pop. (1951) 37,438. In Telugu *kadapa* means "gate," and the town is the gateway from the north to the sacred shrine of Tirupathi (*q.v.*). Cuddapah lies 5 mi. S. of the Penner river and is shut in on the north, east and south by the rocky Nallamalai and Palkonda hills, rising to 3,000 ft. The heat radiated from these in summer makes Cuddapah perhaps the most uncomfortable town in the region. It has a government arts college affiliated to Sri Venkateswara university at Tirupathi.

Cuddapah District is well known for its fine-grained compact limestones, used mainly as floor tiles and sometimes as table tops under the name Cuddapah slabs. The Penner and its tributaries are nonperennial. They are torrents after rain, then dwindle to thin trickles in wide sandy beds. Pop. (1961) 1,342,140. Area 5,924 sq.mi. (G. Kn.)

CUDWORTH, RALPH (1617–1688), the leading systematic philosopher among the Cambridge Platonists (*q.v.*), was born at Aller, Somerset, the son of Ralph Cudworth (d. 1624), rector of Aller, formerly fellow of Emmanuel college, Cambridge. Cudworth was sent to his father's college and was elected fellow in 1639. In 1642 he published *A Discourse Concerning the True Notion of the Lord's Supper* and a tract entitled *The Union of Christ and the Church.*

At first under a cloud because of his notorious sympathy with nonconformity, he was in 1645 appointed by the parliamentary visitors to the mastership of Clare hall and elected regius professor of Hebrew. He supported the Commonwealth as the only hope of wider toleration; however, in an eloquent sermon to the house of commons on March 31, 1647, he spoke out against the increasing rigidity of the Puritan sectaries. In 1654 he was elected master of Christ's college, whereupon he married. The Restoration, which Cudworth welcomed, left him undisturbed in his mastership of Christ's college, where he died on June 26, 1688. His daughter, Damaris, Lady Masham (1658–1708), friend and correspondent of Locke and of the 3rd earl of Shaftesbury, published in 1696 a *Discourse Concerning the Love of God;* she did much to spread her father's moral and religious ideals.

In 1678 (though the imprimatur was dated 1671) Cudworth published *The True Intellectual System of the Universe: the First Part; wherein all the reason and philosophy of atheism is confuted and its impossibility demonstrated.* A remarkably candid work ("He has raised," Dryden wrote, "such strong objections against the being of a God and Providence that many think he has not answered them"), it aroused considerable theological opposition. He did not publish the second or the third parts, *Of Moral Good and Evil* and *Of Liberty and Necessity;* only fragments remain in manuscript in the British museum. He wrote a short summary of part ii with the title *A Treatise Concerning Eternal and Immutable Morality* (published 1731). *A Treatise of Freewill* (pub-

lished 1838) is probably a summary of part iii.

The True Intellectual System is a criticism of two forms of materialistic atheism: the atomic (Democritus and Hobbes); and the hylozoic (Strato and Spinoza), which holds that matter has its own life. Cudworth accepts the atomic theory because, he argues, it shows that matter is entirely inert and so cannot think or be alive. For the Cartesian dualism of extension and thought he substitutes a dualism of matter and life; life may be either conscious (spirit) or that sort of unconscious "plastic power" exemplified in purposeful but unconscious animal instincts. His theory of plastic powers was widely influential, but his metaphysics suffers from being embedded in lengthy historical digressions.

A Treatise Concerning Eternal and Immutable Morality is directed against the Calvinists, against Descartes' conception of divine omnipotence and against Hobbes's reduction of morality to civil obedience. It is not an ethics but an attempt to state the philosophical presuppositions of ethics. The mind in knowledge, Cudworth argues, is directed toward "general notions," understood as systems of relationships; these, not the isolated objects of sensation, constitute reality. Such general notions, of which good is an example, are modifications of that divine wisdom in which, as rational beings, we participate. "Things are what they are," he wrote, "not by Will but by Nature." No will, then, whether the Calvinist-Cartesian God or Hobbes's sovereign, can make anything good or evil which is not so by nature. Cudworth's manuscripts sketch a more detailed ethics in which he emphasizes the rational, spontaneous, disinterested, public-spirited character of the good life.

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(JN. A. P.)

CUENCA, a central Spanish province with a capital of the same name, is situated in the southern half of the Meseta and fórms part of the ancient kingdom of New Castile. Pop. (1960 est.) 337,999. Area 6,587 sq.mi. The density of population is very low because of the large area of mountainous and uncultivated land. In the northeast is the Serranía de Cuenca, consisting of a series of plateaus divided by valleys and ravines which give it a complicated topography. The rivers draining this area (the Júcar, Guadiela and Tagus) run through deep valleys in an eroded limestone zone which is as picturesque as the so-called Ciudad Encantada ("Enchanted City") formation nearer Cuenca. The Serranía de Cuenca is a region of pine forests and nomadic pastures. In the north is part of the Alcarria, while westward lie the Sierra de Altamira and broken country, sloping in the southwest to plains which form part of the district known as La Mancha. The climate is bleak and cold in the mountains and extreme on the plains, where summer heat is excessive. Prolonged droughts are common. Cereals, vines and olives predominate in the province, but the main natural source of wealth is timber, used for casks, carpentry and constructional work. The province is crossed by the Madrid-Cuenca-Valencia railway line and there are main roads from Madrid to Valencia and Cartagena.

CUENCA, the capital, 201 km. (125 mi.) E.S.E. of Madrid by rail, lies on the western edge of the Serranía de Cuenca at the confluence of the Júcar and Huécar, whose deep gorges almost surround it. Pop. (1960 est.) 24,969 mun. The Moors built a fortress on the high part. It was finally captured from the Moors in 1177 by Alfonso VIII of Castile, who made it an episcopal see in 1182. It enjoyed great prosperity during the later middle ages and especially during the 16th century, and was well known for its silver and its woolen textiles. Many of its convents and churches and the Romanesque-Gothic cathedral, celebrated for its sculpturing and for its beautifully carved wooden doorway, date from this period of prosperity. Cuenca was partially destroyed by Napoleonic troops, and later by Carlist rebels in 1874. During the 19th century the town spread to nearby lowland, so that there are in fact two cities: the upper or old city and the lower or modern one. Viewed from below, the houses of the old city, built on a limestone height, appear to be suspended. Formerly walled, old Cuenca still preserves some of its gateways. The streets are very steep, and there are many large houses and palaces. Cuenca's chief trade is in timber from the forests. Its industries are furniture, pottery, paper and leather manufacturing. (M. B. F.)

CUENCA, the third city of Ecuador, and capital of the province of Azuay. Pop. (1959 est.) 66,800. It is located in the basin of Cuenca, about 190 mi. south of Quito, and 75 mi. southeast of Guayaquil, at an elevation of 8,468 ft. Cuenca is reached from both Quito and Guayaquil by all-weather automobile highways and by regular airlines. A railroad connects it with the Guayaquil-Quito railroad. The city is the commercial centre for a large part of southern Ecuador, trading in agricultural products, cattle, hides and marble. Its chief manufactured products are Panama hats, made from straw sent up from the coastal lowlands for weaving. Other industries include cotton and woolen textiles, lace, leather, articles of gold and silver, cheese, flour, refined sugar, beer, alcohol and soft drinks. It was founded by the Spaniards in 1557 on the site of an Inca settlement called Tumibamba. In 1786 it was made an episcopal see. It has a fine cathedral, a university and some fine examples of colonial architecture. At its weekly fair people from the surrounding countryside come to buy and sell, and to enjoy the social life. (P. E. J.)

CUESTA, a name of Spanish origin for a type of geological structure and land form characterized by a steep cliff or escarpment on one side and a gentle dip or back slope on the other. It occurs in areas of tilted strata and is caused by the differential weathering and erosion of the hard capping layer and the soft underlying cliff maker, which erodes more rapidly.

Cuesta escarpments tend to be cut into rough, hilly country with numerous ravines and steep valleys, because the short streams flowing down the steep scarp face can erode so rapidly. The back slopes commonly are smooth. Cuestas are common in Arizona and New Mexico and along the Atlantic and Gulf coasts of the U.S. (W. C. C.)

CUEVA, JUAN DE LA (1543?–1610), Spanish dramatist and poet, and historically important as a precursor of Lope de Vega, was born at Seville. He based his plays (pub. 1588) on classical sources (*Tragedia de Ayax Telamón*), Spanish historical legend (*Los siete infantes de Lara*), contemporary history (*El saco de Roma*) and novelesque subjects (*El degollado*, "The beheaded"). *El infamador* ("The slanderer") is a distant forerunner of the Don Juan plays. Although capable of writing good dramatic scenes, he lacked the ability to construct plots and fell into ridiculous improbabilities. Most of his verse is commonplace, though some poems show that he could write well. He expressed his literary theories in the *Ejemplar poético* (1606). (J. Gs.)

CUI, CÉSAR ANTONOVICH (1835–1918), Russian composer of operas, songs and piano music, music critic and military engineer. Born at Vilna, Jan. 6 (old style; 18, new style), 1835, he was the son of a French officer, a prisoner of 1812 who remained in Russia after the war, and a Lithuanian. Cui began to compose as a boy, imitating Chopin, and received lessons in composition from Stanislaw Moniuszko, but in 1851 he was sent to St. Petersburg, where he entered the school of engineering, and, in 1855, the academy of military engineering, becoming a lecturer there in 1857. In 1878 he became professor of fortification—his pupils included Gen. M. D. Skobelev and Nicholas II—and he retired with the rank of lieutenant general.

Friendship with Balakirev and Dargomyzhski developed his musical interests: he began to compose copiously and, although he had no Russian blood, became a pugnacious journalistic champion of the Russian nationalist school. From 1864 to 1877 he was music critic of the *St. Peterburgskiye vedomosti*, and later he became a successful propagandist of Russian music in Belgium and France, notably with his *La musique en Russie* (1881). Cui's own music has little Russian flavour and of his ten operas only the first, *The Prisoner of the Caucasus* (begun 1857, produced 1883),

the last, *The Captain's Daughter* (St. Petersburg, 1911) and the one-act *Feast in the Time of the Plague* (Moscow, 1901) are on Russian subjects, all by Pushkin. He turned more readily to French sources: Victor Hugo, Jean Richepin, Dumas *père*, Maupassant and Prosper Mérimée, and his only moderately successful operas are based on Heine's *William Ratcliff* (St. Petersburg, 1869) and Maupassant's *Mam'selle Fifi* (Moscow, 1903). Cui is at his best in the miniature forms, notably his short piano compositions ranging in style from the Schumannesque to the tasteful salon-piece, and in his songs. He died at Petrograd, March 24, 1918.

See Comtesse de Mercy-Argenteau, *César Cui: esquisse critique* (1888). (G. Ab.)

CUIABÁ, capital of Mato Grosso state, Braz., is situated upon the Cuiabá river, a tributary of the Rio Paraguay. Pop. of the *municipio* (1950) 56,204; city 23,745. It lies at 541 ft. elevation, has an annual average temperature of about 80° F. and an average annual rainfall of 55 in. Cuiabá is not served by a railroad but may be reached by steamer from La Plata, by river boat from Corumbá and by road from Campo Grande. There is an airport. The city was founded by Paulista gold hunters in 1719 and became the centre of an important gold-mining region in the 18th century. Agriculture and stockraising are the main economic activities, but are limited by the isolation of the area, the lack of markets and the sparse population. (J. L. Tr.)

CUIRASSIERS, a kind of heavy cavalry, originally developed out of the men-at-arms or *gendarmerie* forming the heavy cavalry of feudal armies. Their special characteristic was the wearing of full armour, which they retained long after other troops had abandoned it. Hence they became distinguished as cuirassiers. The first Austrian corps of *kyrissers* was formed in 1484 by the emperor Maximilian and was 100 strong. In 1705 Austria possessed 20 regiments of cuirassiers. After the war of 1866, however, the existing regiments were converted into dragoons. Russia likewise in modern times abolished all but a few guard regiments of cuirassiers. The Prussian cuirassiers were first so called under Frederick William I, and in the wars of his successor, Frederick the Great, they bore a conspicuous part. After the Seven Years' War they ceased to wear the cuirass on service, but after 1814 these were reintroduced, the spoils taken from the French cuirassiers being used to equip the troops. In France the cuirassiers date from 1666, when a regiment was formed. During the first empire many regiments were created, until in 1812 there were 14. The number was reduced after the fall of Napoleon, but was again increased in the period previous to World War I when the French regiments alone in Europe wore the cuirass on all parades and at maneuvers.

CUJAS, JACQUES (latinized as Jacobus Cujacius) (1522–1590). French jurist and scholar, a leader of the school of humanists who in the 16th century gave new impetus to the study of Roman law which accompanied the revival of interest in the classical literature, was born in 1522 at Toulouse, where his father was a fuller. He taught himself Latin and Greek before studying law under Arnoul Ferrier, then professor at Toulouse. He rapidly gained a great reputation as a lecturer on Justinian and in 1554 was appointed professor of law at Cahors. About a year after, M. de L'Hôpital called him to Bourges, but F. Douaren, who also held a professorship at Bourges, stirred up the students against the new professor, and such was the consequent disorder that Cujas yielded and accepted an invitation he had received to the University of Valence. Recalled to Bourges on the death of Douaren in 1559, he remained there until 1567, when he returned to Valence. There he gained a European reputation and collected students from all parts of the continent, among whom were Joseph Scaliger and J. A. de Thou. In 1573 Charles IX appointed Cujas counselor to the *parlement* of Grenoble, and the following year a pension was bestowed on him by Henry III. Margaret of Savoy induced him to remove to Turin; but, after a few months, in 1575 he once more took his old place at Bourges. Driven from that city by the religious wars, he was called by the king to Paris, where the *parlement* granted him permission to lecture on civil law in the university. A year after, however, he finally took up his residence at Bourges, where he remained until his death in 1590.

Cujas devoted his life to scholarship and teaching. In the religious wars which filled all the thoughts of his contemporaries he steadfastly refused to take any part. *Nihil hoc ad edictum praetoris,* "This has nothing to do with the edict of the praetor," was his usual answer to those who spoke to him on the subject. His surpassing merit as a jurisconsult was that he turned from the ignorant commentators on Roman law to the Roman law itself, which he studied as literature and in its historical context. He collected more than 500 manuscripts, but his library was broken up after his death and a great part lost. His emendations, of which a large number were published under the title of *Animadversiones et observationes,* were not confined to legal texts, but extended to many of the Latin and Greek classical authors. In jurisprudence his study was by no means limited to Justinian; he recovered and published, with explanations, a part of the Theodosian Code; and he procured the manuscript of the Basilica, a Greek abridgement of Justinian, afterward published by C. A. Fabrot (*see* Basilica). He also composed a commentary on the *Consuetudines Feudorum* and on some books of the Decretals. In the *Paratitla,* or summaries which he made of Justinian's Digest and Code, he condensed into short axioms the elementary principles of law and gave definitions remarkable for their clarity and precision.

The complete edition of his works (Neville, 1577) is very scarce. The edition of Colombet (1634) is incomplete. Fabrot, however, collected the whole in the edition which he published at Paris (1658), and which was reprinted at Naples (1722, 1727), and at Naples and Venice (1758) with an index forming an 11th volume.

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CULDEES. "Culdee," an anglicizing of the two Irish words *céle,* a "companion" or "friend," and *Dé,* "God," was applied originally to monks and nuns, but from the 8th century onward more particularly to groups of ascetics in various parts of Britain, principally in Ireland and Scotland. It is not possible always to distinguish these Culdees clearly from other contemporary ascetics, but it may be said that generally speaking they stood for the old ways of the Celtic Church (*q.v.*) in religion as against Roman influences in the 7th and 8th centuries and against continental religious orders after the Norman Conquest. To their activities is due the preservation of most of the surviving Irish rules, penitentials, martyrologies and service books, such as the 8th-century "Rule of Máelrúain" and the 9th-century "Observances of Tallacht," and it is in this revival and love of native monastic ways of life and worship and not, as has sometimes been suggested, in the rule of Chrodegang of Metz (*c.* 755) that their origin must be sought. Organization was not their strong point (another Celtic characteristic) and there seems to have been considerable diversity, but by and large they appear as secular clerics living under a superior within a common enclosure attached to some established community. There they practised a strict and old-fashioned way of life, busying themselves with caring for the sick and poor and for the choral parts of the church services. After the Norman Conquest they gradually disappeared before the continental religious orders or were absorbed in the new foundations of canons regular. Information about them comes chiefly from their supplanters and must be used with caution, being subject to both national and ecclesiastical bias. In places such as Armagh in Ireland and St. Andrews in Scotland their name and endowments survived until the Reformation. At York the flourishing Culdee community found there by King Athelstan in the 9th century was transformed into St. Leonard's hospital in the 12th. As late as 1190 Giraldus Cambrensis referred to Culdees still existing at Bardsey Island and Beddgelert in north Wales, and, while noting the hostility with which the Cistercians regarded them, he praised the piety and asceticism of their lives.

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CULEBRA ISLAND is the smallest of the three offshore islands under the jurisdiction of Puerto Rico. The island is about equidistant between the east coast of Puerto Rico and St. Thomas of the Virgin Islands. Passenger and mail launches from Fajardo to St. Thomas often stop at Culebra Town, formerly Dewey, located on the island's excellent harbour called Puerto Grande. The island, colonized in 1879, is 10 sq.mi. in area and in 1960 had a population of 573; (1950) 887. Because of its fine harbour, the U.S. navy has occupied one-third of the terrain and used its port as a base for naval maneuvers. Grazing is the main industry of the island; no sugar cane is cultivated, but some coconuts and local crops are grown. Fishing in the surrounding waters is excellent. Water is scarce, and during the dry season the collected rain water must be supplemented from Puerto Rico. Three small keys lie close to Culebra Island. One of these, Culebrita Island, was declared by Theodore Roosevelt a sanctuary for wild birds; however, in recent years this order has not been respected.

(T. G. Ms.)

CULIACÁN, capital of the state of Sinaloa on the west coast of Mexico. Pop. (1960) 82,045. The city is located on a small coastal plain (elevation 175 ft.) at the foot of the lofty Sierra Madre Occidental on the left bank of the Culiacán river. Along the river bank, the Jardín Rosales contains many cultivated plants and a large variety of bird life. Although generally hot and semi-arid, Culiacán has an average precipitation of 24 in. during the summer rainy season. An elaborate irrigation system in the Culiacán river valley provides for a great variety of crops, including maize, sugar cane, chick peas, beans, chilies, melons, potatoes, groundnuts, tobacco, oranges, limes, bananas and grapes. Culiacán is connected by rail with the port of Guaymas on the Gulf of California and is on the west coast artery of the Pan-American highway. The city was founded in 1531 by Nuño de Guzmán, conqueror of Nueva Galicia, and played an important part in early Spanish-colonial days as a base for expeditions. (H. R. Hv.)

CULION ISLAND is one of the Calamian Islands (*q.v.*) in the province of Palawan (*q.v.*), Philippine Islands. Area 150 sq.mi. It is the location of Culion Reservation (pop. [1960] 4,756), a leper colony founded in 1906. The lepers are gathered from all parts of the Philippines and are kept at government expense. Excellent medical and hospital services are furnished free of charge, and many cures have been made. The local government is administered by the lepers themselves, who, so far as possible, live normal village lives in the healthful climate, raising rice and coconuts.

CULLEN, PAUL (1803–1878), Irish cardinal and archbishop of Dublin, was born near Ballytore, County Kildare, on April 27, 1803, and educated first at the Quaker school at Carlow and afterward at Rome. There he joined the Urban College of Propaganda and, after passing a brilliant course, was ordained in 1829. He then became vice-rector and afterward rector of the Irish National college in Rome. During the Mazzini revolution of 1848 he was rector of the Urban college. In 1849 Cullen was nominated as successor to the primatial see of Armagh. Taking a strong line on the educational question which was then agitating Ireland, he played a leading part in the National movement of 1850–52. In May of the latter year he was translated to Dublin, and soon a divergence of opinion broke out between him and the more ardent Nationalists. As time went on, his distrust of the National movement grew deeper; and in 1853 he sternly forbade his clergy to take part publicly in politics. He was made cardinal in 1866, being the first Irish cardinal. Cullen was an energetic administrator, and churches and schools rose throughout his diocese; the excellent Mater Misericordiae hospital and the Catholic University of Ireland are lasting memorials to his zeal. He took part in the Vatican council as an ardent infallibilist. The cardinal died in Dublin on Oct. 24, 1878. (E. TA.; X.)

CULLEN, a royal burgh and popular holiday resort on a Moray firth bay in Banffshire, Scot., 58 mi. N.W. of Aberdeen by road. Pop. (1961) 1,327. Its appeal lies in its scenery, sandy beaches, cliffs, hills, woods and moors, and in its historical associations. William the Lion first granted its royal charter and Robert the Bruce endowed a chaplaincy for prayer for his wife, Elizabeth de Burgh, who died there. The Cullen burn enters the sea at the western boundary between the Seatown, inhabited by the fishing community, and the golf links. Southward, on sloping ground, stands the new town with its wide, straight streets dating from 1820–30 when the original township, which stood one mile south, was cleared to improve the amenities of Cullen house, the early-17th-century Scots baronial seat of the earls of Seafield. The nearby parish kirk of St. Mary existed by 1236; later additions produced the present cruciform structure. (W. D. McH.)

CULLODEN, a tract of moorland in Inverness-shire, Scot. It forms part of the northeast of Drummossie moor, and is situated about 6 mi. E. of Inverness by road. It is celebrated as the scene of the battle of April 16, 1746, by which the fate of the house of Stuart was decided. By Highlanders the battle is sometimes described as the battle of Drummossie. Several memorials, including a tall cairn, have been erected, and scattered stones inscribed with names of clans act as grave markers of fallen highlanders.

About one mile to the southeast of the field, on the right bank of the Nairn, is the plain of Clava, containing several stone circles (varying in circumference from 12 to 140 yd.), monoliths, cairns and other prehistoric remains.

Battle of Culloden.—For the course of the 1745 rebellion, which was crushed at Culloden, *see* SCOTLAND: *History*. Concentrating his forces, Prince Charles Edward, the Young Pretender, awaited the British on Drummossie moor. Hearing, however, that the duke of Cumberland had halted at Nairn, eight miles away, to celebrate his 25th birthday (April 15), Charles, with Lord George Murray, decided to surprise his camp; but the long night march over the moors was too much for the tired and starving Highlanders and they returned to their old position, more exhausted and depressed than ever. Early on the morning of April 16, Cumberland made contact with the pretender's army. The Jacobites, about 5,000 strong, were drawn up in two widely separated lines, with a small reserve of horse, one flank resting on the park walls of Culloden house. Their opponents, 9,000 strong, were also in two lines, at a distance of 50 paces, with cavalry on each flank and a reserve of Highland irregulars. The battle began with an artillery duel, in which the 18 well-served guns on the Hanoverian side caused great distress to the Highlanders, who sought to escape their fire by attack. The regular British infantry awaited them in three ranks, the first kneeling, the second stooping and the third standing. Cumberland had trained each of his soldiers to engage the man to his right front, so evading the Highlander's target and thrusting under his raised sword arm. The Highlanders on the left failed to attack effectively; on the right they broke through, but were taken in flank by supports from the second line and thrown back in great confusion. Seeing this, the Jacobite centre and left lost heart and retreated, the regulars following up and causing heavy losses with their musketry fire. At the same time the dragoons broke through the walls which were protecting the Jacobite flanks and attacked the second line in the rear.

The Highlanders, finding themselves outflanked, broke and fled. About 1,000 were killed in the battle or the subsequent pursuit, and the same number were taken prisoner; Cumberland lost only 50 killed and 200 wounded.

BIBLIOGRAPHY.—*Culloden Papers* (1815); D. G. Warrand (ed.), *More Culloden Papers*, 5 vol. (1923–30); A. and H. Tayler (eds.), *1745 and After* (1938); Sir B. Seton and Jean Arnot (eds.), *Prisoners of the '45*, 3 vol. (1928–29). (G. S. P.)

CULLUM, GEORGE WASHINGTON (1809–1892), U.S. army officer and author, was born in New York city on Feb. 25, 1809. He entered the U.S. Military academy at West Point in 1829 and after graduation in 1833 received a commission in the corps of engineers. He served as an engineer officer with the U.S. army during the Mexican War and from 1848 to 1855 taught practical engineering at West Point. At the outbreak of the Civil War, Cullum became aide-de-camp to Gen. Winfield Scott, then com-

mander in chief of the U.S. army. He later served on the staff of Gen. H. W. Halleck, first in the department of Missouri and then in Washington, D.C., after Halleck became general in chief of the armies of the U.S. Upon retiring from active service, as a colonel, in 1874, Cullum devoted himself to literary, scientific and military studies.

Of his many published works he is best known for his *Biographical Register of the Officers and Graduates of the U.S. Military Academy From 1802 to 1850,* published in 1850. Second and third editions extended the coverage to 1891. At his death on Feb. 28, 1892, Cullum left provision in his will for continuance of the *Biographical Register,* and supplements were published at intervals thereafter. (H. C. T.)

CULMANN, KARL (1821–1881), German engineer whose method of graphostatics has been used extensively in many problems of engineering and mechanics, was born in Bergzabern, Ger., on July 10, 1821, the son of a Bavarian clergyman. At 17 he matriculated in the engineering school of the Polytechnical institute in Karlsruhe, after which he entered the Bavarian civil service as an apprentice on the Hof railway section, where he remained until 1847. For the next three years he traveled in England, Ireland and North America, re-entering the civil service on his return. With an appointment to the faculty of the Polytechnical institute in Zürich, Switz. (1855), he began a career of teaching and research. In 1864 he made a valuable report following his investigation of the wild mountain streams of Switzerland, the control of which was a seasonal problem. His most important work, however, was concerned with the problem of determining the distribution of stresses in structures. With the publication of *Die Graphische Statik* (vol. 1, 1865, no others published; 2nd ed. 1875), he presented a survey of all that had been done up to that point toward the solution of static problems by the graphic method, at the same time laying a foundation for its use as an exact science.

In 1880, Culmann was made honorary doctor of the faculty of philosophy at the University of Zürich. He died at Reisbach near Zürich on Dec. 9, 1881.

CULMINATION, in astronomy, the term given to the passage of a heavenly body over the meridian of a given place. Two culminations take place in the course of the day, one above and the other below the pole. The first is called the upper, the second the lower. Either or both may occur below the horizon and therefore be invisible.

CULPEPER'S REBELLION (1677–79), one of the first popular uprisings in the American colonies. The Albemarle colony, in the northern part of Carolina, consisted of about 4,000 persons engaged primarily in the raising of tobacco to be sold through New England merchants and shippers. Enforcement of the navigation acts denied the colonists a free market outside of England, and heavy duties placed on tobacco kept the northern merchants from their harbours. Feelings of repression found an object in the deputy governor, Thomas Miller, who was also customs collector. The insurrection came to a head in 1677, with John Culpeper and George Durant as leaders. The first act of the rebels was to imprison Miller and most of his council. They then took over all public records, established courts of justice, appointed judges and convened an assembly. On Dec. 3, 1677, they issued a manifesto entitled "Remonstrance of the Inhabitants of Paspatancke to All the Rest of the County of Albemarle," signed by 34 persons and outlining the grievances justifying their rebellion.

For two years, with Culpeper as governor, they capably exercised all the powers and duties of government. An appointed governor sent from England the following year died before reaching Carolina. The settlers, hopeful of a just settlement, sent Culpeper to England, promising submission to proper authority. Miller had in the meantime escaped and was in England to greet Culpeper with charges of treason and embezzlement. Culpeper willingly submitted to trial and found support in the influential earl of Shaftesbury, one of the proprietors of Carolina, who defended Culpeper by asserting that no regular government existed in Albemarle and that his actions were not treasonable. Culpeper was acquitted. (W. S. P.)

CULROSS (locally pronounced *Coo-rus*), a royal and small burgh of Fifeshire, Scot., 6 mi. W.S.W. of Dunfermline by road. Pop. (1961) 514. It is attractively situated on a hillside sloping gently to Torry bay in the Firth of Forth. Its early history has much to do with that of the church. St. Serf (or Servan) probably founded a church and cemetery there in the 5th century, and for years after his death the townsfolk celebrated his feast (July 1) by walking in procession bearing green boughs. It is the reputed birthplace of St. Kentigern (also called Mungo), the first bishop of Glasgow. These religious associations, coupled with the fertility of the soil, led to the founding of a Cistercian abbey in 1217. Of this only the western tower and choir remain to form the parish church. James VI made Culross a royal burgh in 1588. All the old industries of the town—the coal mines, saltworks, linen manufactures and the making of iron "girdles" (for making oat cakes)—have disappeared. Culross is an outstanding survival of 17th- and 18th-century domestic architecture, with houses, which often have dormer windows, huddled along narrow cobbled streets. The older buildings were put under the care of the National Trust for Scotland, which continued their maintenance and restoration. These include the "Palace," built (*c.* 1597–1611) by Sir George Bruce, with paneled and painted rooms, the Abbey house, built by his brother in 1608, and the "Study," a 17th-century house facing the mercat (market) cross. Bishop Leighton's lodgings, the Snuff Maker's house (1763), the "House with the Evil Eyes" and the 17th-century townhouse are further examples.

Dunimarle castle (½ mi. W.), containing a fine art collection, adjoins the site of the castle where, according to tradition, Macbeth slew the wife and children of Macduff.

CULTIVATING MACHINERY: *see* TILLAGE MACHINERY; FARM MACHINERY.

CULTIVATION: *see* AGRICULTURE; AGRICULTURE (ARTICLES ON).

CULTURAL ANTHROPOLOGY: *see* SOCIAL ANTHROPOLOGY.

CULVER CITY, an industrial and residential city in southwestern Los Angeles county, Calif., U.S., best known for its motion-picture production. About 1819 the area was used for cattle grazing and barley fields. In 1912 the Culver Investment company acquired the section. Harry H. Culver, after whom the city was named, proceeded to subdivide the local area in 1913. By 1914 several shops had appeared. Motion pictures began to be made there as early as 1915. Thomas H. Ince needed a stream for an Indian canoe scene and La Ballona creek in Culver City provided the answer. Culver City is ranked with Hollywood in motion-picture production.

Culver City was incorporated as a chartered city on Sept. 20, 1917. In addition to motion pictures, its industries include pen manufacture, aircraft production and wearing apparel. For comparative population figures *see* table in CALIFORNIA: *Population.* (J. M. Wo.)

CULVERWEL, NATHANAEL (1618?–1651?), English philosophicoreligious thinker, whose mixture of empiricism, a legislative ethics and rationalism probably influenced Locke, was most likely a son of Richard Culverwel, rector of St. Margaret's, Friday street, London. Culverwel entered Emmanuel college, Cambridge, in 1633 and was elected to a fellowship in 1642. His last years appear to have been clouded by mental disorder.

His writings were posthumously published by an Emmanuel colleague, William Dillingham: first six sermons under the title *Spiritual Opticks* (Cambridge, 1651); then his complete works as a single volume (London, 1652). His best-known essay, *An Elegant and Learned Discourse of the Light of Nature,* was composed as the introduction to a large work, in which Culverwel hoped to defend both reason against its more violent adversaries and faith against Arian rationalism. It is not closely reasoned, but has been much admired for its passionate rhetoric, although it labours under the weight of scholastic-Aristotelian authorities.

Culverwel is usually described as one of the Cambridge Platonists (*q.v.*), and certainly that part of the *Discourse* which glorifies reason reveals Benjamin Whichcote's influence. But he did not entirely shake off the influence of Calvinism, which is

particularly marked in his sermons. Reason is important, according to Culverwel, because it discovers to us the need for revelation and the existence of a divine law; but God's will, not reason, is the "rule of good and evil." Human reason does not, as the Platonists thought, participate in divine reason; it dimly reflects it. Nor does Culverwel accept the Platonist view that the mind is active in knowledge; the understanding, he says, is "a glass not prejudiced, but nakedly receiving, and faithfully returning, all such colours as fall upon it."

BIBLIOGRAPHY.—*See* J. Cairns's preface to J. Brown's edition of the *Discourse* (1857). Of the works listed under CAMBRIDGE PLATONISTS *see* especially Tulloch, Powicke, Pawson and Campagnac (who includes the *Discourse*). *See* also W. C. de Pauley, *Candle of the Lord* (1937); A. C. Scupholme, "Nathanael Culverwel," in *Theology* (1939). On Culverwel's relation to Locke *see* W. von Leyden, *John Locke's Essays on the Law of Nature* (1954). (JN. A. P.)

CULZEAN, a castle in Ayrshire, Scot., 4 mi. W. of Maybole, built between 1771 and 1792, is an outstanding example of the work of Robert Adam. It stands on cliffs and incorporates a medieval keep of the Kennedys, who were feudal overlords in southwest Scotland. Features of the castle, which was acquired by the National Trust for Scotland in 1945, are the magnificent oval staircase, the staterooms with painted ceilings and the armoury. The top flat was given to Gen. (later Pres.) Dwight D. Eisenhower as a Scottish residence for use during his lifetime in gratitude for his services to the Allied cause during World War II. Beneath the castle are coves, or caves, said to have been a rallying point of King Robert the Bruce in his struggles against the English.

(L. M. CR.)

CUMAE, an ancient city on the west coast of Campania, Italy, about 12 mi. W. of Naples, on a volcanic hill, overlooking the plain of the Volturno river.

Cumae (Gk. *Cyme*) was founded about 750 by Euboean Greeks from Chalcis and Eretria who had previously settled on the nearby island of Pithecusae (Ischia); it was probably the oldest Greek mainland colony in the west. Cumaean pirates settled at Zancle (Messina) before the city's official foundation about 730 by colonists from Cumae and Chalcis, and Naples (Gk. *Neapolis*, "New City") is also said to be a Cumaean foundation. The Cumaeans controlled the most fertile portion of the Campanian plain and were probably the means of bringing the Etruscans into contact with Greek culture. In 524 B.C. under the tyrant Aristodemus they withstood an attack by the Etruscans of Capua, the Daunians of the district of Nola, and the Aurunci of the Mons Massicus and in 508 helped the Romans against the Etruscans at the battle of Aricia. A renewed Etruscan attack was repelled with the help of Hiero of Syracuse, who in the battle of Cumae of 474 B.C. defeated the Etruscan fleet. The Samnites finally destroyed the Etruscan supremacy by the capture of Capua about 440 (*see* CAMPANIA: CAPUA [ancient city]), and the Greeks of Cumae were overwhelmed in 428 or 421. The beautiful series of Greek coins from the town now ended, and Oscan, one of the Italic dialects, became its language (though in many respects the Greek character of the town survived) until about 180 B.C. when the Cumaeans asked for permission to use Latin for public purposes. Cumae had already come under the supremacy of Rome in 338. In the Hannibalic wars it remained faithful to Rome. Under the empire it was a quiet country town, in contrast to the gay and fashionable Baiaè (Baia), though the nearby lakes of Avernus and Lucrinus became naval bases in 37 B.C. In the Gothic wars the acropolis of Cumae was, except for Naples, the only fortified town in Campania, and it retained its military importance until it was destroyed as a nest of pirates by the Neapolitans in 1205, after which time it was deserted.

The acropolis hill (269 ft. above sea level), a mass of trachyte which has broken through the surrounding tufa, lies hardly 100 yd. from the low sandy shore. It is traversed by caves, and a long gallery, cleared in 1932, which may have been identified with the *antrum* (cave) famous in legend as the seat of the oracle of the Cumaean Sibyl (*see* SIBYL). The acropolis has only one approach, on the southeast; on all other sides it falls away steeply and in classical times the sea reached its foot. Remains of fortifications of all ages run around the edge of the hill; some of the original Greek work, in finely hewn rectangular tufa blocks, exists on the east. Within the acropolis stood two Greek temples, one of Apollo, both restored in Roman times and later converted into Christian basilicas.

To the south of the town, just outside the wall, is the amphitheatre. A mile to the east of Cumae, the *Via Domitiana* passes through the Arco Felice, an arch of brick-faced concrete 63 ft. high which spans a cutting through Monte Grillo, made by Domitian to shorten the course of the road. The Roman underground road (¾ mi.) known as the Grotto della Pace leads from southeast of Cumae through Monte Grillo to the shores of Avernus (Averno) lake. Pre-Hellenic (9th to 8th centuries B.C.) and Greek, Samnite and Roman graves near Cumae have yielded many important objects.

See A. Maiuri, *The Phlegraean Fields* (Eng. trans.) pp. 93–131 (1947).

CUMANÁ, a city of Venezuela and capital of Sucre state, is on the Río Manzanares, one mile from the river mouth where Puerto Sucre, its port, is located. Pop. (1961) 71,563. The city has an elevation of 52 ft. and an enervating climate which averages 83° F. It is 180 mi. from Caracas and 62 mi. from Barcelona with which it is connected by a highway. The city has an airport. Cumaná is subject to frequent earthquakes, the severest being in 1530, 1766, 1797, 1853 and 1929. Coffee, cacao, sugar, tobacco, beans and a variety of excellent fruits are raised in the vicinity. Near the city is a major cotton mill. A small but important fishing industry is carried on. Missionaries were first in the region and in 1521 González Ocampo established near the present site a settlement that was soon destroyed by Indians. Cumaná was founded under the name Nueva Córdoba by Jacome Castellón in 1523 and claims to be the oldest European settlement on the South American mainland. English pirates sacked the town in 1576. Between about 1590 and 1625 the city served as a base of operations against the Dutch, who came illegally to Punta de Araya for salt. Cumaná enjoyed a profitable trade with neighbouring settlements and with Spain throughout much of the colonial period. Famous old Venezuelan families with Spanish colonial roots give the city a prestige which is nationally recognized. (J. J. J.)

CUMBERLAND, EARLS AND DUKES OF. The earldom of Cumberland was held by the family of Clifford (*q.v.*) from 1525 to 1643, when it became extinct by the death of Henry, the 5th earl. HENRY (1493–1542), 11th Lord Clifford, was created earl of Cumberland by Henry VIII in 1525. He held Skipton castle against the rebels led by Robert Aske in 1536. His son HENRY (1517–70) was twice married. By his first wife, Eleanor, the daughter of Charles Brandon, duke of Suffolk, and of Mary Tudor, daughter of Henry VII, he left an only daughter, Margaret (1540–96), who married Henry Stanley, 4th earl of Derby, and in 1557 was by many regarded as the rightful heiress to the English throne. By his second wife he left two sons and a daughter. His elder son, GEORGE (1558–1605), a great mathematician and navigator, made nine voyages of exploration and plunder, mainly to the West Indies, sometimes with the support of Queen Elizabeth I. He commanded the "Bonaventure" against the Spanish Armada (1588). George left no sons, and he was succeeded in the barony by his daughter Anne and as earl of Cumberland by his brother FRANCIS (1559–1641). Francis' son HENRY (1592–1643), 5th earl of Cumberland, supported Charles I in the early months of the Civil War. When he died of a fever at York without issue on Dec. 11, 1643, the earldom became extinct; his new barony of Clifford (created 1628) went to his daughter Elizabeth (1613–91), wife of Richard Boyle, earl of Cork and Burlington, and the Cumberland estates passed to his cousin Anne (d. 1676), Baroness Clifford and countess of Dorset, Pembroke and Montgomery.

The title of duke of Cumberland has been held from 1644 by various members and connections of the English royal family. Prince RUPERT (1619–82), son of Frederick V, elector palatine and king of Bohemia, was created duke of Cumberland in 1644 by his uncle, Charles I. The title lapsed when Rupert died without legitimate issue, but was revived in 1689 in favour of GEORGE (1653–1708), prince of Denmark, who had married (1683) Princess Anne (afterward Queen Anne). The title was held from 1726 until his death in 1765 by WILLIAM AUGUSTUS, duke of Cumberland (*q.v.*),

second surviving son of George II. William Augustus was unmarried; the title lapsed at his death and was granted in 1766 to Henry Frederick (1745–90), 4th son of Frederick, prince of Wales, and brother to George III. The fifth creation (1799) was in favour of Ernest Augustus (*q.v.*), fifth son of George III. On the death of his brother William IV in 1837, Ernest Augustus became king of Hanover under the Salic law, and on his death in 1851 the title descended with the kingdom of Hanover to his son George Frederick (1819–78), afterward King George V of Hanover. Hanover was annexed by Prussia in 1866 but King George never renounced his rights. His son Ernest Augustus (*q.v.*) was known as the duke of Cumberland during his father's lifetime. He inherited the duchy of Brunswick in 1884, but was prevented from becoming reigning duke by a federal decision inspired by Prussia in 1885 and repeated in 1907 (*see* Brunswick). The duke never formally renounced the throne of Hanover, and the hostility between his family and the Hohenzollerns was only ended in 1913 when his son Ernest Augustus (1887–1953) married Princess Victoria Louise, daughter of the Prussian emperor William II. The elder Ernest Augustus then renounced his rights to his son, who became sovereign ruler as duke of Brunswick. He was obliged, with other German princes, to abdicate on Nov. 8, 1918; a Titles Deprivation act (1917) and an order in council (1919) effectively deprived father and son of their United Kingdom titles. Ernest Augustus (1914–), son of the last duke of Brunswick, successfully claimed British citizenship in 1955, and his claim was upheld by the house of lords in 1956; he was thus entitled to petition the crown for a revival in his favour of the title of duke of Cumberland.

CUMBERLAND, RICHARD (1631–1718), English moral philosopher and bishop of Peterborough, son of a London citizen, was born in the parish of St. Bride's, London, on July 15, 1631. He was educated at St. Paul's college, London, and Magdalene college, Cambridge, which he entered in 1648. He was made a fellow in 1656 and began the study of medicine, but accepted preferment first to the rectory of Brampton in Northamptonshire (1658) and then to the rectory of Allhallows at Stamford (1667). Although not ambitious for office he was named bishop of Peterborough in 1691, partly because of his staunch Protestantism. He died on Oct. 9, 1718.

Cumberland's works fall into two groups: historical and philosophical. Like many other Cambridge men of his time he was greatly interested in Hebraic antiquities and published in 1686 *An Essay Toward the Recovery of the Jewish Measures and Weights, Comprehending Their Monies; by the Help of Ancient Standards Compared with Ours of England.* His domestic chaplain and son-in-law Squier Payne prepared for posthumous publication a translation and commentary on *Sanchoniatho's Phoenician History* (1720), the authenticity of which Cumberland did not doubt. Cumberland thought it threw light on the origins of idolatry; in a manner typical of Cambridge scholarship he identified the personages mentioned by Sanchuniathon with a variety of Old Testament characters. Payne also published a sequel to the work: *Origines gentium antiquissimae; or Attempts for Discovering the Times of the First Planting of Nations; in Several Tracts* (1724).

Cumberland's reputation rests on his *De legibus naturae disquisitio philosophica* (1670), "Wherein the essence, the order, the publication, and the obligation of these laws are deduced from the nature of things and the principles of Mr. Hobbes' philosophy are examined and confuted." An abridged version by James Tyrrell appeared in 1692 as *A Brief Disquisition of the Laws of Nature According to the Principles Laid Down by the Rev. Dr. Cumberland's Latin Treatise;* the best English translation is that of John Towers, *A Philosophical Enquiry into the Laws of Nature* (1750).

Cumberland's starting point is Grotius. But whereas Grotius—or so Cumberland interprets him—rested the authenticity of his laws of nature on the general agreement of civilized nations, Cumberland looked for a more secure philosophical foundation. He is very conscious of the writings of Hobbes, against whom his work is largely directed; his object, in general terms, is to show in opposition to Hobbes that there are firmly established laws of nature which make it desirable for us to pursue the common good rather than our own particular advantage. Although he was sympathetically inclined toward, and influenced by, Cambridge Platonism he did not wish to rely upon "the short and easy expedient" of the Platonists by maintaining that natural laws are innate principles; or to rest his case upon scriptural authority. "Our sole design and aim here," he writes, "is to establish the Law of Nature just so far as and no farther than, we are conscious of such a Law from our own natural Reason, Observation and Experience."

The basic doctrine on which Cumberland's theory depends is that the whole is exactly the same as all its parts taken together, from which it follows that whatever preserves the whole preserves the parts. His "great moral principle" is "That the fullest, most vigorous Endeavour, of each and all rational Agents, in Promoting the Common Good of the whole rational System, contributes effectually to the Good of each single Part in such a System; Under which Whole, or System, the single, individual Happiness of each, and all of us, is essentially contained: on the contrary, that Acts, opposite to such a Propensity, must produce Effects opposite, and by Consequence, amongst many other Evils, involve us, and each of us, in Misery." Thus Cumberland's reply to Hobbes's egoism is that in fact the happiness of the individual is ensured only if he works for the common good. Right action, he argues, is that action which takes the shortest means to the common good; and such action will also be naturally good, morally good, beautiful, decent and praiseworthy. Thus all the principal moral concepts are related to the single idea of the energetic pursuit of the common good. Similarly, more particularized moral duties (*e.g.*, gratitude, promise-keeping, familial responsibilities) are all of them specific applications of the single, general moral law. God, as rational, uses this law to bind all rational beings and supports it by sanctions.

Since he defines moral action in terms of ends and lays great stress on happiness, Cumberland has sometimes been described as the father of English utilitarianism. Equally, he is the father of the sort of rationalism exemplified in the ethics of Samuel Clarke, who was greatly influenced by Cumberland. For much of Cumberland's argument is directed toward showing that the pursuit of the common good is the conduct "naturally fitting for a rational being"—a "fitness" which can be quite as certainly apprehended as the mathematical relation of congruity. He is also one of the first to attempt to work out a quasi-mathematical morality, a "moral calculus" of the sort later developed by Hutcheson and Bentham. Indeed, a surprising number of the trends in later moral philosophy can be detected within Cumberland's verbose, prosaic, not wholly consistent work. He was better at proposing ideas than at working them out.

Bibliography.—S. Payne, *Life of Cumberland,* being Appendix iv of Towers' 1750 edition of the *Laws of Nature. See* also E. Albee, *A History of English Utilitarianism* (1902); F. C. Sharp, "The Ethical System of Richard Cumberland, and Its Place in the History of British Ethics," *Mind* (1912). (Jn. A. P.)

CUMBERLAND, RICHARD (1732–1811), English dramatist whose reputation rests mainly on his sentimental comedies, which suited the temper of the time and showed skill in stagecraft, was born in Cambridge on Feb. 19, 1732. He was the great-grandson of the bishop of Peterborough, and his father, Denison Cumberland, became in turn bishop of Clonfert and of Kilmore. His mother was Joanna, the daughter of the great scholar Richard Bentley. Cumberland was educated at Westminster school and Trinity college, Cambridge. He had just begun to read for his fellowship when he was offered, and accepted, the post of private secretary to the earl of Halifax, first lord of trade and plantations in Newcastle's ministry. In 1761 he accompanied Halifax (who had been appointed lord lieutenant) to Ireland as Ulster secretary and later held other government positions. In 1780 he was sent on a confidential mission to Spain, the expenses of which he strove in vain to recover, and soon after he retired on an allowance of less than half pay. He died in London on May 7, 1811.

Although chiefly famous as a dramatist, Cumberland is also memorable for his *Memoirs* (1806–07), which include a long account of his Spanish mission and reminiscences of politicians and of David Garrick, Samuel Foote and Oliver Goldsmith. He was a good observer of men and manners, but the uneasy self-absorption which Sheridan immortalized in Sir Fretful Plagiary in *The*

Critic is apparent. As a dramatist Cumberland met alternately with periods of great success and complete failure, but he continued to write with enthusiasm, and produced at least one, often three, plays a year. His success began with a sentimental comedy, *The Brothers* (1769). Its plot is reminiscent of Fielding's *Tom Jones,* but the characters, the jovial Captain Ironsides and the henpecked Sir Benjamin Dove, are closer to those of Smollet. Sentiment was becoming an important literary force at the time (Sterne's *Sentimental Journey* appeared in 1768, Henry Mackenzie's *Man of Feeling* in 1771), and in giving dramatic expression to the current mood Cumberland gained great popularity. He continued his success with *The West Indian,* which was produced in 1770 by Garrick and subsequently became one of the stock plays of the late 18th-century theatre. The plot is fantastic and the psychology crude, but the play is stageworthy (Cumberland was a master of stage effect) and again a great deal of feeling is extracted from the situations. He followed this with another sentimental comedy, *The Fashionable Lover* (1772).

Although Cumberland's most successful genre was clearly sentimental comedy, he hankered to produce more exalted dramas in the grand style. All through his life he kept by him an early tragedy, *Tiberius in Capreae,* which no manager would produce but which he regarded as his masterpiece, and he attempted to break away into more serious works such as *The Battle of Hastings* (1778) and *The Carmelite* (1784), as well as altering for the stage Shakespeare's *Timon of Athens* and Philip Massinger's *The Bondman* and *The Duke of Milan.* Although he was in general less successful in serious plays, exception must be made for *The Jew* (1794), in which he attempted to depict an avaricious Jew as endowed with humane feelings, and *The Wheel of Fortune* (1795), which contains the part of the misanthropist Penrudock, one of John Philip Kemble's most famous roles.

Cumberland's querulousness in the face of criticism led him to quarrel with many of his contemporaries, including Goldsmith, whom he disliked because of the antisentimentalism of *She Stoops to Conquer,* and Sheridan, who had caricatured him in *The Critic.* Besides his plays and *Memoirs* he produced a series of essays, *The Observer* (1785), and two novels, *Arundel* (1789), epistolary in form, and *Henry* (1795), which adopts Fielding's narrative method.

See S. T. Williams, *Richard Cumberland, His Life and Dramatic Works* (1917). (JN. C.)

CUMBERLAND, WILLIAM AUGUSTUS, DUKE OF (1721–1765), English military leader in the Austrian Succession and Seven Years' wars, derived his nickname, "Butcher Cumberland," from his stern suppression of the 1745 Jacobite rebellion. He was born on April 15, 1721, the third but second surviving son of George Augustus, prince of Wales (afterward King George II), and of Caroline of Ansbach, and was created duke of Cumberland in July 1726. He was educated for a naval career but his own preference was for the army, and in April 1740 he was appointed colonel of the Coldstream guards. He was promoted major general in 1742 and fought with conspicuous bravery in the battle of Dettingen (June 27, 1743). He returned to Flanders early in 1745 as captain general of all British land forces and as commander in chief of the allied British, Hanoverian, Dutch and Austrian troops. Attempting to relieve Tournai, he was defeated by Marshal Saxe at the battle of Fontenoy (May 11, 1745).

Cumberland was recalled from Flanders to oppose the invasion of England by Prince Charles Edward (Nov.–Dec. 1745). He followed the Jacobites in their retreat from Derby to Carlisle, but early in Jan. 1746 returned to London. News of Gen. Henry Hawley's failure to relieve Falkirk took Cumberland north again, where he spent six weeks at Aberdeen preparing his army. He won the decisive battle of Culloden on April 16, 1746, after which he remained another three months in Scotland supervising the pursuit and punishment of the rebels. As reward, he was voted an income of £25,000 a year, in addition to his revenue from the civil list.

Cumberland was back in Flanders in 1747, and was defeated by Marshal Saxe at the battle of Lauffeld, near Maestricht (July 2, 1747). When the Seven Years' War broke out he was sent to defend Hanover, but was defeated by the superior forces of Marshal d'Estrées at Hastenbeck, near Hameln, on July 26, 1757. His troops were subsequently cornered between the North sea and the Elbe river and on Sept. 8 he signed the convention of Klosterzeven, promising to evacuate Hanover. George II repudiated the agreement and Cumberland was disgraced. He resigned all his military commands and retired to Windsor. In the reign of George III he did much to bring about the fall from power of the earl of Bute (1763) and of George Grenville (1765); gradually he regained his early popularity, and his death in London on Oct. 31, 1765, was much regretted.

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CUMBERLAND, a county lying in the extreme northwestern corner of England. It has a geographical area (administrative county and Carlisle county borough) of 1,521 sq.mi. Together with the county of Westmorland, the region—which includes the greater part of the Lake district (*q.v.*)—is cut off on the west and south by the Irish sea and Morecambe bay and on the east by the Pennines (*q.v.*). Its northern boundary marches with that of Scotland.

Physical Features.—Within this region the Lake mountains form a central mass bounded by the narrow coastal plain and the much greater expanse of the Carlisle plain on the west and north and by the Eden valley to the east. Structurally, the Lake mountains are the relics of a great dome-shaped earth movement of about 40,000,000 years ago. The mountainous area is now deeply dissected by the lake-filled valleys that are disposed in a radial manner about a centre in the Scafell region. The rocks of this region are the oldest in the county, consisting of mudstones of the Skiddaw Slate series and volcanic ashes and lavas of the Borrowdale Volcanic series, all of which have been hardened and altered by pressure to slaty rock types. The Skiddaw slates in the northern zone of the Lake district (Skiddaw, 3,054 ft., and Saddleback, 2,847 ft.) give rise to softer scenery than the tougher volcanic rocks to the south, from which all the principal craggy scenery of the Lake district proper has been formed. Scafell pike (3,210 ft.), Helvellyn (3,118 ft.), Great Gable (2,949 ft.) and the Langdale pikes are the principal mountains of this region. The newer rocks of the district, *i.e.*, the limestones of the Carboniferous system and the sandstones of the New Red series, outcrop in encircling bands around the older slaty rocks. The limestones, which are associated with the later Coal Measure series of the west Cumberland coal field, form the inner band, and the sandstones compose the rocks of the Carlisle plain and the Eden valley. A great thickness of soil (cover consisting principally of heavy clays with local patches of sand and gravel) conceals the solid rock formations, especially in the low-lying areas, where they form the basis of a rich agriculture.

The coastal marshes and mosses are known internationally for their avifauna, and the Drigg Dunes and Gullery Nature reserve near Ravenglass was so designated by the county council in 1954.

J. RUFUS FROM PAUL POPPER

BUTTERMERE, A LAKE OF WEST CUMBERLAND

Long after the Norman conquest, Cumberland remained one of the most densely forested regions of England, and much of the low-lying land is still wooded. The oak, ash and birch are the principal natural trees, while sycamores have been planted for shelter round many farmsteads. Plantations of larch are numerous, and extensive afforestation has been carried out. The National trust owns the principal peaks and lakes in the Lake District National park.

History.—The earliest evidence of man in the area is datable to the New Stone Age, *c.* 2500 B.C. A settlement site of this period was found at Ehenside tarn, near St. Bees, in 1870, and later a "factory" site, where polished stone axes were wrought from the volcanic rocks, was discovered in Great Langdale. Finds of the subsequent Bronze Age period, especially from coastal and Eden valley localities, give some indication of the passage routes with Ireland to the west and the east Pennine regions to the east. The stone circles, of which Long Meg and her Daughters, near Little Salkeld, and the Castlerigg circle, near Keswick, are the best preserved, are thought to be of this period. The cultural isolation of the region was such that it was still at a Bronze Age level of development at the time of the Roman conquest.

Agricola erected a chain of forts between Solway and Tyne and may have built the Roman naval base at Clanoventa (Ravenglass). About 40 years later, in 122–126, the emperor Hadrian constructed the great wall complex between Wallsend in Northumberland and Bowness-on-Solway, a distance of 73½ mi., and defended the west coast by means of strong forts and signal towers. The Roman occupation was chiefly military in character, with Luguvallium (Carlisle) as the main civil settlement, and Petrianae (Stanwix), the major cavalry headquarters on the wall, on the opposite bank of the Eden.

Christianity came through St. Martin's disciple, St. Ninian (*q.v.*). He founded Candida Casa (Whithorn) in the year 397 on the north shore of the Solway and several years later, probably, the church at Brampton, within the Roman fort. Re-evangelization came with the defeat of Gwenddoleu ap Ceidio at the battle of Ardderyd in 573 by Rederech, the Christian leader. A century later the district known as Cumbria was in Northumbrian hands, and the famous Bewcastle cross was erected during the period of the Anglian ascendancy. Cumbria was originally the same as Cambria, a Latinized derivative of Cymry or Cymru (Wales). The two names were subsequently differentiated.

The Danes under Halfdan raided Cumbria in 875, but one threat to the northwest was from Ireland or the Isle of Man, the invaders being Norwegian by descent but influenced by their stay among the Celts. Their mark is seen in the inversion compounds of a number of place names, usually on higher ground, *e.g.*, Setmabanning, and in such crosses as that at Gosforth with its mixture of heathen Scandinavian and Christian motives.

In 945 Edmund I ravaged all "Cumbraland" (first mentioned under that name), presumably Strathclyde (*q.v.*) in its widest sense, handing it over to the Scots king Malcolm I. The earls of Northumbria controlled part of the county in the first half of the 11th century, but by 1068 the area had been taken by the king of Scots and formed no part of William the Conqueror's kingdom, the three manors that appear in Domesday Book being regarded as part of Yorkshire. In 1092 Gospatric II, son of Dolfin, was ruling from Carlisle, under the Scots king, when the city was captured by William II, surnamed Rufus. This king repaired the city, gave orders for the castle to be built and sent settlers to dwell there and till the ground. Immigration from the south about this time is evidenced by the occurrence of place names ending in *by* to which a Norman personal name is prefixed, a number of these being in the neighbourhood of Carlisle. According to Sir William Dugdale's *Baronage of England* (1675–76) the "land of Carlisle," which included parts of Cumberland and the neighbouring county of Westmorland, was granted to Randulf, earl of Chester, styled le Meschin (died *c.* 1129). Confusion followed the death of Henry I, and the Scots recovered the province, until it was retaken in 1157 by Henry II. The county of Cumberland, as it now exists, dates from 1177. It was divided into five wards, a name peculiar to the English and Scottish borders and corresponding to the hundred (*q.v.*). Because of its border position Cumberland was the scene of constant strife until after the union of England and Scotland in 1603.

Edward I, "the hammer of the Scots," died near Carlisle in 1307, when preparing an assault on Scotland, and there was much bloodshed in succeeding centuries. In the Wars of the Roses, England had its own troubles, the prevailing sympathy in Cumberland being with the Lancastrian cause. Carlisle, Cockermouth and Egremont were key points for border defense, but a large number of strong towers were erected along the northern frontier, and Border balladry preserves the records of medieval frays, as well as those of Arthurian legend.

The father of Mary, queen of Scots (James V), died after hearing of the defeat of his army by the English at Solway Moss in 1542, one of his country's worst disasters. Mary's own long journey to her execution at Fotheringay began at Carlisle in 1568. Her son, James, when monarch both of Scotland and England, discovered that Cumbrians were tenacious of their rights, but in the Civil War of the 17th century, along with others in the north, they were loyal to the Stewart cause. The people of Carlisle withstood a siege from Oct. 1644 until June of the following year and regained the town for the king for a few months in 1648. Political feeling would appear to have changed during the reign of James II, and leading men in the county were among the first to welcome William III to England. Active support given to the Stewarts in the risings of 1715 and 1745 was meagre, even if considerable sympathy lingered for them among those who clung to the old faith.

It was after the "'45" rebellion of the Jacobites that Cumberland became known to England as a whole. Roads were built or improved, trade was extended and the Lake district, instead of remaining in isolation and known only to the "semiwild inhabitants," became a place to be visited by people of fashion. The mountains and lakes were objects that should be seen and admired, and a mild form of mountaineering was begun. Early in the 19th century William Wordsworth, who was born in Cumberland, and Samuel Taylor Coleridge were leaders of the romantic revival in English poetry. Wordsworth lived at Grasmere and Coleridge settled near Keswick and, with Robert Southey and others, formed a literary group, which had its later counterparts, among others, in Hugh Walpole, O. S. Macdonell, Norman Nicholson and Graham Sutton. The district has its school of painters.

Historic Buildings.—Until the death of Elizabeth I in 1603, architectural style was largely determined by the physical nature of the district and by political considerations, especially the need for defense. Materials varied from daub and cobble to sandstone, limestone and the characteristic slate that distinguishes the Keswick neighbourhood, a natural harmony following from the use of native material. The typical Cumberland dwelling is a solid erection, any beauty resting on form and the relationship of solids and voids, carving and other architectural embellishments being rare. The major buildings still occupied in modern times include the castles of Carlisle, Rose, Naworth, Corby, Greystoke and Muncaster, along with Netherby, Hutton-in-the-Forest and Hutton John. The Norman castles of Cockermouth, Egremont, Millom and the later structure at Penrith are in ruins. Many halls dating from the 17th century, or conversions from earlier peles (or peels), have been or are the homes of armigerous families. The upper story of the pele tower was the solar. Almost all the peles were incorporated into larger buildings; one forms part of the deanery at Carlisle, possibly the most interesting example of domestic architecture in the county. Naworth castle is typical of development from the 14th-century pele to the greater comfort of later ages.

Conventual buildings include the Augustinian priories of Carlisle and Lanercost, the abbeys of Holm Cultram and Calder and the Benedictine priory of St. Bees. These date from the 12th century. The priory of Carlisle (the cathedral), with its wonderful east window, and surviving portions of Lanercost, Holm Cultram and St. Bees are still in use. Parish churches date from the 12th century and vary in size, age and architectural merit; Burgh-by-Sands, Newton Arlosh, Dearham and Great Salkeld were built in the 14th century and are part church and part fortress, their towers being used as places of refuge. Greystoke, which was also a college for priests, and Crosthwaite, for a generation associated with Canon H. D. Rawnsley (1851–1920), one of the founders of the National

trust, are good examples of 15th- and 16th-century work. Robert Southey's tomb is in Crosthwaite church. The small unpretentious fellside churches, Wordsworth's

> "Modest house of prayer
> As lowly as the lowliest dwelling"

(from the poem "The Waggoner"), make their own special appeal.

Bridges scheduled as ancient monuments include those at Penrith across the Eamont (1425) and at Lanercost over the Irthing (1533, rebuilt 1724). The bridge at Penrith was saved through the efforts of Canon Rawnsley. The present Eden crossings at Carlisle and Kirkoswald replaced earlier buildings. Old pack-horse bridges exist in many parts of the country.

Industries.—About half of the total area of the county is under cultivation, and more than one-third is in rough grazings. Stock farming, especially for sheep, is the main rural occupation, though cattle are important; the number of sheep is about three times that of cattle. The principal arable crop is oats, followed by turnips, swedes, beets and potatoes. Herdwick and Swaledale fell sheep are favoured in the hills, and draft ewes are crossed with larger ones in the lowlands.

The industries of Cumberland have been from earliest times connected with its fisheries and mineral wealth. The lead and silver mines of Alston and the iron mines near Egremont have been worked since the 12th century. Those in the neighbourhood of Keswick, of copper, lead and silver, were a major industry during part of the 16th century and, though worked intermittently thereafter, closed down in 1927; development in the early years at both places was the result of German enterprise. Coal has been worked in both the east and west of Cumberland since the middle ages on a developing scale, but an output of 2,000,000 tons annually of saleable coal in the west was not reached after 1929, and haulage difficulties there have added greatly to the cost of production. For economic reasons the mines in the east of the county were closed in 1953. Near Whitehaven, methane gas, the possibilities of which were first shown there in the 1760s, is in use for industrial purposes, and new coal fields were open near Maryport, close to the Scottish border on the northwest. In the early 1960s the known iron-ore reserves, about 7,000,000 tons, were at Ullcoats and Florence, Beckermet and Hodbarrow and served the west Cumberland blast furnaces, which required 1,100,000 tons of haematite iron ore annually for the production of 600,000 tons of pig iron and iron alloys. The chief supplies of ore come from Spain and north Africa. Nonferrous metals occur but not in sufficient quantity to justify exploitation. Important developments have taken place in the mining of anhydrite (gypsum without water of crystallization), used in the manufacture of sulfuric acid and ammonium sulfate. The Solway mine, at Sandwith, near Whitehaven, was opened in 1955; it was designed to produce 7,000 tons per week and to absorb much of the ore locally as acid, with cement as a by-product. The Long Meg mine, near the druid circle of that name, has a potential annual output of 250,000 tons. Gypsum, an associated mineral, is mined on a considerable scale at Lazonby and Cocklakes, and granite, slate and limestone are extensively quarried. Textiles, haulage machinery, metal containers and biscuits are manufactured at Carlisle. Sellafield on the coastal plain was the site chosen for the development of Great Britain's atomic energy industry. In 1947 work was begun on the Windscale works, the first plant in the country to produce plutonium, and its two chimneys, each 412 ft. high, are a well-known Cumberland landmark. Nearby, at Calder Hall, on the other side of the river Calder, the first atomic power station in Great Britain was opened by Queen Elizabeth II in 1956. The later construction of three more thermal reactors brought the total capacity of the station to 184,000 kw., 150,000 of which was fed into the national electricity grid. By the early 1960s an advanced gas-cooled reactor with an electrical generating capacity of 28,000 kw. was also in operation. John Dalton (1766–1844), chemist and natural philosopher who pioneered the concept of the atomic theory, was born nearby at Eaglesfield.

The Eden, Derwent (*qq.v.*) and Esk rivers are famed for their salmon.

The chief ports are Workington, Whitehaven, Maryport and Silloth. Main railway lines from the south enter the county at Penrith and Culgaith, with Carlisle as the focus. This is the western route to Scotland.

Cumberland is probably unexcelled in England for scenic beauty and attracts many visitors. The tourist centre of the county is a "pocket Switzerland," with the Keswick (*q.v.*) neighbourhood as the chief attraction.

Population and Administration.—The area of the administrative county (which excludes Carlisle county borough) is 1,511.5 sq.mi., with a population of 223,050 in 1961. The county contains two boroughs, Workington (pop. [1961] 29,507) and Whitehaven (27,541); four urban district councils, Cockermouth, Keswick, Penrith and Maryport; and seven rural district councils. The county town is the city of Carlisle (71,112), a county borough. Cumberland is in the northern circuit, and assizes are held at Carlisle. It has a court of quarter sessions and 12 petty sessional divisions. Carlisle has a separate commission of the peace and court of quarter sessions. It returns one member to parliament, and three others are returned, respectively, by the Penrith and the Border, Whitehaven and Workington divisions of the county.

In 685 Carlisle and district were annexed by Egfrith of Northumbria to the diocese of Lindisfarne, to which it continued subject until the Danish invasion of the 9th century. In 1133 Henry I created Carlisle a bishopric. In 1856 the diocese was extended to include the whole of Cumberland except the parish of Alston (in the diocese of Newcastle), the whole of Westmorland and the Furness district of Lancashire. The parish of Firbank, in Westmorland, is in the diocese of Bradford.

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(T. Gv.)

CUMBERLAND, the third largest city of Maryland, U.S., on the Potomac river, in the northwestern part of the state; seat of Allegany county. The city is 635 ft. above sea level and is surrounded on three sides by mountain scenery. A deep gorge of great beauty, the Narrows, forms a natural gateway through the Appalachian mountains west to the Ohio valley. Cumberland was the eastern terminus of the Cumberland (or National) road and the western terminus of the Chesapeake and Ohio canal. It has a large trade in coal, of which the county mines about 1,500,000 tons a year. Manufactures include plastics, rubber tires, glassware, firebrick, lumber products and beer. The railroad shops repair and build all types of equipment. Cumberland is a retail and wholesale centre for western Maryland, large sections of West Virginia and Pennsylvania. The first settlement was made in 1750, and in 1754 Col. James Imes built Ft. Cumberland at Wills creek as a defense against the French and their Indian allies. From this fort Gen. Edward Braddock started on his disastrous expedition of July 9, 1755. A town was laid out in 1763 and incorporated in 1815. In 1850, when the population was 6,073, it was chartered as a city. For comparative population figures *see* table in MARYLAND: *Population.*

(R. M. La.)

CUMBERLAND PLATEAU, the westernmost of the three great divisions of the Appalachian highlands in the U.S., extends from West Virginia to northern Alabama. Its steep eastern escarpment, known as the Allegheny front, separates the plateau from the Appalachian Ridge and Valley region. Its dissected westnorthwestern boundary faces the rolling, limestone-based plains of central Kentucky, Tennessee and southern Ohio. The plateau surface merges with the unconsolidated sediments of the Gulf coastal plain west of Birmingham, Ala. From southern West Virginia northward the plateau is known as the Allegheny plateau. Ap-

proximately 450 mi. in length and from 40 to 50 mi. in width, the plateau surface rolls extensively and slopes gently westward. The surface consists of coarse sandstones overlain by thin, sandy, relatively infertile soils.

The roughest, highest, most dissected portion of the plateau, a narrow linear ridge about 140 mi. in length, forms its eastern margin in eastern Kentucky and northeastern Tennessee; the name Cumberland mountains generally is applied to this area. This ridge varies in elevation from about 2,000 to 4,145 ft. at Big Black mountain, Kentucky. Sequatchie valley, an anticline uncovered by erosion, separates Walden ridge from the main plateau surface northwest of Chattanooga. Lookout mountain, situated in southern Tennessee, northwestern Georgia and northeastern Alabama, is separated from Walden ridge at Chattanooga by the incised, steep-sided valley of the Tennessee river. Headwaters of the Tennessee, Kentucky and Cumberland rivers rise in the central segment of the plateau.

The plateau is underlain by large deposits of coal, limestones used for cement, and fine-grained sandstones suitable for construction and decorative purposes. Forests, a major resource, composed mainly of hardwoods, occupy more than three-fourths of the plateau area. Sand mountain, in northern Alabama, is the only segment of the plateau characterized by a well-developed agriculture.

Cumberland gap (elevation *c.* 1,650 ft.), situated near the point where Virginia, Tennessee and Kentucky meet, is a structural fault which provides a natural passage through the Cumberland mountains. It was discovered in 1750 by Thomas Walker; Daniel Boone's Wilderness road to Kentucky ran through it. Because of its strategic importance, it was held alternately by Confederate forces (1861; 1861–63) and Union troops (1861; 1863–65) during the American Civil War. (M. C. P.)

CUMBERLAND RIVER, a large southern branch of the Ohio river, U.S., rises in the Cumberland mountain region of the Cumberland plateau in Harlan and Letcher counties in extreme southeastern Kentucky. After a devious course of 687 mi. in Kentucky and Tennessee the Cumberland reaches the Ohio at Smithland, Ky., 12 mi. upstream from the mouth of the Tennessee (*q.v.*). Three principal headwater streams unite at Harlan, Ky., to form the Cumberland river proper. From its headwaters through Harlan and to Cumberland falls, a natural drop of 63 ft. in Whitley county, Ky., and site of a state park, the river is a mountain stream of little volume during late summer and subject to disastrous floods during winter and spring.

The portion of the Cumberland from Williamsburg, above the falls, past the falls and to the Kentucky-Tennessee state line crosses a highland bench in the Cumberland plateau and flows in a gorge between precipitous cliffs 300–400 ft. in height. Thence the river enters the central limestone basin of Tennessee and finally turns northward and crosses the plain of western Kentucky to the Ohio. At one point the river is less than two miles from the lower Tennessee. Chief tributaries, all entering downstream from the falls, are the Laurel, Rockcastle and South Fork in Kentucky; the Obey, Caney Fork, Stones, Harpeth and Red in Tennessee; and the Little river in western Kentucky.

Nashville, Tenn., is the only large city on the river. Smaller cities are Pineville, Barbourville and Williamsburg in eastern Kentucky; Carthage, Clarksville and Dover in Tennessee; and Eddyville in western Kentucky. Middlesboro, Ky., at the northern slope of Cumberland gap, is on an upstream headwater.

Development of a series of lakes on the Cumberland comparable to those on the Tennessee (Tennessee Valley authority) was planned by the U.S. army corps of engineers. Dams, both existing and authorized, will control the mountain headstreams. Wolf Creek dam, for flood control and power, in Russell county, Ky., created Lake Cumberland, which extends to the base of Cumberland falls. Large power dams are in operation on two tributaries: Dale Hollow dam on the Obey near Celina, Tenn., and Center Hill dam on Caney Fork southeast of Carthage. The dams on the lower river are power and navigation dams and contain locks. Old Hickory dam, upstream from Nashville, ponds the water to Carthage, the head of navigation. Cheatham dam is upstream from Clarksville. Barkley dam in western Kentucky was planned to control the lower river, with its reservoir submerging five smaller dams and their locks, and connect with the lower Tennessee.

During the Civil War, Fort Donelson on the Cumberland was captured by Gen. U. S. Grant—a decisive event of the war. (L. Dd.)

CUMBERNAULD, a New Town in the detached part of Dunbartonshire, Scot., between Stirlingshire and Lanarkshire, lying 14 mi. N.E. of Glasgow by road. Formed in 1956 and designated to accommodate overspill population from Glasgow, this New Town of 18.5 sq.mi. had a population of 4,924 in 1961; the estimated eventual population was 70,000. (*See* New Towns.)

At Cumbernauld the main Glasgow-Stirling road joins the road to Airdrie and the south, and the town is also on the Forth and Clyde canal and on the main railway line from Edinburgh to Glasgow. The area, which is hilly, is rural and agricultural, the only former industries being a brickwork and two grain mills. The first new factory was for making adding machines.

CUMBRAES, THE, two islands forming a parish and part of Buteshire, Scot., lie in the Firth of Clyde between the southern shores of Bute and the coast of Ayrshire. In 1961 the population of the two islands was 1,645, concentrated almost entirely in Millport (1,592), on Great Cumbrae.

Great Cumbrae island, about 1½ mi. W.S.W. of Largs, is 3¾ mi. long and 2 mi. broad and has an area of 4.4 sq.mi. Of Old Red Sandstone, its highest point is 417 ft. above sea level. The island is well farmed and there is some fishing. The burgh of Millport, which is primarily a holiday resort, is well situated at the head of a fine, sandy bay with a climate that is both warm and bracing. It has steamer connections with Wemyss Bay, Largs and Fairlie. There are excellent facilities for bathing, boating and fishing, together with a golf course, tennis courts and bowling greens. Among the chief buildings are the Episcopalian cathedral, erected in Gothic style on rising ground behind the town, the college connected with it (not now used as such), a marine biological station with an aquarium, and Garrison house, now used as the municipal headquarters. The cathedral, originally the collegiate church, was founded in 1849 by the earl of Glasgow and constituted the cathedral of Argyll and the Isles in 1876.

Little Cumbrae island lies to the south, separated by the Tan, a strait half a mile wide. It is 1¾ mi. long and barely 1 mi. broad and has an area of 1.1 sq.mi. Pop. (1951) 19. Its highest point is 409 ft. above sea level and on the bold cliffs of the west coast stands a lighthouse. On an islet off the eastern shore Robert II is said to have occupied a castle, which was demolished by Cromwell's soldiers in 1653; the remains of the tower can be seen.

See R. A. Downie, *Bute and the Cumbraes* (1934). (A. H. Wd.)

CUMIN or Cummin (*Cuminum cyminum*) is a small, slender annual herb of the family Umbelliferae, with finely dissected leaves, white or rose coloured flowers, and grayish, bristly fruits about one-fourth inch long, tapering toward both ends and laterally compressed. It is apparently native to the Mediterranean region where it is extensively cultivated, as it is also in India, China and Mexico.

Cumin seeds have an aromatic odour, a spicy somewhat bitter taste and are widely used as condiment. They are employed as an essential component in all mixed spices and curry powders, for flavouring cheese, sausages, soups and pickles, and for seasoning breads and cakes. Cumin seeds were at one time widely used as home medicinals but they are now chiefly used in veterinary medicine. The seeds yield on distillation a volatile oil which has the odour and taste of the whole seeds. The oil is used in perfumery, for flavouring liquors and cordials and medicinally as a stomachic and carminative. (Q. J.)

CUMMINGS, BRUCE FREDERICK: *see* Barbellion, W. N. P.

CUMMINGS, EDWARD ESTLIN (1894–1962), U.S. poet and artist, whose poetry is marked by typographical nonconformity and by stylistic originality and experiment (and who signed his name as "e. e. cummings"). He was born in Cambridge, Mass., on Oct. 14, 1894, and received his B.A. degree from Harvard university in 1915, his M.A. in 1916. During World War I, he served

with an ambulance corps in France, where, because of a military error, he was interned for a time in a detention camp, an experience recorded in his first book, the prose work *The Enormous Room* (1922). Later he served as a private in the U.S. army at Camp Devens, Mass.

He began writing poetry at Harvard and after the war devoted himself wholly to writing and painting. His first book of verse was *Tulips and Chimneys* (1923), followed by *XLI Poems* (1925) and *&* (1926); in 1926 he received the Dial award. He then began also to exhibit his paintings and drawings. In 1927 his first play, *Him*, was produced by the Provincetown Players in New York; he later wrote other poetic dramas, including *Tom* (1935) and *Santa Claus: A Morality* (1946). Among many volumes of verse were: *Is 5* (1926), *ViVa* (1931), *No Thanks* (1935), *Collected Poems* (1938), *One Times One* (1944), *Poems 1923–1954* (1954) and *95 Poems* (1958). His experimental prose book, *Eimi* (1933), recorded his trip to Russia and his reaction to communist society. In 1953 he published his discussions as Charles Eliot Norton lecturer on poetry at Harvard (1952–53) as *i: six nonlectures*. In 1957 he received both the Bollingen prize for poetry and the Boston Arts Festival award. After 1920 he lived in New York city and on a farm in the White mountains near North Conway, N.H., where he died on Sept. 3, 1962.

See Charles Norman, *The Magic Maker: E. E. Cummings* (1958).

CUMMINS, ALBERT BAIRD (1850–1926), U.S. lawyer, state governor and U.S. senator, was born at Carmichaels, Greene county, Pa., Feb. 15, 1850 and educated at Waynesburg (Pa.) college. He studied surveying, worked in railroad construction and then studied law in Chicago, practising there for three years. In 1878 he moved to Des Moines, Ia., and soon became the leading lawyer in that city, winning fame as counsel for the Iowa Grange in its suit to break up the "barbed wire" trust. Professional life was soon mixed with politics, which he pursued with vaulting ambition. Beginning in the Iowa house of representatives in 1888, he served the Republicans as state central committee chairman, 1892–96; member of the national committee, 1896–1900; and four times as delegate to national conventions. He tried for the U.S. senate in 1894 and 1900 but failed. Between 1902 and 1908 he was elected governor three terms in succession and became the recognized spokesman for the progressive Republicans in Iowa. These progressives owed nothing to Populism; the leaders were successful, often wealthy, urban businessmen who wanted political power and a new moral tone in Iowa government. Cummins' three terms brought further regulation of the railroads, abolition of the free pass system and enactment of a senatorial primary law.

In 1907–08 he precipitated a political war by running against the aged William B. Allison for the Republican senatorial nomination and lost by 10,000 votes. Allison died just two months later and Cummins was soon seated in his place. Sen. Jonathan P. Dolliver, who had managed Allison's campaign, quickly accepted Cummins and the two made a strong team of progressive senators against the archconservative Sen. Nelson W. Aldrich. Cummins opposed President Wilson on the arming of merchantmen in 1917 and on the treaty of Versailles. In 1920 the Esch-Cummins act provided for the return of the railroads to private control—after their government operation during the war—but did not include Cummins' plan for consolidation of the roads into a few national, truly competitive companies. His last years were embittered by the rebellion of his erstwhile lieutenant, Smith W. Brookhart, who defeated him in 1926. Cummins died of a heart attack two months later, July 30, 1926, at Des Moines. (L. L. S.)

CUMMINS, GEORGE DAVID (1822–1876), U.S. clergyman, first bishop of the Reformed Episcopal Church, was born near Smyrna, Del., on Dec. 11, 1822, of Scotch-English ancestry. His father was an Episcopalian, his mother a Methodist. After graduating from Dickinson college (Carlisle, Pa.), on July 8, 1841, he served three years as a licentiate in charge of Bladensburg (Md.) circuit of the Methodist Episcopal Church before deciding to study for the ministry of the Protestant Episcopal Church. He was ordained by Bishop Alfred Lee of Delaware on Oct. 26, 1845. Cummins gained early recognition as a distinguished preacher and served a succession of important parishes in Norfolk, Richmond, Washington, Baltimore and Chicago. He married Alexandrine Macomb Balch on June 24, 1847. Elected assistant bishop of Kentucky in 1866, he soon found himself, as a recognized younger leader of the Evangelicals, in the midst of the ritualistic controversy which reached its peak in the Protestant Episcopal Church in the years following the Civil War. As early as 1869, he began to receive appeals from some who, despairing of the future of Evangelicalism within the Protestant Episcopal Church, wanted him to take the lead in organizing a new body. Though deeply disappointed by the failure of Evangelical measures in the General convention of 1871, Cummins did not finally decide on a break until 1873. The Reformed Episcopal Church was organized in New York on Dec. 2, 1873, with Cummins as its only bishop, though a second, Charles Edward Cheney (*q.v.*), was soon consecrated. Cummins continued active in the leadership of the new church until his death on June 26, 1876. (W. W. Ms.)

CUMNOCK AND HOLMHEAD, a police burgh of Ayrshire, Scot., in the parish of Old Cumnock. It lies on the Lugar water, 26 mi. S. of Glasgow (36 mi. by road) and about 360 ft. above sea level. Pop. (1961) 5,403. Holmhead is part of the parish of Auchinleck but is joined to Cumnock for administrative purposes. A considerable proportion of the population depends on coal mining, there being more than 30 pits or mines within 10 mi. of Cumnock. It is also an agricultural centre with a large woolspinning mill. The civil parish of New Cumnock lies 5 mi. S.E. at the confluence of Afton water and the Nith. New Cumnock is a mining parish and was separated from Cumnock in 1650. Auchinleck, 2 mi. N.W., is the seat of the Boswell family. Auchinleck house, built by Lord Auchinleck, father of James Boswell, was visited in 1773 by Samuel Johnson. Boswell is buried in the church. Alexander Peden, the persecuted Covenanter known for his prophecies, was also buried in the church (1686), but his body was exhumed by a company of dragoons 40 days after the burial and reinterred at the foot of the gallows at Cumnock. After the revolution of 1689 the inhabitants, out of respect for the "prophet's" memory, abandoned their old burying ground and made a new one round the gallows' hill. A monument was erected to Peden's memory. James Keir Hardie (1856–1915), the Labour leader, made his home in Cumnock.

CUMONT, FRANZ VALÉRY MARIE (1868–1947), Belgian historian of religion, was born on Jan. 3, 1868, at Alost. After studying at Ghent, Bonn, Berlin, Vienna and Paris, he was from 1892 to 1910 professor in Ghent university, and from 1899 to 1912 curator of the Brussels Royal museum. Cumont's chief writings deal with Mithraism, Manichaeism, Roman paganism and other aspects of ancient religion.

He died Aug. 25, 1947, at Brussels.

CUNA, a tribe of Chibchan-speaking Indians who occupied the central region of Panamá and the neighbouring San Blas islands and who still survive in marginal areas. In the 16th century they were an important group, living in federated villages under chiefs having considerable power, and engaging in warfare with each other and with neighbouring tribes. Agriculture was primarily based on slash-and-burn techniques, and there was extensive trade, mainly by canoe along the coast. There was a well-developed class system, with captives generally being enslaved. Important chiefs were carried in hammocks. Their bodies were preserved after death and buried in large graves with their wives and retainers.

The important excavations in the Coclé region present additional information on the Cuna and their neighbours in the late prehistoric period. Metallurgy was well developed and numerous gold ornaments have been found in the graves, along with fine ceramics and shell ornaments.

The principal effects of European contact were to destroy the political superstructure of the Cuna and to modify the social and religious system. In modern times they live in small villages and depend primarily on agriculture for subsistence, supplemented by fishing and hunting. Marriage is matrilocal, giving rise to extended families in which the son-in-law is under the authority of his wife's father. Religion centres around shamanism, which is highly developed. The sun and moon were formerly major deities and the world is thought to be composed of multiple layers; the my-

thology has been much affected by European conceptions. The so-called "white Indians" of San Blas are actually albinos who comprise about 0.7% of the Cuna population and are not permitted to intermarry.

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CUNARD, SIR SAMUEL, Bart., (1787–1865), British merchant and shipowner, founder of the first regular Atlantic steamship line, was born at Halifax, N.S., Canada, on Nov. 21, 1787. In partnership with George Burns, David MacIver and other prominent merchants of Glasgow and Liverpool, he formed a company to carry out the British government's proposal to substitute steamships for sailing vessels in the transatlantic mail service.

Cunard was created a baronet in 1859. He died on April 28, 1865.

CUNAXA, BATTLE OF. This battle, fought in 401 B.C. on a site north of Babylon, in which Cyrus the Younger (*see* Cyrus) was defeated by his brother Artaxerxes II and killed, was followed by the "Retreat of the Ten Thousand" under Xenophon (*q.v.*). Cyrus had surreptitiously increased his forces and marched inland from Sardis against Artaxerxes. The two armies met unexpectedly at Cunaxa, on the left bank of the Euphrates river. The Greek mercenaries under Clearchus, nearly 13,000 strong and the best trained and equipped troops in Cyrus' army, were stationed on the right wing near the river, supported by about 1,000 Paphlagonian cavalry. Artaxerxes' right extended beyond Cyrus' left. Cyrus ordered Clearchus to advance obliquely against Artaxerxes' centre, as the king himself was there. Clearchus, however, was unwilling to expose his flank by leaving the river. In the battle, Persian cavalry charged harmlessly through the Greek light-armed by the river, and the Greek heavy-armed routed the Persian left with few casualties. Cyrus charged Artaxerxes' centre with 600 cavalry and succeeded in wounding his brother, but was killed. The Greeks returned from pursuing the Persian left to find that the rest of Cyrus' troops had been routed and his camp plundered. By forming ranks again, they discouraged Artaxerxes from attacking them and despite the subsequent capture and murder of their leaders by the satrap Tissaphernes succeeded in marching through hostile country to the Black sea.

See Xenophon, *Anabasis*.

CUNDINAMARCA, most populous of the departments of the republic of Colombia. Area 8,934 sq.mi.; pop. (1961) 2,071,260, including the Special District of Bogotá. A considerable part of its area consists of old inter-Andean lake surfaces or *sabanas* from 8,000 to 9,000 ft. above sea level that were lakes during the Pleistocene. These *sabanas* have a temperate to cool climate and their fertile but poorly drained soils support fine herds of blooded European dairy cattle and produce many of the fruits and cereals of more northerly latitudes. Another important part of Cundinamarca lies in the hot, dry valley of the Magdalena. The slopes between these two regions are densely settled, being especially celebrated for their coffee plantations.

Cundinamarca, and especially the *sabana* of Bogotá, was one of the centres of the Chibcha empire. It was on the plains of Bogotá (elev. 8,600 ft.) that the three conquistadores, Gonzalo Jimenez de Quesada, Nikolaus Federmann and Sebastián de Belalcázar (Sebestián Moyano), met accidentally in 1538. Santa Fé de Bogotá, founded in that year by Quesada, from the start was the most important city in the viceroyalty of New Granada, later to become Colombia.

Bogotá (*q.v.*) has remained the economic, cultural and political capital of Colombia despite its inaccessible interior location. In 1955 it was separated from Cundinamarca as a Special District (*Distrito Especial*) for administrative purposes, though at the same time remaining the capital of Cundinamarca.

Other important cities are Girardot, Fusagusagá and Facatativá. Zipaquirá, 30 mi. north of Bogotá, is famed for its underground salt mines. An important tourist attraction is the 300-ft.-high Tequendama falls where the Río Bogotá leaves the high *sabana* surfaces. Lake Guatavitá is celebrated for the legend of Eldorado (*q.v.*) or the gilded man. *See* also Colombia. (Js. J. P.)

CUNEIFORM, a Latin coinage meaning "wedge-shaped" (in German *Keilschrift*), has been the modern designation, from the early 18th century onward, for the most widespread and historically significant writing system in the ancient near east. Its active history comprises the last three millenniums B.C.; its long development and geographic expansion involve numerous successive cultures and languages; and its over-all significance as an international graphic medium of civilization is second only to that of the Phoenician-Greek-Latin alphabet. (*See* also Babylonia and Assyria; Alphabet.)

Origin and Character.—The origins of cuneiform may be traced back approximately to the end of the 4th millennium B.C. At that time the Sumerians, a people of unknown ethnic and linguistic affinities, inhabited southern Mesopotamia and the region west of the mouth of the Euphrates known as Chaldea. While it does not follow that they were the earliest inhabitants of the region or the true originators of their system of writing, it is to them the first attested traces of cuneiform writing are conclusively assigned. Excavations of remote prehistoric strata at the ancient sites of Ur and Uruk have failed to reveal decisive evidence of preceding populations. The earliest written records in the Sumerian language (*q.v.*) are pictographic tablets from Uruk, evidently lists or ledgers of commodities identified by drawings of the objects, and accompanied by numerals (*see* Numerals and Numeral Systems) and personal names. Such word writing was able to express only the basic ideas of concrete objects. Numerical notions were easily rendered by the repetitional use of strokes or circles. However, the representation of proper names, for example, necessitated an early recourse to the rebus principle; *i.e.*, the use of pictographic shapes to evoke in the reader's mind an underlying sound form rather than the basic notion of the drawn object. This brought about a transition from pure word writing to a partial phonetic script. Thus, for example, the picture of a hand came to stand not only for Sumerian *šu* ("hand"), but for the phonetic syllable *šu* in any required context. Sumerian words were largely monosyllabic, so the signs generally denoted syllables, and the resulting mixture is termed a word-syllabic script. The inventory of phonetic symbols henceforth enabled the Sumerians to denote grammatical elements by phonetic complements added to the word signs (the latter are called ideograms or logograms; *see* Logogram and Syllabary). Because Sumerian had many identical sounding (homophonous) words, several ideograms frequently yielded identical phonetic values, and are distinguished in modern transliteration as; *e.g.*, *ba, bá, bà,* ba_4. Because an ideogram often represented several related notions with different names (*e.g.*, "sun," "day," "bright"), it was capable of assuming more than one phonetic value (this feature is called polyphony).

In the course of the 3rd millennium the writing became successively more cursive, and the pictographs developed into conventionalized linear drawings. Due to the prevalent use of clay tablets as writing material (stone, metal or wood also were employed occasionally), the linear strokes acquired a wedge-shaped appearance by being pressed into the soft clay with the slanted edge of a stylus. Curving lines disappeared from writing, and the normal order of signs was fixed as running from left to right, without any word-divider. This change from earlier columns running downward entailed turning the signs on one side.

Spread and Development.—Before these developments had been completed, the Sumerian writing system was adopted by the Akkadians, Semitic invaders who established themselves in Mesopotamia about the middle of the 3rd millennium. In adapting the script to their wholly different language the Akkadians retained the Sumerian ideograms and combinations of ideograms for more complex notions, but pronounced them as the corresponding Akkadian words. They also kept the phonetic values, but extended them far beyond the original Sumerian inventory of simple types (open or closed syllables like *ba* or *ab*). Many more complex syllabic values of Sumerian ideograms (of the type *kan, mul, bat*) were transferred to the phonetic level, and polyphony became an increasingly serious complication in Akkadian cuneiform (*e.g.*, the

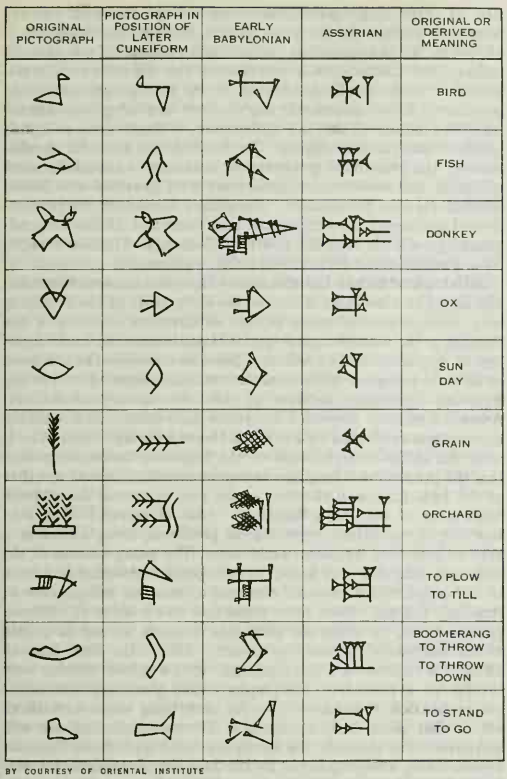

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TABLE SHOWING THE DEVELOPMENT OF CUNEIFORM SCRIPT FROM PICTOGRAPHS TO ASSYRIAN CHARACTERS

original pictograph for "sun" may be read phonetically as *ud, tam, tú, par, lah, hiš*). The Akkadian readings of the ideograms added new complicated values. Thus the sign for "land" or "mountain range" (originally a picture of three mountain tops) has the phonetic value *kur* on the basis of Sumerian, but also *mat* and *šad* from Akkadian *mātu* ("land") and *šadū* ("mountain"). No effort was made until very late to alleviate the resulting confusion, and equivalent "graphies" like *ta-am* and *tam* continued to exist side by side throughout the long history of Akkadian cuneiform.

The earliest type of Semitic cuneiform in Mesopotamia is called the Old Akkadian, seen for example in the inscriptions of the great ruler Sargon of Akkad (*c.* 2350 B.C.). Sumer, the southernmost part of the country, continued to be a loose agglomeration of independent city-states, until it was united by Gudea of Lagash (*c.* 2050 B.C.), in a last brief manifestation of specifically Sumerian culture. The political hegemony then passed decisively to the Akkadians, and King Hammurabi of Babylon (*c.* 1700 B.C.) unified all of southern Mesopotamia. Babylonia thus became the great and influential centre of Mesopotamian culture. The Code of Hammurabi is written in Old Babylonian cuneiform, which developed throughout the shifting and less brilliant later eras of Babylonian history into Middle and New Babylonian types. Farther north in Mesopotamia the beginnings of Assur were more humble. Specifically Old Assyrian cuneiform is attested mostly in the records of Assyrian trading colonists in central Asia Minor (*c.* 1950 B.C.; the so-called Cappadocian tablets) and Middle Assyrian in an extensive Law Code and other documents. The New Assyrian period was the great era of Assyrian power, and the writing culminates in the extensive records from the library of Assurbanipal at Nineveh (*c.* 650 B.C.).

The expansion of cuneiform writing outside Mesopotamia began in the 3rd millennium, when the country of Elam in southwestern Iran was in contact with Mesopotamian culture and adopted the system of writing. The Elamite sideline of cuneiform continued far into the 1st millennium B.C., when it presumably provided the Indo-European Persians with the external model for creating a new simplified quasi-alphabetic cuneiform writing for the Old Persian language.

The Hurrians in northern Mesopotamia and around the upper stretches of the Euphrates adopted Old Akkadian cuneiform around 2000 B.C. and passed it on to the Indo-European Hittites, who had invaded central Asia Minor at about that time.

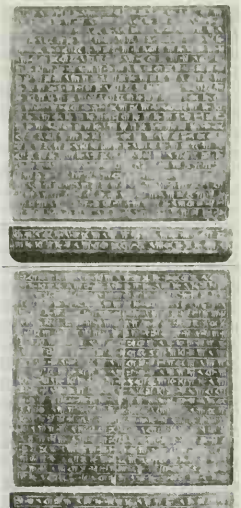
In the 2nd millennium the Akkadian of Babylonia, frequently in somewhat distorted and barbarous varieties, became a *lingua franca* of international intercourse in the entire near east, and cuneiform writing thus a universal medium of written communication. The political correspondence of the era is conducted almost exclusively in that language and writing. Cuneiform was sometimes adapted, as in the consonantal script of the Canaanite city of Ugarit on the Syrian coast (*c.* 1400 B.C.), or simply taken over, as in the inscriptions of the kingdom of Haldi or Urartu in the Armenian mountains from the 9th to 6th centuries B.C.; the language is remotely related to Hurrian, and the script a borrowed variety of New Assyrian cuneiform. Even after the fall of the Assyrian and Babylonian kingdoms in the 7th and 6th centuries B.C., when Aramaic had become the general popular language, rather decadent varieties of Late Babylonian and Assyrian survived as written languages in cuneiform almost down to the time of Christ. *See* also AKKADIAN LANGUAGE.

DECIPHERMENT

Many of the cultures employing cuneiform (Hurrian, Hittite, Haldian) disappeared one by one, and their written records fell into oblivion. The same fate overtook cuneiform generally with astonishing swiftness and completeness. One of the reasons was the victorious progress of the Phoenician script in the western sections of the near east and the classical lands in Mediterranean Europe. To this writing system of superior efficiency and economy cuneiform could not offer serious competition. Its international prestige of the 2nd millennium had been exhausted by 500 B.C., and Mesopotamia had become a Persian dependency. Late Babylonian and Assyrian were little but moribund artificial literary idioms. Unlike the hieroglyphs (*q.v.*) of Egypt, which served continuously for more than three millenniums as an aesthetically refined ornamental medium on the monuments of an almost monolithic culture, cuneiform was essentially a practical everyday writing, tied to the vicissitudes and uncertainties of changing civilizations. So effective was its disappearance in the sands of the near east that the classical Greeks were practically unaware of its existence, except for the widely traveled Herodotus who in passing mentions *Assyria Grammata* ("Assyrian characters").

Old Persian and Elamite.—The rediscovery of the materials and the reconquest of the recondite scripts and languages have been the achievement of modern times. Paradoxically the process began with the last secondary offshoot of cuneiform proper, the inscriptions (*q.v.*) of the Achaemenid kings (6th to 4th centuries B.C.) of Persia. (*See* PERSIAN HISTORY.) This is understandable, because almost only among the Persians was cuneiform used primarily for monumental writing, and the remains (such as rock carvings) were in many cases readily accessible. Scattered examples of Old Persian inscriptions were reported back to Europe by western travelers in Persia since the 17th century, and the name cuneiform was first applied to the script by Engelbert Kämpfer (*c.* 1700). During the 18th century many new inscriptions were reported; especially important were those copied by Carsten Niebuhr at the old capital Persepolis. It was recognized that the typical royal inscriptions contained three different scripts, a simple type with about 40 different signs, and two others with considerably greater variations. The first was likely to reflect an alphabet, while the others seemed to be syllabaries or word writings. Assuming identical contents in three different languages,

scholars argued on historical grounds that those trilingual inscriptions belonged to the Achaemenid kings, and that the first writing represented the Old Persian language which would be closely related to Avestan and Sanskrit. The recognition of a diagonal wedge as word-divider simplified the segmentation of the written sequences. The German scholar Georg Friedrich Grotefend (*q.v.*) in 1802 reasoned that the introductory lines of the text were likely to contain the name, titles, and genealogy of the ruler, the pattern for which was known from later Middle Iranian inscriptions in an adapted Aramaic (*i.e.*, ultimately Phoenician) alphabet. To a repetitive sequence he assigned the meaning "king of kings," and he also isolated the word for "son." The genealogy of Achaemenid rulers was known from Herodotus, and the available names could now be tested in appropriate places in the text. Grotefend found that the author of one inscription was identical with the father of the ruler in another; this father was also styled "king," while his own father in the former inscription was not. Thus it was ingeniously deduced that the kings must be Darius and his son Xerxes, because the father of Darius, Hystaspes, was not king (the preceding rulers, Cyrus and Cambyses, belonged to a different branch of the Achaemenid dynasty). This enabled the several long proper names to be read and a number of sound values to be determined. The initial results of Grotefend were expanded and refined by other scholars. Henry Rawlinson published in 1846 the great Behistun inscription of Darius, which enabled him to delve deeper into the language and to establish its close affinity with Avestan and Sanskrit.



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PERSIAN CUNEIFORM FROM THE XERXES INSCRIPTION AT PERSEPOLIS

Next the second script of the trilinguals was attacked. It contained over 100 different signs and was thus likely to be a syllabary. Mainly by applying the sound values of the Old Persian proper names to appropriate correspondences a number of signs were gradually determined, and some insight gained into the language itself, which is New Elamite; the study of it has been rather stagnant, and considerable obscurity persists. The same holds true for the Old Elamite of the late 2nd millennium.

Akkadian and Sumerian.—The third script of the Achaemenian trilinguals had in the meantime been identified with that of the texts found in very large numbers in Mesopotamia, which obviously contained the central language of cuneiform culture, namely Akkadian. Here also the proper names provided the first concrete clues for a decipherment, but the extreme variety of signs and the peculiar complications of the system raised difficulties which for a time seemed insurmountable. The serious external divergencies between older and newer types of Akkadian cuneiform, the distribution of ideographic and syllabic uses of the signs, the simple (*ba, ab*) and complex (*bat*) values of the syllables, and especially the bewildering polyphony of many notations were only gradually surmised by scholars like Rawlinson, Edward Hincks (by the use of frequency counts), Fox Talbot and Jules Oppert. Once the Semitic character of the language had been established, the philological science of Assyriology developed rapidly from the closing decades of the 19th century onward, especially because of scholars like Friedrich Delitzsch, and in more recent years Benno Landsberger and Wolfram von Soden. (*See* SEMITIC LANGUAGES.)

Once Akkadian had been deciphered, the very core of the system was intelligible, and the prototype was provided for the interpretation of other languages in cuneiform. Until the 20th century Sumerian was not definitely recognized as a separate language at all, but rather as a special way of noting Akkadian. Even when its independent character was established, the difficulties of interpretation were appalling, because of its strange and unrelated structure. After Sumerian finally died out as a living language toward the middle of the 2nd millennium, it lingered on as a cult idiom of Babylonian religion. To facilitate its artificial acquisition by the priesthood grammatical lists and vocabularies were compiled, and numerous religious texts were provided with literal translations into Babylonian. These have facilitated the penetration of unilingual Sumerian texts, and Sumerian studies have advanced greatly through the efforts of Delitzsch, Thureau-Dangin, Arno Poebel, Anton Deimel and Adam Falkenstein.

Hittite and Other Languages.—An important new dimension was added to cuneiform studies in the early years of the 20th century, through the discovery in 1906 of the royal archives of the Hittites at the ancient capital site of Hattusa near the Turkish village of Bogazköy, east of Ankara. Some years earlier the existence of an Indo-European idiom in some cuneiform letters found in the Egyptian diplomatic archives of the 18th dynasty at Tell el-Amarna had been suspected by Johan Knudtzon. This unlikely surmise was confirmed by Friedrich Hrozný during World War I, when his initial interpretation of the Bogazköy materials proved that the predominant language in the thousands of tablets was that of the Indo-European Hittites, whose rule in central Asia Minor filled most of the 2nd millennium. (*See* HITTITES.) The tablets offered no serious cryptological problems, being edited in a type of borrowed Akkadian cuneiform. The interpretation of the unknown language was aided by the partial ideographic nature of the script, which revealed elements of meaning independent of linguistic factors. Even more important was a series of bilingual parallel texts, in which the Akkadian versions served as a clue to the analysis of linguistic structure. This is the ideal state of affairs for recovering a lost language: it is a mixed blessing only insofar as a consistent ideography, while providing immediate comprehension, sometimes hides the underlying words to such an extent that some basic elements of Hittite vocabulary are still unknown. For example, the words for "son" and "horse" are not known, being always denoted by the Sumerian ideograms DUMU and ANŠU.KUR.RA (these are traditionally transliterated by capital letters). An added complication was that the Hittites created a secondary level of ideography by using Akkadian words or phonetic complements in the midst of a Hittite context, though this doubtless was not reflected in the pronunciation (these are transliterated by italic capitals). For example, the dative of the word for "god" is written with the Sumerian ideogram DINGIR followed by the Akkadian syllable *LIM* extracted from the oblique case *ilim* of *ilum* ("god") and a Hittite phonetic complement *-ni:* DINGIR-*LIM-ni,* pronounced *siuni,* as is known from parallel phonetic "graphies" of the form in other occurrences.

In the Hittite religion the autochthonous Khattish, or Hattic, language held a position of cult idiom reminiscent of that of Sumerian in Babylonia; it is attested especially in rituals. In much of southern Asia Minor the predominant language was Luish, or Luwian, and in parts of the north Palâ, or Palaic, both closely related to Hittite. The remains of all these at Bogazköy are written in a variety of cuneiform with few ideograms, which also characterizes the Hurrian texts in the Hittite archives and at Tell el-Amarna (the so-called Tushratta letter). The interpretation of these languages has proceeded slowly, due mostly to the paucity of texts and bilinguals. To the great mainstream of Hittitology, Hrozný, Ferdinand Sommer, Johannes Friedrich, Albrecht Goetze and Hans Gustav Güterbock have made the most memorable contributions.

In the absence of close affinity to known languages, which vouches adequate safeguards against the notoriously misleading comparative method of interpretation, inner analysis of the unknown language is the only trustworthy procedure. Hurrian and Haldian are definitely related languages, but neither may yet be safely used to explain the other. Haldian has been solved to some extent with the help of its rather free use of ideograms, and the As-

syrian versions of two bilingual inscriptions.

Excavations at Ras Shamra in 1929 unearthed the remains of Ugarit. Inscriptions in an unknown simple system of cuneiform were found; the low number of 30 different signs pointed to an alphabetic type. The use of a vertical stroke as word-divider facilitated the decipherment, which was based on the correct assumption that an early West-Semitic Canaanite dialect was involved. Thus the script was solved with astonishing speed by Hans Bauer, Edouard Dhorme and Charles Virolleaud, yielding a Semitic dialect named Ugaritic, closely related to Old Phoenician. Hurrian inscriptions in the same script were also found, as were texts in conventional Middle Babylonian cuneiform.

Conclusions.—The main type of cuneiform with its inventory of ideograms (including "determinatives" or "classifiers") and phonetic signs is a word-syllabic system like the Egyptian, "Hieroglyphic Hittite," Minoan-Mycenaean, Proto-Elamite, Proto-Indic and Chinese. The Sumerian system seems to be the oldest. To what extent it stimulated the origin or influenced the development of the others is a difficult problem connected with the monogenesis or polygenesis (common or multiple origin) of writing. The Phoenician consonantal script provided the new typological pattern on which the Ugaritic and Old Persian systems were constructed, keeping only the outer likeness of the wedge form.

See also references under "Cuneiform" in the Index volume.

See J. Friedrich, *Extinct Languages* (1957); I. J. Gelb, *A Study of Writing* (1952). (J. PL.)

CUNENE: *see* KUNENE.

CUNEO, the capital city of the province of the same name, in the Piedmont region, Italy, is 84 km. (52 mi.) S. of Turin by road and is the seat of a bishop. Pop. (1957 est.) 43,306 (commune). It stands at an altitude of 1,752 ft. on a plateau at the base of which flow the Stura di Demonte and Gesso rivers, forming at their junction the characteristic wedge (*cuneo*) from which the city takes its name. The old city has narrow streets flanked by porticoes; the modern part, which extends toward the railway station, is linked with the old by a great viaduct. Among the remarkable buildings are the cathedral (10th century; restored in the 18th); the church of S. Francesco (1227) in Lombard-Gothic style; that of S. Ambrogio (1231; reconstructed in the 18th century); the sanctuary of Sta. Maria degli Angeli (15th century); the town hall (18th century); and the Palazzo Audiffredi (18th century) which contains the civic museum. The railway station is on the Turin-Ventimiglia line. Important industries are iron and marble working, spinning and the making of cheeses, spirits and beer.

Founded in 1120 by fugitives from baronial feuds and Lombard refugees after the destruction of Milan by Frederick I Barbarossa, it became in 1382 part of the duchy of Amadeus VI of Savoy. By the armistice of Cherasco (1796) it was ceded to France. Captured in 1799 by the Austro-Russian armies, it again passed to France after the battle of Marengo (1800). (M. T. A. N.)

CUNIBERT, SAINT (*c.* 590–*c.* 663), bishop of Cologne, was born of good family in the Moselle area and was educated at Trèves, where he became archdeacon. He was made bishop of Cologne in 623. At the court of the Merovingians, especially under Sigebert III (d. 656), Cunibert exercised great political influence. He encouraged missions to the Frisians.

His feast day is Nov. 12.

CUNITZ, MARIA (1610–1664), Silesian astronomer called the "Silesian Pallas" from her universal accomplishments, was born at Schweinitz in 1610. In 1630 she married Elias von Löven of Pitschen in Silesia, and gained a European reputation by her *Urania propitia* (1650). This was a simplification of Kepler's tables of planetary motion called the Rudolphine tables after Kepler's patron, the emperor Rudolph II. Maria Cunitz died at Pitschen on Aug. 24, 1664.

CUNLIFFE, WALTER CUNLIFFE, 1ST BARON (1855–1920), English banker who in 1890 established in London the merchant banking business of Cunliffe brothers, was born in London on Dec. 4, 1855, and was educated at Cambridge. He became director of the Bank of England in 1895, deputy governor in 1911 and governor in 1913, a position he held until his retirement in 1918. He had an active part in the financing of World War I and accompanied Arthur Balfour on his financial mission to the United States in 1917. He was created Baron Cunliffe of Headly in 1914. He died at Epsom Jan. 6, 1920. (J. R. LT.)

CUNNINGHAM, SIR ALAN GORDON (1887–), British general who took an important part in the liberation of Ethiopia (1941), was born in Dublin, Ire., on May 1, 1887, of Scottish parentage (his brother became Adm. Viscount Cunningham of Hyndhope). Alan Cunningham was educated at Cheltenham college and the Royal Military academy, Woolwich. He joined the royal artillery and served with distinction in France in World War I. In Nov. 1940 he took command, under Gen. Sir Archibald (soon Earl) Wavell, of the British forces in Kenya, consisting mainly of south, east and west African troops with South African air support, and he invaded Italian Somaliland in Feb. 1941. In the face of great geographical and administrative difficulties, Cunningham's force achieved remarkable mobility and complete success. After occupying the Red sea ports of Chisimaio (Kismayu) and Mogadiscio (Mogadishu), he pursued the enemy into the mountainous interior and entered the Ethiopian capital, Addis Ababa, on April 6, 1941, thus enabling the exiled emperor Haile Selassie to return. Six weeks afterward, in co-operation with Gen. Sir William Platt's army advancing from the north, he secured the surrender of the main Italian forces at Amba Alagi. Cunningham left for Egypt in Aug. 1941 to command the 8th army during the first phase of Gen. Sir Claude Auchinleck's November offensive in the Libyan desert, but he returned to England shortly afterward. After the war he served (1945–48) as high commissioner in Palestine during the last troubled years of the British mandate. He was knighted in 1948. (J. R. M. B.)

CUNNINGHAM, ALLAN (1784–1842), Scottish poet and man of letters, best known for the sea song "A wet sheet and a flowing sea," was born at Keir, Dumfriesshire, on Dec. 7, 1784. His father was a neighbour of Robert Burns, and Allan and his brother James became friends of James Hogg (*q.v.*), "the Ettrick shepherd." Allan was apprenticed to a stonemason, but contributed songs to E. Roche's *Literary Recreations* (1807). He submitted poems to R. H. Cromek for inclusion in *Remains of Nithsdale and Galloway Song* (1810), disguising them as old ballads, and Cromek accepted them although he may have suspected their real authorship. Through him Cunningham went to London in 1810 and while acting as secretary to Francis Chantrey, the sculptor (1814–41), wrote for *Blackwood's Magazine* and the *London Magazine*, and also published *Songs, chiefly in the Rural Language of Scotland* (1813), *Traditional Tales of the English and Scotch Peasantry* (1822) and *Songs of Scotland, Ancient and Modern* (1825), as well as dramatic and romantic poems. These have little merit, but his lyrical poems, though lacking the unself-consciousness of the true ballad, or the perfect artistry of Burns, are often memorable for their lilting rhythm and their verbal felicity. His detailed knowledge of contemporary artists made his *Lives of the most Eminent British Painters, Sculptors and Architects*, 6 vol. (1829–33), interesting, and his edition of Burns (1834) included a life containing much valuable new material. He died in London on Oct. 30, 1842.

Of his five sons, four attained distinction, the most notable being JOSEPH DAVEY CUNNINGHAM (1812–1851), whose *History of the Sikhs* (1849) was the first authoritative work on the subject. Based on first-hand knowledge acquired while serving with distinction in the Bengal engineers before and during the Sikh wars, it brought him fame as a historian but ruined his career. His allegations that certain Sikh leaders had been bought by the British, made as a result of his observations when acting as an army political agent, led to his dismissal (1850) from the post of political agent at Bhopal, to which he had been appointed in 1846. He died soon afterward, at Umballa, on Feb. 28, 1851.

CUNNINGHAM, WILLIAM (1805–1861), Scottish theologian and leader of the Free Church immediately after the Disruption, was born at Hamilton, Lanarkshire, on Oct. 2, 1805, and educated at the University of Edinburgh. In 1834 he received the charge of Trinity college parish, Edinburgh. At the Disruption (1843), Cunningham was sent to the United States to win support for the Free Church of Scotland. He was appointed pro-

fessor in the New college, Edinburgh, of which he became principal in 1847 in succession to Thomas Chalmers. In 1859 he was elected moderator of the general assembly. He died in Edinburgh on Dec. 14, 1861. He was one of the founders of the Evangelical alliance. The Cunningham theological lectureship at the New college was endowed in 1862.

See R. Rainy and J. Mackenzie, *Life of Cunningham* (1871).

CUNNINGHAM, WILLIAM (1849–1919), British economist and churchman whose most important contributions were in economic history, was born at Edinburgh, Scot., on Dec. 29, 1849. He was educated at Edinburgh, Tübingen and Cambridge and was ordained in 1873; his career as economist and economic historian overlapped his career in the Church of England. Professor of economics in University college, London, from 1891 to 1897, he was appointed vicar of Great St. Mary's, Cambridge, in 1887 and archdeacon of Ely in 1906. He became a fellow of the British academy in 1887. His principal work, *The Growth of English Industry and Commerce* (1882; later expanded to 3 vol.; 5th ed., 1910–12), is a standard reference work. A bibliography of his works will be found in his *Progress of Capitalism in England* (1916). He died at Cambridge on June 10, 1919. (Fk. L. K.)

CUNNINGHAME GRAHAM, ROBERT BONTINE (1852–1936), Scottish writer and nationalist, described by Joseph Conrad as a grand seigneur born out of his time, was born in London on May 24, 1852. As well as claiming descent from Robert II, he had a Spanish grandmother from whom he inherited the look of a 17th-century Spanish grandee which made him such a romantic figure. Much of his youth was spent cattle farming in the Argentine, and he traveled throughout South America, where he was so greatly respected that the new city of Don Roberto was named after him. On his father's death in 1884 he returned to the family estate and from 1886 to 1892 was Liberal M.P. for North Lanarkshire. He took an active part in the early development of the Labour party and supported the Scottish nationalist movement, being elected its first president in 1928. He died in Buenos Aires, Arg., on March 20, 1936. His essays, biographies, short stories and books of travel reveal his original and ironical mind and the directness and humanity which made him a champion of the oppressed. They include *Mogreb-el-Acksa* (1898), *Success* (1902), *Scottish Stories* (1914), *A Brazilian Mystic* (1920) and *Portrait of a Dictator* (1933).

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CUNNINGHAM OF HYNDHOPE, ANDREW BROWNE CUNNINGHAM, 1st Viscount (1883–1963), British naval officer who became first sea lord and chief of naval staff during World War II. He left school at an early age to train on H.M.S. "Britannia" and in 1898 entered the Royal Navy. He served with distinction in World War I and at the outbreak of World War II in 1939 was commander in chief of the Mediterranean fleet. In this capacity he directed the action in Nov. 1940 that seriously crippled the Italian fleet at Taranto. His forces later suffered serious losses in evacuating British troops from Crete. In 1942 he became head of the British admiralty delegation to Washington, D.C. The following year he returned to London to succeed Admiral of the Fleet Sir Dudley Pound as first sea lord and chief of naval staff, at which post he remained until 1946. In the latter year he was created 1st Viscount Cunningham of Hyndhope. He published a book of memoirs, *A Sailor's Odyssey* (1951). He died in London on June 12, 1963.

CUNOBELINUS (1st century A.D.), sometimes called Cymbeline, was the son of the Catuvellaunian chief Tasciovanus, and conquered the Trinovantes of Britain early in the 1st century. He established a mint at Camulodunum (Colchester), was styled by Gaius Suetonius Tranquillus *Britannorum rex*, and employed the title *rex* on his coins. Three sons are known, Adminius, who was exiled and fled as a suppliant to the emperor Caligula (Gaius Caesar) in A.D. 40, Togodumnus, who was killed resisting the Claudian invasion, and Caractacus, who had carved out a kingdom among the Atrebates and continued resistance among the Silures and Ordovices until defeated and captured in A.D. 50.

See D. Allen in *Archaeologia*, xciii, 20–29 (1949). (I. A. Rd.)

CUPAR, a royal and small burgh and the county town of Fifeshire, Scot., 18 mi. N.N.E. of Kirkcaldy by road. Pop. (1961) 5,495. It is situated on the left bank of the Eden, in the east of the Howe (Hollow) of Fife, and is sometimes called Cupar-Fife to distinguish it from Coupar Angus in Perthshire. The mercat (market) cross stands at the meeting of the three main streets, where it was set up in 1897 after its removal from nearby Tarvit or Wemysshall hill, 2 mi. S., whence it was taken from the town in 1817. The hill is allegedly the spot where a treaty was signed in 1559 between Mary of Guise and the lords of the congregation. The town received a charter from David II (1356), Robert II (1381) and other kings, and being situated between Falkland and St. Andrews was constantly visited by Scottish royalty. The site of the 12th-century castle of the Macduffs, thanes of Fife, is occupied by a school. Along the northern slopes of Castle hill stretched the Playfield where morality plays were performed. There took place an early performance of Sir David Lyndsay's *Ane Satyre of the Thrie Estaits* and his *Tragedie of the Cardinall* (1547), referring to the murder of Cardinal David Beaton. Of the Benedictine monastery that stood on the southern side of the castle no trace remains. The tower of the parish kirk survives from the original church built in 1415.

The chief industries are linen, tanning and engineering; there are beet sugar and flax factories and the town has a reputation for printing. It has long been the market town of the Howe of Fife and on Tuesdays a cattle and grain market takes place.

To the northeast (3 mi.) is the village of Dairsie, where one of the few parliaments that ever met in Fife assembled in 1335. In the upper Old Red Sandstone of Dura Den, a ravine on Ceres burn, 3 mi. E. of Cupar, have been found great quantities of fossils of ganoid fishes.

CUPBOARD: *see* Cabinet Furniture.

CUPID, Roman counterpart of the Greek Eros (*q.v.*), son of Venus, equivalent to Amor in Latin poetry. From earliest Roman literature Cupid is seen as a playful boy shooting arrows of passion. In the 1st century B.C. and later, he constitutes a standard theme of Roman wall paintings at Pompeii, and Greek statues of him were brought to Rome and copied. According to Pliny, Varro owned a famous Cupid by Arcesilaus, and one of Praxiteles' masterpieces graced a Roman portico. Cupid plays a prominent part in Latin love elegy from the time of Catullus, particularly in the more sophisticated works of Propertius and Ovid, where Cupid ironically assumes the formidable qualities of an invincible warrior. In the *Aeneid*, Cupid helps to destroy Dido's honour (*Aeneid* 1, 657 ff.); in Ovid's *Metamorphoses* he inspires passion in Apollo and Pluto. The Romans carved Cupids, often sleeping or drunken, on sarcophagi; in these cases, he represented the pleasant sleep of death or a beneficent spirit.

For Cupid and Psyche, *see* Psyche. (Wm. S. A.)

CUPOLA FURNACE, a vertical type, cylindrical, or shaft furnace designed to melt ferrous metal in the production of cast-iron castings. It also has been employed to melt scrap iron and pig iron for charging in specialized furnaces, as the Bessemer and side-blow converter used in steel making. The cupola, which is similar in principle to the blast furnace (*q.v.*), consists of a refractory-lined steel stack 20 to 35 ft. high, resting on a cast-iron base plate which is supported by four steel legs. The bottom of the cupola consists of two hinged doors which are supported in closed position by a centre prop. Molding sand is rammed over the closed bottom doors to support the coke bed, molten metal and succeeding charges. Forced air for combustion enters the cupola through openings known as tuyères which are situated around the periphery of the lower portion of the cupola; sometimes the air is preheated. Iron, coke and flux (limestone) are charged onto a coke bed of sufficient height to hold the iron charges above the tuyère openings where the maximum temperature is maintained. Melting is continuous and molten metal may be allowed to flow continuously through an open tap hole at the base of the cupola or it may be tapped intermittently. Intermittent tapping is done by piercing a clay bott (plug) in the tap hole with a steel pointed rod, creating a passageway through the clay

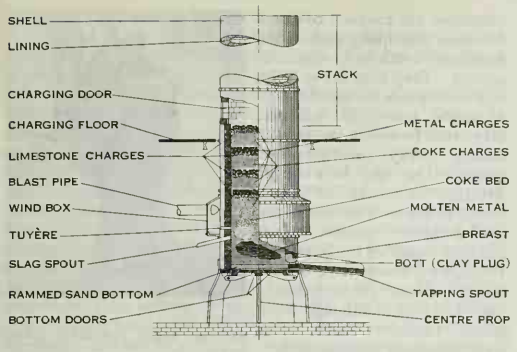

DIAGRAM OF THE CUPOLA FURNACE

portion known as the "breast" of the cupola. The tap hole is stopped up again by plugging it with a fresh clay bott. Wastes in the form of slag flow out of the cupola when the slag hole is tapped. Continuous cupola operation may go on without interruption from 1 to 16 hours and even longer. At the end of melting operations, the prop which supports the bottom doors is pulled out, allowing the doors to swing open and discharge all the remaining contents of the cupola.

The first cupola on record was built by R. A. Ferchault de Réaumur in France about 1720, and the furnace was introduced in the United States in 1820.

Cupola melting is still recognized as the most economical melting process, and most of the gray iron (*see* CAST IRON) produced is melted by this method. (C. T. M.)

CUPPING, a method of medical treatment, long obsolete, whereby blood was drawn to some cutaneous region by the partial vacuum within a heated cupping glass (dry cupping). In wet cupping the skin was incised. In both instances, as in the action of leeches, there was local abstraction of a small quantity of blood which was held to relieve subjacent inflammation.

CUPRESSACEAE, the cypresses and junipers, is one of the largest and most widespread families of coniferous trees and shrubs. Many are important timber plants or serve as sources of oils, resins or tannins. They are also extensively cultivated for ornament.

There is no general agreement as to the number of genera but the following are customarily recognized: *Cupressus* (true cypress), *Chamaecyparis* (false cypress), *Cupressocyparis* (an intergeneric hybrid), *Arceuthos, Juniperus* (juniper), *Actinostrobus, Callitris, Tetraclinis, Callitropsis, Widdringtonia, Fitzroya, Diselma, Thujopsis, Libocedrus, Pilgerodendron, Fokienia, Thuja* (arborvitae), *Biota* and *Microbiota.*

The leaves of the Cupressaceae are always opposite or whorled and often in flattened branchlets. The staminate, or pollen-bearing, cones are at the ends of short twigs, and the scales, opposite or in threes, bear three to six sporangia. The ovulate, or seed-bearing, cones are terminal with opposite or whorled cone scales which consist of fused bract and scale, these becoming thick and woody, or sometimes fleshy, at maturity. The erect ovules are attached near the base or appear axillary. There are four main types of embryogeny within the family, including both cleavage and simple polyembryony. The number of cotyledons ranges from two to six.

See CONIFERS; GYMNOSPERMS. (R. W. H.; X.)

CUPRITE, a mineral consisting of cuprous oxide, Cu_2O, is an important ore of copper (*q.v.*), of which it contains 88.8%. The name cuprite (from the Latin *cuprum,* "copper") was given by W. Haidinger in 1845; earlier names are red copper ore and ruby copper, which at once distinguish this mineral from cupric oxide, known as black copper ore or melaconite.

Cuprite occurs in the reduction zone of copper-bearing lodes, and is of secondary origin. It is found in Europe, Australia, Africa and South America. In the United States it occurs in the copper districts of the southwest, as at Bisbee, Ariz. Well-developed crystals are of common occurrence, and beautifully crystallized specimens were formerly found in Cornwall; they also occur in the copper mines of the Urals, in Arizona and elsewhere.

Cuprite crystallizes in the cubic system and crystals usually have the form of the regular octahedron, sometimes in combination with the cube and the rhombic dodecahedron. The colour is cochineal-red, and the lustre brilliant and adamantine to submetallic in character; crystals are often translucent, and show a crimson red colour which on prolonged exposure to light becomes dull and opaque. The streak is brownish-red. Hardness 3.5; specific gravity 6.0; refractive index 2.85.

BY COURTESY OF THE NATURAL HISTORY MUSEUM

CUPRITE, CRYSTALLIZED SPECIMEN

Compact to granular masses also occur, and there are two curious varieties—chalcotrichite and tile-ore—which require special mention. Chalcotrichite (from the Greek words for copper and hair) or "plush copper ore" is a capillary form with a rich carmine colour and silky lustre: the delicate hairs are loosely matted together, and each one is an individual crystal enormously elongated in the direction of the edge of the cube. Tile-ore is a soft earthy variety of a brick-red to brownish-red colour; it contains admixed limonite, and has been formed by the alteration of chalcopyrite (copper and iron sulfide). (L. J. S.)

CURAÇAO, the largest island of the Netherlands Antilles (*q.v.*), lies in the Caribbean sea 60 mi. off the Venezuelan coast. Its length is 40 mi., average width 10 mi., and area 173 sq.mi. It consists of igneous rocks and is mainly flat, except in the northwest where hills rise to 1,230 ft. Deep bays indent the south coast, the largest of which, the Schottegat, provides a magnificent harbour for the capital, Willemstad. The landscape is barren due to low rainfall (about 20 in. a year) and sparse vegetation. Large areas support only cactus thickets and there is much bare, eroded soil, the result of centuries of over-grazing.

Curaçao was discovered by Alonso de Ojeda in 1499 and settled in 1527 by the Spanish, who used it mainly for livestock raising; in 1565 John Hawkins described it as "one great cattle ranch." In 1634 Johannes van Welbeck of the Dutch West India company occupied and fortified the island, which became the base for a rich entrepôt trade flourishing through the 18th century. During the Napoleonic wars it was held by Great Britain but was returned to the Netherlands by the treaty of Paris, 1815. The 19th century was a time of economic decline, alleviated only by such ventures as the cultivation of aloes for pharmaceutical products and oranges for Curaçao liqueur.

The prosperity of Curaçao dates from 1914 when the Lake Maracaibo oilfield in Venezuela was first exploited by Royal Dutch Shell. A large refinery, built beside the Schottegat, began operating on Curaçao in 1918. It refines crude petroleum from Venezuela and Colombia. The industry supports most of the island's population and oil products are the only important export. Minor industries are calcium phosphate mining in the east, and tourism. Foreign trade is mainly with the United States and Venezuela, and Curaçao has been a free trade zone since 1956.

In 1960 the total population was 124,500, about 50,000 of whom lived in Willemstad. Curaçao has an extensive road system and is linked to the outside world by Dutch, U.S. and Venezuelan airlines as well as by numerous steamship services. (D. R. H.)

CURAÇAO, an alcoholic beverage originating in the Dutch island of Curaçao and deriving its principal flavour from the peel of the native orange of the same name. Its production later found favour in continental Europe, where its original formulation as a liqueur of the Curaçao orange was modified. It was then produced as an alcoholic distillate and infusion of the bitter as well as the sweet orange peel, compounded with sirups, brandies, rum, ethereal oils or spice isolates.

Varieties include Curaçao de Marseille, Pomeranzen, Ratafia

Curaçao, Grand Marnier, Triple Sec, all related orange flavoured potions of variant quality and ranging from 30% to 40% alcohol with their corresponding sugar content 30% to 23%. The liqueur is fined and is recognized among connoisseurs in either white or brown coloured varieties, likewise as a sweet or dry palative of a delicate nature.

Its prime essence is employed in a number of bitters and occasionally as a carminative. (D. An.)

CURARE (D-Tubocurarine or Intocostrin; obsoletely or primitively called curari, wourara, wourari, wourali, urari, curara, urirarery, etc.), a nonspecific term used by certain South American Indians to designate a group of varying but related arrow poisons; in pharmacognosy and medicine, specifically a form of curare like that discovered by R. C. Gill in 1938, used in human beings to induce muscle relaxation.

Curare produces flaccidity in striped (skeletal, or voluntary) muscles, and is used most widely as an auxiliary in general inhalation anesthesia, especially in abdominal surgery. In that field, frequently in association with cyclopropane gas, it is particularly useful because it produces profound surgical relaxation (comparable only with that seen in spinal anesthesia) with a minimal concentration of anesthetic agent. From this there is prompt postanesthetic recovery and a radical reduction of the possibilities of postoperative pneumonias and other complications. The drug is also employed as a relaxant in oral intubation, general endoscopy (oral, rectal, etc.), various tetanic seizures and lumbar and sacroiliac manipulations. Because of its quickly reversible action, it is useful in the diagnosis of myasthenia gravis. Curare also is used for relief of spastic paralysis (by reducing to normal the tone of hyperinnervated muscles), in the reduction of fractures and dislocations (by eliminating muscle pull during setting or reduction) and in other fields where a state of profound muscular relaxation or even immobility is desirable. Another use is as an adjunct in the shock therapy of schizophrenia and various other mental disorders, in which it is claimed to reduce the incidence of vertebral fractures.

Since curare can cause respiratory depression or arrest if administered in overdose or too rapidly, a carefully controlled technique of administration is necessary. It may be given either intramuscularly or intravenously.

Crude curare is a resinous-appearing, dark-brown to black mass of a sticky to hard consistency and has an aromatic, tarry odour. It is frequently prepared by the Indians as a decoction (though often also as a cold concoction). The types of curare most often studied have each contained several ingredients, variously grouped, from several botanical families. Of primary importance are the Loganiaceae (*Strychnos* species) and Menispermaceae (*Chondodendron, Cissampelos, Sciadotenia, Telitoxicum, Elissarrhena, Anomospermum* species, etc.); of secondary, and even rare, use are the Piperaceae (*Piper* species), Annonaceae (*Annona*), Leguminosae (*Lonchocarpus*), Rutaceae (*Erythrochiton*), Moraceae (*Ficus*), Rubiaceae (*Psychotria*), Solanaceae (*Capsicum*) and Aristolochiaceae (*Aristolochia* species) (*qq.v.*).

Different curares contain one or more of the following complex basic alkaloids: curin(e), curarine, tubo-curarine, paracurarine, protocurarine, the phenolic alkaloids protocuradine and neo-protocuradine, and others.

See also Anesthesia and Anesthetics.

Bibliography.—A. R. McIntyre, *Curare: Its History, Nature and Clinical Use* (1947), contains extensive bibliographies; *see* also R. C. Gill, *White Water and Black Magic* (1940); K. R. Unna *et al.*, New York Academy of Sciences, *Curare and Anti-Curare Agents* (1950). (R. C. Gl.; X.)

CURASSOW, a group of fowllike (gallinaceous) birds comprising several genera (*Nothocrax, Mitu, Pauxi, Crax*) of the family Cracidae. They are among the finest game birds of tropical America and resemble turkeys superficially, having short wings, long broad tail, strong legs and large feet. The hind toe is on a level with the other toes, unlike the condition in the majority of gallinaceous birds. The plumage may be glossy black, black and white or reddish brown. Many species are crested and some casqued. In most species the sexes are similar in colour.

With the exception of one species found north of Panamá, the curassows are confined to South America, principally east of the Andes and south to northern Argentina. They have heavy flight, and usually live in small flocks. Although essentially arboreal, they often forage on the ground, feeding chiefly on fruits and leaves. The nest is a simple structure of sticks or leaves placed in trees. The white eggs, two or three in number, apparently are incubated by the female. The downy young have striped heads, and leave the nest shortly after hatching. Although often tamed, curassows have never been thoroughly domesticated.

OLIN S. PETTINGILL, JR., FROM NATIONAL AUDUBON SOCIETY

MEXICAN GREAT CURASSOW (CRAX RUBRA)

The Mexican great curassow (*Crax rubra*), about three feet long, lives in lowland forests from southern Tamaulipas to western Ecuador. Males are glossy black except for the white abdomen and tail coverts; females are reddish brown. Both sexes have conspicuous erectile crests with recurved tips. (E. R. Be.)

CURB MARKET (Street Market), a name given to any stock market which either now transacts or originally transacted its business in the open, presumably in the streets or upon the curbs. At the outset, the curb markets of the various cities were entirely unorganized and operated only through the custom of a number of brokers meeting at certain places. Now they are well-organized exchanges, most of them well housed.

The London street market operated in 'Change alley during most of the 18th century. It is known that a street market existed in Paris in 1720, for records show that a part of the Rue Quincampoix was roped off at the time of the Mississippi Bubble to protect the street traders from the general public. In Boston the curb market operated in Exchange place for years before going into its present building.

The New York Curb exchange had its origin before the Civil War when its meeting place was located in Wall street near Hanover street. During the war it functioned in William street between Exchange place and Beaver street. In those days trading began at 8 A.M. and continued until 6 P.M. or later and, at night, was carried on in the corridors of uptown hotels. From 1880 to 1900 it was carried on at all hours in front of the Mills building in Broad street but after 1900 was reduced to a regular session from 10 A.M. to 3 P.M. Later the open-air traders located opposite 44 Broad street just south of Exchange place. A more closely knit organization was formed in 1908 and known as the New York Curb agency.

The modern exchange, under the name of the New York Curb market, or Market association, was organized as a voluntary association in 1911. The official title was changed to New York Curb exchange in 1929. On Jan. 5, 1953, the name was again changed to American Stock exchange. *See* also Stock Exchange.

CURÉ D'ARS: *see* Vianney, Saint Jean Baptiste Marie.

CUREL, FRANÇOIS, Vicomte de (1854–1928), French dramatist whose plays introduced a new range of ideas to the French stage, was born at Metz on June 10, 1854. Trained as a civil engineer, Curel obtained an opening as a dramatist when the Théâtre Libre accepted three plays (1891). His early plays are purely psychological studies. Subsequently Curel dramatized such themes as relations between capital and labour (*Le Repas du lion,* 1897); the misdirected cult of science (*La Nouvelle idole,* 1899); the persistence of the animal in civilized man (*La Fille sauvage,* 1902; and *L'Ame en folie,* 1919). His plays are known as "dramas of ideas," but he maintained that his interest in ideas lay only in their power to inspire passion and promote action (see *La Comédie du génie,* 1921, and prefaces to other plays). His one popular success was *Terre inhumaine,* a war play (1922), translated as *No Man's Land.* Curel died in Paris on April 25, 1928.

See E. Pronier, *La Vie et l'oeuvre de F. de Curel* (1934). (D. Ks.)

CURETES, a word with two meanings:

1. A people who fight the Calydonians in the quarrel arising out of the boar hunt. (*See* MELEAGER.) Later writers placed them in Aetolia, Acarnania or Chalcis.

2. Certain diamones connected with the cult of Rhea and regularly conceived as the attendant band of the infant Zeus. In historic times they had a certain amount of cult in various parts of the Greek world, which comprised Pyrrhic dances (*i.e.*, war dances in armour). In cult, art and literature they are frequently confused with the Corybantes (*see* CORYBANT), but their proper home is Crete and their proper function attendance on Zeus and Rhea. Names of several of them point to these facts, as Kres (Cretan) and Labrandos (he of the double ax, *labrys*, a very old Cretan and Asiatic sacred symbol). The legend states that when Zeus was born in, or conveyed in infancy to, Crete, they danced and clashed their weapons to drown his cries. A highly interesting hymn in their honour was discovered at Palaikastro in Crete; the worshipers call on Zeus Kouros and his attendants to bring all manner of fertility.

It is a not improbable supposition that the original Curetes were the human worshipers of Zeus Kouros (*i.e.*, that the *kouroi*, "adolescent boys," worshiped a god supposed to be of their own age, a variant of the "infant" Zeus of Crete); that the object of their worship was the increase of fertility, vegetable and animal; and that, although the hymn is of Hellenistic date, the rite itself may go back to Minoan times. It is also possible that the Curetes who fight the Calydonians are in their origin nothing but the young warriors of the neighbouring states.

BIBLIOGRAPHY.—The text of the hymn is best given in Powell, *Collectanea Alexandrina* (1925); other texts are cited in Immisch. *See* also J. E. Harrison, *Themis*, 2nd ed. (1927); M. P. Nilsson, *Minoan-Mycenaean Religion* (1927).

CURFEW (from O.F. *cuevrefu*, "cover fire"), a signal, as by tolling a bell, to warn the inhabitants of a town to extinguish their lights and fires or cover them up and retire to rest. This was a common practice throughout Europe during the middle ages. In medieval Venice the Barbers' quarter was exempt, doubtless because they were also surgeons and their services might be needed during the night. The curfew originated in the fear of fire when most cities were built of timber. Its use is obvious, as the household fire was usually made in a hole in the middle of the floor, under an opening in the roof through which the smoke escaped. The custom is said to have been introduced into England by William the Conqueror; but as there is good reason to believe that the curfew bell was rung each night at Carfax, Oxford, in the reign of Alfred the Great, it would seem that all William did was to enforce more strictly an existing regulation. The absolute prohibition of lights after the ringing of the curfew bell was abolished by Henry I in 1100. The practice of tolling a bell at a fixed hour in the evening, still extant in many places, is a survival of the ancient curfew. In 1848 the curfew was still rung at Hastings, Sussex, from Michaelmas to Lady day, and this was the custom too at Wrexham, north Wales.

On April 2, 1918, the British board of trade, with a view to economy in the consumption of coal, introduced the "curfew order," rescinded on Dec. 23, 1918, which restricted restaurant, theatre and shop-front lighting. Similar orders have since been issued and enforced during periods of unrest, as by the British military authorities in Ireland in the early 1920s and in Cyprus in the 1950s, and by the German military authorities in occupied Europe during World War II.

CURIA, an ancient political division of the Roman people. According to Roman tradition, Romulus divided the people into three tribes and 30 *curiae*, each of which in turn was composed of families (*gentes*). Citizenship depended on membership in these kinships, which probably included both the patricians and the much less important plebeians. Yet regional associations of the *curiae* are indicated in some names, though others were personal. They were the political units which composed the primitive assembly of the people, the *comitia curiata*, and were the basis of the early military organization. Though they lost their political and military importance to the later organizations by tribes and centuries (*see* COMITIA), certain formal and religious functions survived. For these purposes each *curia* had its own organization headed by a *curio* with a priest or *flamen* to assist him, while the head of the college of *curiones* was the *curio maximus*, always a patrician until a plebeian was elected in 209 B.C. The *curiae* had individual sacred rites, such as those to Juno and those performed by each *curia* at the "feast of ovens" (Fornacalia) on Feb. 17 and the "sacrifice of pregnant cows" (Fordicidia) on April 15, festivals which also had general public rites under the charge of the *curio maximus*.

Meeting places of the *curiae* were also called *curiae*, which gave rise to such terms as *Curiae Veteres* and *Curiae Novae*. The term was then applied to other meeting places, such as the *Curia Calabra*, where religious announcements concerning the calendar were made, and the *Curia Saliorum* (*see* SALII), and particularly to the senate house, the *Curia Hostilia*, its successor the *Curia Julia*, and finally by metonymy to the senate itself. *Curia* was also a regular title for the wards or voting divisions of colonies and *municipia*, both in Italy and in the western provinces. Under the later empire it appears also as a term for the local *senates* or boards of *decuriones* (*see* DECURIO), while their members were termed *curiales*.

In medieval Latin the word *curia* was used in the general sense of "court." It was used of "courts" in the sense of solemn assemblies summoned by the king (*curiae solennes*); of courts of law, whether developed out of the imperial or royal *curia* (*see* HOUSEHOLD, ROYAL) or not. Sometimes *curia* means jurisdiction, or the territory over which jurisdiction is exercised, whence its use for the courtyard of a house, or for the house itself; *e.g.*, Hampton Court. The word "curia" is now used only of the papal court of Rome (*see* CURIA ROMANA).

BIBLIOGRAPHY.—T. Mommsen, *Romisches Staatsrecht*, vol. iii, 3rd ed. (1887); W. Warde Fowler, *Roman Festivals*, pp. 71, 302 *et seq.* (1899); H. H. Scullard, *History of the Roman World from 753 to 146 B.C.* 2nd ed. (1953); on municipal *curiae*, F. F. Abbott and A. C. Johnson, *Municipal Administration in the Roman Empire*, p. 85 *et seq.* (1926); E. Kornemann in Pauly-Wissowa, *Real Encyclopädie Der Altertumswissenschaft*, 610 *et seq.* (1933). (T. R. S. B.)

CURIA REGIS: *see* HOUSEHOLD, ROYAL.

CURIA ROMANA, that is, the Roman curia or court, is the name properly given to the group of departments and persons used by the pope in the exercise of his supreme and universal power over the Roman Catholic Church. It comprises the Roman congregations, the tribunals of the curia and the offices of the curia. For the papal court in the sense of the pope's personal entourage, *see* VATICAN, THE.

In the first three centuries of Christianity the pope was chiefly assisted by the Roman clergy and by neighbouring bishops; for instance, the seven Roman deacons were entrusted with the care of the poor. From the time of the emperor Constantine I onward into the middle ages important affairs were handled by the Roman synods, either provincial or (later) general; but later in the middle ages the popes began increasingly to avail themselves of the assistance of the cardinals (*see* CARDINAL). The deliberative functions of the synods were taken over by the papal consistory; and individual cardinals were set over particular spheres of business, other cardinals being associated with them.

The first pope, however, authoritatively to organize a permanent system of agencies for the dispatch of all ecclesiastical business was Sixtus V, by the constitution *Immensa* on Jan. 22, 1588 (new style; 1587, old style). He established 15 congregations, most of them designed to assist the pope in the spiritual affairs of the church, but a few for the administration of the papal states. His dispositions, modified by Clement VIII, by Gregory XV, by Urban VIII (who added the Congregation for the Propagation of the Faith), by Clement IX and by Pius VII (who added the Congregation for Extraordinary Ecclesiastical Affairs), obtained in substance until 1908.

Pius X, however, saw that the efficiency of the Sixtine organization had gradually deteriorated: the competency of the several organs was indistinct, some were overworked, others idle. He therefore proceeded to a reform of the curia with the constitution *Sapienti consilio* of June 29, 1908. By this, some congregations

were amalgamated with others; the competency of each was defined; all affairs concerning the discipline of the sacraments were entrusted to a new congregation created for that purpose; all judicial business except certain specified cases was withdrawn from the congregations and committed to the Rota or to the Signatura, two tribunals which had previously found themselves with nothing to do; and general rules were laid down for the expedition of business and regarding personnel. The ordinances of *Sapienti consilio* and of its annexed *Ordo servandus in ss. congregationibus, tribunalibus et officiis romanae curiae* were received, with some small changes, into the Code of Canon Law, promulgated by Benedict XV in 1917.

Roman Congregations.—There are 11 congregations: the Holy Office, the Consistorial Congregation and the Congregations of the Sacraments, of the Council, of Religious, for the Propagation of the Faith, of Sacred Rites, of Ceremonial, of Extraordinary Ecclesiastical Affairs, of Seminaries and Universities, for the Oriental Church. A 12th, the Congregation of the Basilica of St. Peter, is not considered as such by the code. Meetings of the members of a congregation are always held in the Vatican, except those of the Congregations of the Holy Office and of the Propagation of the Faith, which have their own palaces.

Each congregation is headed by a prefect. The pope himself holds the prefecture of three: the Holy Office, the Consistorial Congregation and the Congregation for the Oriental Church. These are actually directed by a cardinal secretary, who is assisted by a prelate called the *adsessor*. The prefects of the other congregations are cardinals, each assisted by a secretary (a prelate, often a titular archbishop). Only cardinals are members of the congregations themselves; but they are assisted by various officials, and each congregation also has its "consultors."

The competence of the congregations is administrative and disciplinary. They must send cases requiring judicial decision to the competent tribunal (except certain specified cases which the Sacred Congregations of the Holy Office, of Rites and of the Sacraments are competent, severally, to decide); and legislative power is reserved to the pope. The functions of each congregation are defined by the code (canons 247–257); collectively, they comprise care for the faithful observance of the laws of the church, the issuance of instructions to explain or confirm the law, the practical application of legal prescriptions to particular cases, the concession of faculties *secundum vel praeter ius,* the granting of dispensations, the application of disciplinary measures and the resolution of doubts, questions and controversies in disciplinary (nonjudicial) form.

The authority of a congregation, within its own competence, is supreme and universal; it is also ordinary, but vicarious (it is possessed by the congregation in virtue of law, but exercised by it in the name and by the authority of the pope). Congregations do not share in the fullness of the papal power or in the pope's infallibility; their acts are reformable, unless confirmed in specific form by the pope.

Tribunals.—The tribunals of the Roman curia are three: the Sacred Penitentiary, which judges questions of conscience and has authority only over the conscience of the individual; the Sacred Roman Rota; and the Apostolic Signatura. The latter two have external authority.

The Rota consists of a college of prelates auditors, who, sitting in groups of three (hence the name, which means "wheel"), form judicial commissions which give judgment on matters coming under ecclesiastical law (except certain cases reserved to the Sacred Congregations of the Holy Office, of Rites and of Sacraments). The Rota hears appeals from diocesan courts all over the world and judges certain important matters in the first instance. Many of the cases dealt with concern nullity of marriages. The judges or auditors, generally about 15 in number, are nominated by the pope; they are among the senior prelates of the Curia Romana and enjoy many privileges.

The Signatura is composed of cardinals, who consider appeals lodged against decisions of the Rota. It cannot decide on the merits of the question, but may consider whether there has been any error of procedure sufficiently important for the case to be referred back to the Rota, where it will be considered by other judges than those who dealt with it the first time.

Offices of the Curia.—The chief of the five offices is the Secretariat of State. This office is directly controlled by the cardinal secretary of state, whose position in relation to the pope corresponds to that of a prime minister. With the assistance of the Congregation of Extraordinary Ecclesiastical Affairs, which constitutes the first of its three sections, this secretariat deals with all business connected with relations between the Holy See and the various governments. The cardinal secretary and his office are responsible for all matters in which some measure of agreement with a secular authority is necessary (concordats, the nomination of bishops, etc.) and also for the instructions to be given to the faithful on questions relating to national political life. Every day, before dealing with other business, the pope receives the cardinal secretary of state or one of the prelates responsible for the three sections of the secretariat. When we speak of the attitude or policy of the Vatican, we generally mean the activity of the Secretariat of State or the papal diplomacy for which it is directly responsible.

The other offices are the Apostolic Cancelleria, which deals with the dispatch of papal bulls; the Apostolic Dataria, which deals with benefices the grant of which is reserved to the Holy See; the Apostolic Camera, which has charge of the property of the Holy See, especially in the interval between the death of a pope and the election of his successor; and the Secretariat of Briefs to Princes and of Latin Letters, which deals with Latin letters from the pope.

CURICÓ, a province of central Chile bisected by the parallel 35° S. and extending from the Pacific to the Argentine frontier. Colchagua and Talca provinces adjoin, respectively, to the north and south. The province was created in 1865, dissolved in 1927, and reformed in 1936. It is subdivided administratively into Curicó and Mataquito departments. Area 2,033 sq.mi., pop. (1960) 105,802. About 50% of the gainfully employed are in agriculture and wheat, improved pasture, rice, the vine, legumes, maize, potatoes and orchards are cultivated. Cattle and sheep are raised in large numbers on the range land of the coastal mountains and Andean cordillera. Valley pastures are used primarily for finishing local stock and the cattle shipped in from the south. The province is noted for its stock auctions, rodeos and horsemen.

Curicó city (pop. [1960] 51,721 mun.), provincial capital and departmental seat, was founded in 1743 by José Antonio Manso de Velasco as San José de Buena Vista de Curicó and was elevated to city status in 1830. An earthquake largely destroyed the city in 1928. Licantén (pop. [1960] 6,492 mun.), seat of Mataquito department, has rail and road communication with Curicó. The latter is on the main line longitudinal railway and paved highway. Small beach and mountain resorts exist. Mining is unimportant although precious and industrial minerals have been reported.

(J. T.)

CURIE, PIERRE (1859–1906) and **MARIE** (MARJA SKLODOWSKA) (1867–1934), French physicists, were the discoverers of radium and Nobel prize winners for physics in 1903 (Mme Curie for chemistry in 1911). Pierre Curie was born in Paris on May 15, 1859, and educated at the Sorbonne, where he later became professor of physics. His early researches were piezoelectricity, the magnetic properties of bodies at different temperatures and other topics. One of his most important contributions to physics was the discovery that the magnetic properties of substances change at a certain temperature. This temperature is known as the "Curie point." He became chiefly known, however, for his work on radioactivity carried out jointly with his wife, Marie Sklodowska, to whom he was married in 1895. Marie Sklodowska was born in Warsaw on Nov. 7, 1867, and received her early scientific training from her father. She became involved in the students' revolutionary organization and found it advisable to leave Warsaw. Mlle Sklodowska went first to Cracow, then under Austrian rule, and later to Paris, where she took a science degree at the university.

After the discovery of the radioactive properties of uranium by Henri Becquerel in 1896, the Curies began researches into radioactivity (*see* RADIOACTIVITY), and in 1898 they an-

nounced that they had discovered two new elements in the mineral pitchblende which they had subjected to a process of fractionation. These were polonium (named in honour of Mme Curie's native country) and radium. In later years they did much to elucidate the properties of radium and its transformation products. The work of the Curies laid the foundation for much of the later research in nuclear physics and chemistry.

In 1903 they were awarded the Davy medal of the Royal society and in the same year the Nobel prize for physics was divided between them and Henri Becquerel. They received the Nobel prize for the discovery of radioactivity. The same year Mme Curie submitted the results of her researches in her doctorate thesis presented to the university. She then became head of the laboratory at the department of the Sorbonne created for her husband.

Pierre Curie, who was elected to the Academy of Sciences in 1905, was run over by a dray and killed instantly in Paris on April 19, 1906. His widow succeeded him as professor at the Paris university and in 1911 was awarded the Nobel prize for chemistry. This time the prize was awarded for the discovery of radium and the study of its properties. When Mme Curie received the prize in 1911, she became the first person to have been awarded it twice.

Her *Recherches sur les substances radioactives* was published in 1904, and her classic *Traité de radioactivité* was published in 1910. She did much to help the establishment of the radioactivity laboratory in her native city. In 1921 Pres. Warren G. Harding, on behalf of the women of the United States, presented her with a gram of radium in recognition of her services to science. In 1929 Mme Curie received from Pres. Herbert Hoover $50,000 from American friends of science to purchase radium for the use of the laboratory in Warsaw. She died on July 4, 1934, at Savoy, France.

The Curies' daughter, Irène Joliot-Curie, and her husband, Frédéric Joliot (*qq.v.*), were awarded the 1935 Nobel prize for chemistry.

BIBLIOGRAPHY.—Eve Curie, *Madame Curie* (1937); M. Curie, *Pierre Curie* (1923).

CURIE, a unit of measure of the "specific activity" of a radioactive preparation. It is not to be confused with another unit also unfortunately called the specific activity; the latter is defined as the ratio of the number of atoms of a particular radioisotope to the total number of atoms of the same element.

The curie, named in honour of Marie Curie, is a unit that expresses the specific activity of radioactive material in terms of the rate at which unit weight of the material decays; *i.e.*, emits charged particles. Since it is by the experimental detection of charged particles (or their associated gamma rays) that radioactivity is most readily recognized, the curie is thus a very practical unit. Originally defined as the activity of a quantity of radon in radioactive equilibrium with one gram of radium in 1930, the International Radium Standard commission, meeting in Brussels at the Radiology congress, extended the definition of the curie to be the equilibrium quantity of any decay product of radium.

Since one gram of radium undergoes about 3.7×10^{10} disintegrations among its atoms every second, the present definition of the curie needs to make no specific reference to radium but is taken as the specific activity of any material which signalizes a rate of decay of 3.7×10^{10} disintegrations per second per gram, this weight including that of both stable and unstable (active) isotopes of the material.

For example, if a catalogue states that some radioactive preparation, such as phosphorus-32, has a specific activity of 50 millicuries per gram, this indicates that in it there are taking place $50\times3.7\times10^{7}$ disintegrations per second—*i.e.*, 1.85×10^{9} beta particles emitted per second (phosphorus-32 being a pure beta emitter). *See* RADIOACTIVITY; PHYSICAL UNITS. (H. B. LM.)

CURIO, GAIUS SCRIBONIUS (d. 53 B.C.), Roman statesman and orator, son of a distinguished orator of the same name, flourished during the 1st century B.C. He opposed Saturninus in 100 B.C., was tribune in 90 B.C., and served in Sulla's army in Greece against Archelaus, general of Mithradates, and as his legate in Asia, where he was commissioned to restore the kings of Bithynia and Cappadocia to their thrones. In 76 he was consul, and as governor of Macedonia (75–73) defeated the Dardanians, being the first Roman general to penetrate as far as the Danube. On his return he was granted a triumph. In 63, during the discussion as to the punishment of the Catilinarian conspirators, he supported Cicero, but he spoke in favour of P. Clodius (*q.v.*) at his trial (61). This led to a violent attack on the part of Cicero, but it does not appear to have permanently impaired their friendship. He was *pontifex maximus* in 57, published a dialogue against Caesar in 55, and died in 53.

GAIUS SCRIBONIUS CURIO (d. 49 B.C.), son of the above, was first a supporter of Pompey. In 59 B.C. he was implicated in a conspiracy alleged by L. Vettius to exist against Pompey. When elected tribune for 50 B.C. he went over to Caesar, by whom he was said to have been bribed. When it was demanded that Caesar lay down his imperium before entering Rome, Curio proposed that Pompey do the same, adding that, if the rivals refused to do so, they ought both to be declared public enemies. His proposal was carried by a large majority, but, a report having spread that Caesar was on the way to attack Rome, the consuls called upon Pompey to undertake the command of all the troops stationed in Italy. Curio's protest to the people to prevent the raising of an army by Pompey was disregarded, whereupon he fled to Ravenna to Caesar. He was commissioned by Caesar to take a message to the senate, but met with so hostile a reception that he hurried back by night to Caesar. It was now obvious that civil war would break out. Curio collected troops in Umbria and Etruria for Caesar, who sent him to Sicily as propraetor in 49. After some successes against the Pompeians, Curio crossed over to Africa, where he was defeated and killed by Juba, king of Numidia. Curio possessed great ability; Cicero, as an old friend of his father, took an interest in him and seven of his letters (*Ad. Familiares,* ii, 1–7) are addressed to Curio.

See T. Rice Holmes, *The Roman Republic and the Founder of the Empire* (1923).

CURITIBA, the capital of the state of Paraná, Braz., is located 3,000 ft. above sea level, near the Atlantic margin of the Brazilian highlands and has a temperate and healthful climate. It is about 50 mi. W. of the port of Paranaguá, with which it is connected by a spectacular railroad passing through beautiful scenery. The city is also reached by rail, highway and air lines from other parts of Brazil. Pop. (1960) 344,560.

Curitiba was founded in 1654 as a gold-mining camp, but the ores proved unimportant. In 1854, it became the capital of the state of Paraná, and during the next 60 years it received many Italian, German and Polish colonists. Since 1940 growth has been especially rapid because of the economic development of the state as a whole. Curitiba is an important processing centre for maté, lumber and cattle. Manufactured products include paper, furniture, textiles, cement, matches and tobacco products. Many modern buildings distinguish the central business district. The city is an Episcopal see and the seat of the state university. Old, and now incorrect, spellings include Curityba, Curytiba, and Corityba. (P. E. J.)

CURIUM. The synthetic element curium has the chemical symbol Cm and the atomic number 96. It occupies a position in the periodic system of the elements as the seventh member of a rare-earthlike transition series, the actinide series, which includes the heaviest known elements and in which an inner electronic shell (the 5f shell) is being filled. An account of the discovery of curium is given in the article TRANSURANIUM ELEMENTS.

Production.—Curium was first isolated in the form of a pure compound Cm^{242} produced as the result of the strong neutron irradiation of Am^{241}. The Am^{241} absorbs neutrons to form the short-lived (16-hour half life) beta emitter, Am^{242m}, which in turn decays to Cm^{242}. These nuclear reactions may be written as follows:

$$Am^{241} + n \longrightarrow Am^{242m} + \gamma$$

$$Am^{242m} \xrightarrow[16\ hr.]{\beta^-} Cm^{242}.$$

This method was the source of Cm^{242} for much research with macroscopic quantities. The isotope Cm^{242}, with its 162.5-day half life, has a specific alpha activity corresponding to about 10^{14} alpha

disintegrations per minute per milligram. A specific alpha radioactivity of this magnitude presents serious problems arising from the aggregate recoil of submicrogram particles as a result of the tremendous rate of alpha emission. Among the difficulties inherent in the study of pure curium compounds in solution using Cm^{242} are the rapid decomposition of the water in the solution, the formation of hydrogen peroxide and heating of the solution. Nevertheless, a number of studies have been made using Cm^{242} in ponderable amounts.

There seems to be no completely logical assignment of atomic weight possible, since the isotopic composition is variable, depending on the source. Thus Cm^{242}, formed as the result of neutron irradiation, captures neutrons to form higher-mass isotopes such as Cm^{243}, Cm^{244}, etc. For the investigation of curium in weighable amounts, Cm^{244} is better than Cm^{242} since it has a longer half life (19 years) and can be prepared in fairly pure form by a sequence of neutron bombardments and chemical separations, as follows: the bombardment of Am^{241} with neutrons yields Pu^{242}; after chemical separation the Pu^{242} is irradiated with neutrons to form Pu^{243}, which decays with negative beta-particle emission to Am^{243}. Fairly pure Pu^{242} for this purpose can be prepared more simply by intense neutron irradiation of Pu^{239} as the result of successive neutron-capture reactions. The Am^{243} can be finally transmuted to Cm^{244} through neutron bombardment to produce Am^{244} which emits a negative beta particle and yields Cm^{244}. Further neutron bombardment of Cm^{244} produces higher-mass isotopes of longer half life which are even better for use in the investigation of curium.

Isotopes of Curium

Isotope	Half Life	Type* and energy of radiation (Mev)
Cm^{238}	2.5 hr.	EC ($<90\%$) α ($>10\%$) 6.50
Cm^{239}	$\sim$ 3 hr.	EC
Cm^{240}	26.8 days	α 6.25
Cm^{241}	35 days	EC (99%) α (1.0%) 5.95
Cm^{242}	162.5 days	α 6.110 (73.7%) 6.066 (26.3%) 5.965 (0.035%)
Cm^{243}	35 yr.	α 6.054, 5.987, 5.780, 5.736, plus others at 6.061, 6.005, 5.900, 5.872, 5.680, 5.676, 5.634
Cm^{244}	19 yr.	α 5.801, 5.759, 5.661
Cm^{245}	1.4×10^4 yr.	α 5.36, 5.45
Cm^{246}	5,000 yr.	α 5.37
Cm^{247}	$\geq 4 \times 10^7$ yr.	α
Cm^{248}	4.7×10^5 yr.	α 5.05
Cm^{249}	65 min.	β^- 0.9
Cm^{250}	2×10^4 yr.	SF

*EC = electron capture; α = alpha particle; β^- = negative beta particle; SF = spontaneous fission.

Chemical Properties.—The first investigations of the chemical properties of this element were made by the tracer technique with the isotope Cm^{242}. These investigations led to the conclusion that this element probably exists exclusively in the III oxidation state in aqueous solution, as expected on the basis of the stable configuration of the half-filled 5f electron shell, that is, the $5f^7$ configuration. With tracer concentrations of curium, a variety of strong oxidizing agents give no indication of oxidation. Curium is carried quantitatively by the rare-earth fluorides in precipitation reactions and is very similar to the tripositive rare-earth elements in all of its known chemical properties. It is separable from the trivalent actinide and rare-earth elements by the same methods, such as adsorption and elution, used for separating the rare-earth elements from each other. The use of complexing agents, such as concentrated hydrochloric acid, which form complex ions with the actinides that are much more stable than the corresponding ones formed with the lanthanides, is effective for separating curium from the rare-earth elements.

At a concentration of 10^{-5} molar curium (using the isotope Cm^{242}) and at higher concentrations (using the isotope Cm^{244}), and under conditions where americium III is oxidized to americium VI in the same solution, curium is apparently not oxidized above the III state with ammonium peroxydisulfate. All other oxidation attempts in acid solution have yielded negative results. It has also been shown that curium is not oxidized in alkaline solution by sodium hypochlorite under conditions where americium is oxidized to the pentapositive state. Other strong oxidizing agents in alkaline mediums are also ineffective. Solid, black curium dioxide, CmO_2, can be prepared (using the isotope Cm^{244}) from the sesquioxide, Cm_2O_3, and other curium III compounds by heating in an atmosphere of oxygen at 400° C.; this is presumably the result of the great stability of this dioxide structure. CmF_4 is obtained when CmF_3 (as Cm^{244}) is treated with fluorine first at 400° C. and then 300° C. It has also been shown that curium III in tracer amounts apparently is not reduced to curium II by sodium amalgam or barium metal in hydrochloric acid.

The solubility properties of curium III compounds are in every way similar to those of the other tripositive actinide elements and the tripositive rare-earth elements. Thus the fluoride and oxalate are insoluble in acid solution while the nitrate, halides, sulfate, perchlorate and sulfide are all soluble.

Curium III has no absorption bands in the visible spectrum but absorbs heavily in the ultraviolet region. This curium is again analogous in this property to its homologue, gadolinium.

Solid curium trifluoride has been prepared by drying the fluoride which precipitates from dilute nitric acid upon the addition of hydrofluoric acid. Curium trifluoride can be reduced to the metal by heating at 1,275° C. in a beryllia crucible with barium vapour. The metal is silvery in colour and appears to have the properties of an electropositive element, in common with the metals of the other actinide elements.

In common with the other transuranium elements, curium may be determined analytically through the measurement of its radioactive radiation. In all other respects, the chemical properties of Cm III resemble very closely those of other III ions, particularly those of the rare earths.

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CURLEW, the name given to several shore birds of the genus *Numenius* (subfamily Tringinae) of the family Scolopacidae. They are related to snipes, woodcock and sandpipers and have similar habits. As a group they are virtually cosmopolitan; but three of the eight species are restricted to the old world, two occur only in the new world and three are found, at least casually, in both. All are tall, stately birds, much alike in general appearance, although differing considerably in size (12–24 in.). The upper parts are brown, patterned with tawny or gray, and the underparts are buffy-white, more or less conspicuously streaked with brown. The long, slender, decurved bill (two to seven inches) distinguishes curlews from most of its relatives.

Rather gregarious and essentially terrestrial, curlews frequent mud flats, estuaries, marshes and moors, where they subsist on a variety of animal matter. As with most shore birds curlews have strong flight. They winter south of their breeding range. They nest on the ground, laying three or four pale-brown or olive eggs, speckled or boldly spotted with dark brown.

The long-billed curlew (*N. americanus*) breeds from southwestern Canada to southeastern Texas. The Madagascar curlew (*N. madagascariensis*), largest of the family, is about two feet long (including the seven-inch bill) and may have a wingspread of 42 in. The least curlew (*N. minimus*) is but 12 in. long, with a two-inch bill. Both are native to the old world, as is the slender-billed curlew (*N. tenuirostris*), which alone reaches Europe during migration. The lesser curlew, or whimbrel (*N. phaeopus*), is almost cosmopolitan; best known of its three geographical varie-

BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

ESKIMO CURLEW (NUMENIUS BOREALIS)

ties is the Hudsonian curlew (*N. p. hudsonicus*), which breeds in arctic America and winters south to Chile. The bristle-thighed curlew (*N. tahitiensis*) breeds in the mountains of Alaska and migrates some 6,000 miles to winter on islands in the South Pacific. The Eskimo curlew (*N. borealis*), now virtually extinct, formerly bred in abundance in arctic America and wintered on the pampas of South America. The stone curlew, or thick-knee (*Burhinus oedicnemus*), of Europe, belongs to a different family, Burhinidae.

(E. R. Be.)

CURLING, a winter sport similar to bowls or shuffleboard, is played on the ice. The rink is 138 ft. long by 14 ft. wide. There are two contending teams of four players, designated, as in bowls, lead, two, three and skip, or captain, each of whom delivers two stones alternately with his opponent. Which lead goes first is determined by the toss of a coin or by one throwing his broom to the other to catch, and their then placing hand over hand till one comes out on top. The stones are slid down the rink toward the tee, a fixed mark in the centre of a circle, which may be marked with a series of concentric circles or bands to aid in scoring and which is called the house. When all 16 stones have been delivered, a team scores from one to eight points according to the number of its stones that lie nearer the centre of the house than any of its opponent's. If neither side has a stone in the house, or the two opposing stones nearest the centre are equally distant from it, there is no score and a zero is posted. This constitutes an end, or inning. Play is then resumed in the opposite direction by the lead of the winning team, or rink, which is the term commonly employed by curlers. The number of ends in a match varies. Once it was as many as 17, even up to 21 for the finals of a bonspiel, or tournament. Then 12 and 14 ends became usual. With the increasing multitude of curlers, the multiplication of contending teams and the limitation of most curling to enclosed rinks with artificial ice, matches are often reduced to ten ends. In case of a tie, an extra end is played.

Glossary.—The following terms are used in describing the sport and are in common usage among curlers:

Besom, broom or brush used for sweeping (sooping) the ice.
Bonspiel, a curling tournament.
Building a house, strategy of placing a team's stones to protect each other and block opponents.
Button, one-foot circle around the tee.
Chipping-the-winner, striking a winning stone of which only a small part can be seen.
Crampet, a metal plate with spikes to hold it on the ice, just in front of the foot score, used as a foot brace, or hack, from which to deliver a stone.
End, an inning, constituting the delivery of all stones to one end of the rink.
Granite, curling stone.
Hack, a shallow depression in the ice just in front of the foot score, used as a foot brace from which to deliver a stone (see *Crampet*).
Head, the stones in the house after all 16 have been played.
Hog, a stone that fails to cross the hog line (*see* fig.); it is removed from the rink, unless it has struck another stone.
House, the 12-ft. circle around the tee.
Pat-lid, a stone lying on the tee.
Pebbling, spraying the rink with drops of hot water from a sprinkler.
Port, opening between two stones.
Raise, promote a stone toward the tee with another stone.
Rink, the ice on which the game is played; also a team.
Soop, sweep.
Tee, fixed mark on the ice indicating the centre of the circle, or house.
Wick, to carom off a stone.

Equipment.—The rounded stones are about a foot in diameter, between four and five inches high and weigh around 40 lb. Curlers once had individual stones, which sometimes varied greatly. But modern practice is for clubs to have matched stones, which behave uniformly and need not be sorted out for every match and every end. Opposing teams distinguish their stones by the colour of their handles. Only a few inches of the rounded bottom of a stone touch the ice, so that it slides along readily. Though commonly called granites, they are actually made of hone (fine whetstone, used also to sharpen tools) which has a superior smoothness and texture. It takes a stone, put down with average speed, about 17 seconds to traverse the rink.

In Canada, in the province of Quebec and in the vicinity of Ottawa, irons, weighing about 60 lb. and of smaller diameter than stones, are sometimes used.

As already implied, the curler has a broom or, in Scotland, a long-handled brush with which he may sweep ("soop") or scrub before the stone as it moves down the ice. Outdoors the chief object was to keep the ice clean and remove any obstacle brought by the wind. This factor is of less importance on indoor rinks, where, however, some dust and lint or frost may gather, or stray straws from the broom may impede the stone's progress. The ice is prepared for curling by pebbling. Pebbling forms tiny specks on the ice which slightly roughen its surface, prevent the stone from sliding too much and increase its tendency to curl or bend to the right or left. Sweeping presumably lessens the pebble and so makes the stone travel straighter and farther. Some curlers mop the ice instead of pebbling it.

The Rink.—In the accompanying figure of half of a rink (the other half is marked in the same way) A designates the tee, the centre of the house, the outer circle, G, has a radius of 6 ft.; concentric circles with radii of 4 ft., 2 ft. and 1 ft. also may be drawn on the ice. B designates the foot score, often marked by a slab of wood firmly embedded in the ice. C marks the back score, or line, behind which the opposing skip stands until the stone coming toward him has reached the sweeping score, F, drawn through the centre of the house, when he is at liberty to sweep it through. Otherwise, no one may sweep an opposing stone. Such a stone is out of play after it passes the back line, and should be pushed away where another stone may not be stopped on that line by it. Only those stones can count in scoring which are in the house or touch its outer circle, but stones are not out of play until they pass the line C, or touch or cross the side lines of the rink, or fail to cross the hog line, D. But a stone which strikes another lying in play remains itself in play though touching the hog line.

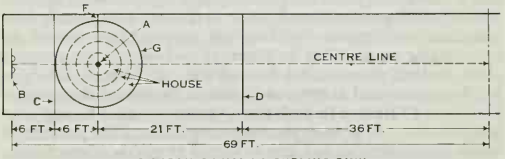

DIAGRAM OF HALF A CURLING RINK

Play.—In delivering a stone, after thoroughly cleaning the bottom to ensure an even course, a right-handed curler stands with his right foot braced against the left hack, a shallow depression made just before the foot score, or in a metal crampet laid on the ice. A left-handed curler similarly places his left foot in the depression, or the crampet to the right. Holding the handle of the stone, with his eyes fixed upon the skip's broom, placed for him to aim at, and his feet pointed toward it, he swings the stone back slowly so that its handle remains on a line directly toward the broom, and then follows through without bending his elbow and so that his hand and arm after releasing the stone point directly toward the broom. "Be on the broom" is a fundamental of curling. If the skip has signaled for an "inturn," the palm of a right-handed curler should turn to the right and be upward at the end of the stroke. For an "outturn," the hand should turn over to the left with the knuckles uppermost at the conclusion of the delivery. For the right-handed curler an inturn should curve (curl) to the right toward the end of the stone's course, and an outturn should curve to the left. The curler balances himself by holding his broom or brush in the other hand. Many slide out from the hack before releasing the stone, but they must let go of it before the sweeping score is reached. While a stone is being delivered, the courtesy and etiquette of the game require that the other players remain motionless and silent. Crossing the rink is a particularly heinous offense.

The other two members of the team stand one on either side of the rink at the nearer hog line, ready to sweep in front of the stone as soon as it crosses that line, if so directed by the skip. In the "running" game, where fast knockout shots are played,

some sweepers take a running start from behind their hog line and sweep the stone at full speed in order to keep it straight in line against the opponent's stone. Sweeping within the house is the skip's prerogative, and he may sweep one of his own stones through rather than leave it in an easy position for an opponent to rest against. If a stone is "marred" by touching the broom or person of a curler, it is declared out of play, if one of his own side's stones. If it is that of an opponent, it may be placed wherever the opposing skip directs.

The lead's stones should be placed where they are difficult to dislodge or where they will obstruct the opposition's shots. Which policy to pursue may depend upon which side curls first. Normally a stone in the front circle of the house is preferable to one in the back. Some skips will not leave an opposing stone on the centre ice, even though outside the house, since it is in the way and is liable to be promoted to count against his side. Unless specifically asked to lay a guard out in front, number two should not be short on his shots, or his stone may block his own side. The skip indicates which are the opposition's stones by pointing at them with the handle of his broom; he identifies his own by pointing with the straw end. Then he signals what kind of a shot is to be played, and where the stone should go.

Variations of speed and distance are indicated by such expressions as draw weight, tee weight and hack weight. Finally, making allowance for the condition of the ice and the amount which he expects the stone to curl, he places his broom for the player to aim at. After the stone has been delivered, he watches its course and directs the sweeping, either in accordance with his original intention or, if the unexpected happens, to attain some other advantageous objective. When his own turn to play comes, number three acts as skip for him.

Of common shots, the knockout (bumping an opponent's stone away from scoring position), guard (placing a stone so as to protect a teammate's stone from a knockout) and promote (bumping another stone so as to move it closer to the tee) have already been mentioned. Others are "wicking" off another stone toward the tee; coming to rest just in front of and against an opposing stone so that yours cannot be knocked out without dislodging it; drawing around a stone or stones to lie behind them nearer the tee; and "drawing through a port" or narrow space between two stones either to lie or to displace opposing stones. The point game, which is good practice and may be played by as few as two curlers, consists in attempting, both by inturns and outturns, such a variety of shots as these. For further particulars and a diagram showing how the rink should be marked for the point game, consult H. E. Weyman, *An Analysis of the Art of Curling*, 9th ed. rev., pp. 79–83 (Lévis, Que., 1953).

There is no generally accepted costume for curling. Some clubs have uniform coats or sweaters, but the most distinctive feature of the curler is the "bonnet," a plaid tam-o'shanter, balmoral or Glengarry, adorned with medals won at bonspiels and club pins exchanged with the members of opposing rinks. An essential feature is footgear that will not slip upon the ice.

History of the Game.—Curling, like golf, is especially associated with Scotland. But the earliest representation of it is a winter scene by the Flemish painter Pieter Bruegel (*c.* 1525–69), in which a band of hunters with their dogs look down upon two expanses of ice. On the farther one are skaters; on the nearer are pairs of curlers with brooms and stones with handles. The Grand Caledonian Curling club was founded at Edinburgh in 1838 "to unite curlers throughout the world into one Brotherhood of the Rink." In 1842 it became the Royal Caledonian Curling club under royal patronage. The Canadian branch of this organization was established in 1852, and in 1956 it affiliated with the Dominion Curling association. The Royal Montreal Curling club dates from 1807, however, and celebrated its 150th anniversary by a bonspiel in 1957.

In the United States, the Grand National Curling club of America was founded in New York on June 26, 1867, and was affiliated with the Royal Caledonian. Of its seven original member clubs the only surviving one is the Caledonian Curling club of New York city. St. Andrew's Golf club at Hastings-on-Hudson, N.Y., the oldest golf club in the United States, has since its foundation and by its original constitution been devoted to curling as well as to golf. But the oldest curling club in the United States is the Orchard Lake club in Michigan, founded in 1831. United States organizations are the Midwest Curling association and the United States Women's Curling association. A magazine, *North American Curling News*, is published at Superior, Wis. The first annual U.S. men's national curling championship was held in the Chicago stadium, March 27–30, 1957. There also is curling in various countries of continental Europe and in Australia. *See* WINTER SPORTS. (L. TE.)

CURLL, EDMUND (1675–1747), London bookseller remembered for his long quarrel with Alexander Pope, was born in 1675 in the west of England. In 1716 he published *Court Poems* and suggested that Pope was one of the contributors. Pope, in an effort to suppress this publication, met Curll at a tavern, with the result described in Pope's *A Full and True Account of a Horrid and Barbarous Revenge by Poison on the Body of Mr. Edmund Curll, Bookseller* (1716). Pope also satirized Curll in the *Dunciad* (1728). In 1716 and 1721 Curll was reprimanded at the bar of the house of lords for his publications concerning its members, and was convicted in 1725 and fined in 1728 for obscene publications—indeed, his notoriety in this respect made "Curlicism" a synonym for literary indecency. When he advertised his edition of *Mr. Pope's Literary Correspondence* (1735), Pope caused all his stock to be seized; but the book was restored to Curll, and it has been proved that Pope deviously instigated Curll's publication of the letters in order to provide him with an excuse for printing his own edition (1737). Curll died in London on Dec. 11, 1747.

See Sir Leslie Stephen, *The Life of Pope*, ch. vi (1880) and R. Straus, *The Unspeakable Curll* (1927).

CURME, GEORGE OLIVER (1860–1948), U.S. grammarian and professor of German, was best known for his *Grammar of the German Language* (1905, revised 1922) and his *Syntax* (1931) and *Parts of Speech and Accidence* (1935)—the third and second volumes respectively of *A Grammar of the English Language* by Curme and Hans Kurath.

Curme received most of his education at De Pauw university and the University of Michigan. He also did postgraduate work at the University of Berlin. His principal teaching posts were at Cornell college in Iowa (1886–96) and Northwestern university (1896–1933). After his retirement from Northwestern, Curme taught from 1934 to 1939 at the University of Southern California.

Curme's *Grammar of the German Language* is still, among the books by non-Germans, probably the best work in its field. His English grammars are very conservative but may be profitably consulted for detailed information, if not for up-to-date grammatical analysis and interpretation. (D. W. R.)

CURRAGH (CURRACH), **THE,** is a plain (about 10 sq.mi.) noted for its excellent springy turf in County Kildare, Republic of Ireland. The right of pasturage was, according to the *Liber Hymnorum* (10th century), granted by the king of Leinster to St. Bridget, who is credited with having made it a common. The downs of Kildare seem to have been an ancient meeting place. *Currach,* meaning a "low plain," signifies a racecourse where, it is said, races were held as early as the 1st century A.D. Aenach Colmain (Curragh fair) and Aenach Life (fair on the Liffey plain) are often mentioned in the Irish annals. The deep rich pasture land with limestone underrock, based on a foundation of glacial drift, is renowned for the breeding of race horses and there are several noted training stables and studs. The Irish Derby is run there at the end of June.

The Curragh has also been known since 1646 as a military training centre, and the former British army barracks, where cavalry brigade officers led by Gen. Sir Hubert Gough offered their resignations on March 20, 1914 (*see* IRELAND: *History*), are now occupied by the Irish army.

CURRAN, JOHN PHILPOT (1750–1817), Irish lawyer and statesman, remembered both as a great advocate and as a champion of Irish liberties, was born on July 24, 1750, at Newmarket, Cork. Educated at Midleton and Trinity college, Dublin, he entered the Middle Temple in 1773 and was made a king's

counsel in 1782. He was given a seat in the Irish house of commons in 1783, but soon repudiated his patron, bought another seat and spoke vigorously for Roman Catholic emancipation and against the prevailing corruption through government patronage. Although handicapped by his small stature and an impediment of speech, he became celebrated very early for his quick and pungent wit. He displayed great moral courage in defending apparently hopeless cases and became the recognized champion of all victims of religious or political oppression although he had no Roman Catholic connections or personal religious sympathies. Between 1794 and 1803, when the French Revolution had inspired the United Irishmen to popular uprising and class warfare, Curran undertook the defense of the more important agitators, including Hamilton Rowan, Wolfe Tone and Lord Edward Fitzgerald, when they were tried for treason. When the survival of the Irish parliament became a question of bitter controversy before the Act of Union in 1800, Curran was a determined and eloquent opponent of the union. Robert Emmet's irresponsible attempt at an insurrection in 1803 involved Curran in personal suspicion because his daughter Sarah had, unknown to him, become devoted to Emmet and knew of his plans. Curran was examined before the privy council and acquitted of complicity, but his sympathies with radical nationalism had been deeply shaken.

Curran's legal practice was by no means confined to political cases, and he took a leading part, with superb forensic oratory and legal acumen, in many famous lawsuits. When William Pitt died and the Whigs took office in 1806, Curran was made master of the Irish rolls with a seat in the Irish privy council. He had hoped for higher promotion, but he held that office until 1813. In 1814 he retired to London and became a distinguished member of the group of wits, writers and lawyers which included Sheridan, Thomas Moore, Lord Byron and Robert Erskine. Curran died at Brompton, Middlesex, on Oct. 14, 1817.

See Charles Phillips, *Recollections of Curran and Some of His Contemporaries* (1818); Leslie Hale, *John Philpot Curran* (1958).

(D. G.)

CURRANT, a common name for certain prickly shrubs of the genus *Ribes* (which also includes the gooseberry) whose piquant juicy berries are used chiefly in jams and jellies. There are at least 100 species, natives of temperate climates of the northern hemisphere and of western South America. The Rocky mountains in North America are especially rich in species. The red currants of America and northern Europe are derived from *Ribes sativum, R. rubrum* and *R. petraeum,* hardy deciduous shrubs five to six feet high, of the family Saxifragaceae (*q.v.*) and indigenous to Britain, northern and central Europe and Siberia. The black currants of Europe and Canada are all derived from *Ribes nigrum,* a native of northern Europe and of northern and central Asia. A few relatively unimportant black varieties of America are derived from *R. americanum* and *R. odoratum,* natives of North America. *Ribes sanguineum,* a native of the western coast of North America, is the flowering currant of northern Europe and *R. aureum* is the chief American flowering currant, or golden currant.

The currant seems to have been first cultivated sometime before 1600 in the Netherlands, Denmark and around the Baltic sea. Bushes were taken to settlements in America early in the 17th century; most American varieties, however, originated there. Both red and black currants are used for making tarts, pies, jams, jellies, etc. Black currants are also found in lozenges, are used for flavouring and are occasionally fermented. Currants are extremely high in vitamin C and a flavonoid substance (formerly called vitamin P) that affects the strength of the walls of blood capillaries. Great Britain grows more black currants than any other country and about ten times as many blacks as reds.

Currants succeed best in cool, moist, northern climates. Clay and silt soils are preferred. They are propagated by cuttings 8 to 12 in. long, usually taken in the autumn and set in the nursery, immediately or in spring, three to six inches apart, with not over two buds above ground. In the plantation they are set four to five feet apart in rows six to eight feet distant. Under intensive cropping, currants are planted under grapes, peaches, cherries and pears because they stand shade better than do most plants.

Currants and gooseberries are the chief agencies in the spread of the white-pine blister rust, a destructive disease of the five-leaved pines in Europe and America. The common garden black currant is the favourite host of the blister rust. Because the white pine is a very valuable timber tree, the black currant has been declared a menace and is not grown in most of the United States, and culture of currants and gooseberries has actually been prohibited in many sections (*see* also BLISTER RUST). The Viking red currant (called Red Dutch in Norway) is immune to the blister rust, as is the Red Holland variety of Germany. Crusader and Coronet, originated in Canada, are immune hybrids between a blister-rust-immune species from Siberia and the common black currant.

The currant maggot, for which there is no known control, infects the fruit so badly in parts of western North America that currants are not grown. The currant worm may defoliate the plants in the spring unless controlled. Black currants are subject to attacks of mites that destroy the unopened buds. The swollen buds should be picked off and burned.

See also GOOSEBERRY. (G. M. D.; X.)

CURRENCY. In the past, this term has been variously used to include all hand-to-hand circulating media, including gold, silver and in some areas commodities such as tobacco or sugar. The most common interpretation of the term in recent years, however, has restricted its identification to bank notes, government paper money and demand deposits in banks. Thus in the United States the money supply is usually identified with the total of government-issued coins, paper money issued by the U.S. treasury department or federal reserve banks and net demand deposits in commercial banks (defined to exclude deposits of banks with other banks, cash items in process of collection and national treasury funds). When used to denote paper money only, currency has accounted for a much smaller proportion of the typical industrial nation's total money supply during recent years than it did throughout the 19th century. In the United States during the 20th century, for example, demand deposits in commercial banks have comprised approximately 80% of the nation's total money supply. (*See* also MONEY; QUANTITY THEORY OF MONEY.)

Historical Background of Term.—The term "currency" has been defined in many different ways since the publication of Adam Smith's *Wealth of Nations* in 1776, and there is not even now any general uniformity in its usage. Smith employed the term "common currency" to refer to all forms of hand-to-hand circulating media, and on occasion applied it specifically to coins and bank notes. This was the general interpretation of the term at the close of the 18th century and the one which, with the addition of government paper money, continued in use through the first third of the 19th century both in Great Britain and the United States.

Many writers have interpreted currency as being synonymous with "money." Apparently under the influence of the gold standard, which was adopted widely during the latter part of the 19th century and the early part of the 20th century, it was sometimes asserted that "the only real money or cash is gold." Others maintained that bank notes were not money. But as early as the 1830s numerous writers, both British and American, recognized that demand deposits, against which checks could be drawn, serve the same purpose and have the same relationship to the price level as hand-to-hand money. Many therefore included demand deposits as part of the currency. Some 80 years later (in 1911) Irving Fisher wrote as follows: "Currency includes any type of property right which, whether generally acceptable or not, does actually, for its chief purpose and use, serve as a means of exchange. Circulating media are of two chief classes: (1) money; (2) bank deposits. But while a bank deposit transferable by cheque is included as circulating media, it is not money. A bank note, on the other hand, is both circulating medium and money."

What may be viewed as an extreme extension of the meaning of the term currency is sometimes encountered. Thomas Tooke asserted in 1826 that "currency is that medium, whether consisting of gold, notes, bills, or credit, by which the purchase of commodities is effected." Nevertheless, while several other writers have also taken the position that bills and credit in all forms have the

same price-level significance as coins and bank notes, few have explicitly included them in the term currency.

While there was some reason for Tooke's position at the time he wrote, since bills were actually used as a means of payment in Lancashire, there is no justification for the inclusion of credit instruments as a part of the currency today. This is not to deny, however, the importance of their monetary significance. Such "near moneys" as government short-term securities (treasury bills), mercantile bills and in fact all high-grade liquid securities are in demand as a substitute for cash because they can be converted into cash quickly and they yield an income that is not obtained if cash itself is held.

Quantity.—The volume of a nation's currency at any given time depends on many factors. Among them are the nature of the country's monetary standard, the relative significance in use of its paper money when compared with commercial-bank demand deposits and coins, the confidence its citizenry has in the credit position of the government, the status of its international balance-of-payments position, the level of general business activity and the economic wealth of the community—both real and in a nominal monetary sense. This list is by no means all-inclusive and no special significance is implied in the order of the items noted.

With the exception of the United States (which has used a managed gold-bullion monetary standard since 1934), the nations of the world have remained on monetary standards of a fiat, or trust, nature since the middle 1930s. These fiat standards have permitted governments to remain free from any obligation to repay the holders of their currencies or coins in any form of precious metal such as gold. Redemption of outstanding U.S. currency has been made only in lawful money since the Gold Reserve act of 1934, such lawful money consisting of all legal-tender currencies and coins in circulation. Realistically, it must be said that the volume of currency the world over is limited by the action of governments and not by the supply of precious metals. (*See* also Gold Standard.)

Under a gold-coin monetary standard, in which all currencies are redeemable in gold at their owners' request, it is reasonable to conclude that the volume of a nation's currency will be governed by the amount of gold held within the country for purposes of such redemption. In contrast, no such automatic restriction on currency issue is present under a fiat system. The argument is sometimes advanced that the only protection against an overissue of currency lies in the adoption of a monetary standard with free convertibility of all currencies and token coins into gold. It is true that whenever there has been a substantial overissue of irredeemable currencies in the past, a fiat rather than a gold monetary standard has been employed. It can be demonstrated, however, that the failure to achieve proper quantitative control of the currency issue was due to conditions other than the absence of a monetary standard associated with gold. The proposition has been widely defended since the close of World War II that the volume of currency issue within a country that will best contribute to a maximum usage of the nation's economic resources can be realized as readily under one monetary standard as another. There is nothing inherently superior about the gold standard from the point of view of its influence upon the economy. If a nation is on the gold standard there will probably be some relationship between the quantity of currency and of money, the output of gold and the price level; but it will be tenuous and uncertain at best.

In the absence of any so-called "automatic" regulator of a nation's currency supply, such as was at one time claimed for the gold standard, one must look elsewhere for the factors which determine its volume. Two examples will suffice, one for the United Kingdom and the other for the United States.

United Kingdom.—The currency of England and Wales is made up entirely of the circulating notes of the Bank of England (*q.v.*), although in Scotland and Northern Ireland several joint-stock banks have the right to issue notes backed by those of the Bank of England. In addition, these Scottish and Irish banks are empowered to issue a small volume of fiduciary or uncovered notes. The note issue of the Bank of England is entirely fiduciary and is placed in circulation with a backing of government securities instead of gold. Since 1939 all gold accumulations in England have been held in the government's Exchange Equalisation account with the consequence that the Bank of England has no gold, can obtain none and must use government securities as collateral for its note issues.

The Bank of England's note-issuing functions have been legally separated from its banking operations since 1844 when the Bank Charter act was passed. To obtain currency for issue, its banking department deposits government securities with its issue department. A small gold holding is regularly shown in the bank's weekly return but it is insignificant in relation to the total volume of notes issued. Any addition to the currency supply, consequently, must be accompanied by an increase in the holding of government securities by the issue department. It is not difficult to see, therefore, that a limiting factor to increases in the currency position of the United Kingdom is the debt position of her government. This factor of public debt is as significant in the currency system of the United States as it is in the United Kingdom.

United States.—The U.S. government uses two agencies in the issuance of its currency—the treasury department and the 12 federal reserve banks. Quantitatively speaking, the currency issues of the reserve banks are more significant, having filled the need since 1913 for a more flexible currency supply in the hands of the public. The outstanding issues of the treasury are composed in large measure of carry-overs from the years prior to 1913 when the Federal Reserve act was passed. The federal reserve system (*q.v.*) was, in fact, created for the purpose of providing a flexible currency supply so that the periodic financial crises which had plagued the nation for many years could be avoided. Sufficient flexibility was sought by tying the issue of the new federal reserve notes directly to the needs of business. The use of short-term business and agricultural paper as collateral for the notes was introduced with the commercial banks being empowered to rediscount or borrow at the federal reserve banks by means of such credit instruments. Subsequently, the list of commercial-bank assets acceptable at the federal reserve banks as collateral for federal reserve note issue was extended. Gold, gold certificates and finally debt obligations of the federal government were added. As a safeguard against overissue of the notes the law provides that the reserve of the issuing federal reserve bank must equal the value of the notes it issues. Furthermore, the federal reserve system's board of governors may require additional collateral when, in the opinion of the board, it is needed.

History of Currency Theories.—Before the advent of commercial banking in Great Britain in the 17th century, paper-money currency did not exist in that country. The hand-to-hand media of exchange consisted exclusively of coins. In the American colonies, however, numerous experiments were made with various types of paper money. Following the development of banking in Great Britain and the establishment of the first commercial bank in the United States in 1782, bank notes became an important element in the currency of both countries. (*See* also Banking.)

From about 1830 to 1844 (during which period the term "currency" was generally interpreted to include coins as well as paper money), there was much controversy in Great Britain between the so-called currency and banking schools. Members of the currency school held that the existing mixed metallic and paper (bank-note) currency should vary with exports and imports of gold precisely as would a purely metallic currency. By this they meant that an outflow of gold should immediately cause a contraction of the currency and thus reduce prices, or contrariwise with an inflow. Thus international equilibrium would be automatically restored. Failure so to control the stock of currency, they asserted, would permit the banks to continue to expand their loans and, consequently, the quantity of circulating medium after an outflow of gold had set in. This development, they believed, would eventually lead to an undermining of the reserve position of the banks, and therefore to a violent contraction and commercial "revulsion." Most of these writers either ignored or greatly underestimated the importance of deposits as an element in the stock of money.

The banking school saw the influence of bank deposits more clearly, and contended that control of the currency alone would

not achieve the result desired by their opponents. In addition they denied that an immediate contraction of the stock of money was to be desired upon the beginning of an outflow of gold. International gold movements frequently were due, they asserted, to the requirement of making some specific and limited payment, rather than to a fundamental condition of disequilibrium. To contract the currency, they claimed, would be unnecessary in these cases and would needlessly worsen domestic business conditions. Moreover, they held that the banks could not unduly expand the quantity of money because they were controlled by the "needs of business." This latter doctrine is still debated but appears to have no foundation in theory or history.

In the political field the currency school won the argument; and the note-issuing privilege of the banks was severely limited by the Bank Charter act of 1844. In its economic aspects, however, the difference of opinion has not yet been satisfactorily resolved. There is in truth a difficult problem of public policy presented when an outflow or inflow of gold takes place. It may or may not be the consequence of a fundamental condition of disequilibrium; if it is, the international position then requires a change in the domestic price level and a shift of production from domestic to international commodities, or the contrary, depending upon the direction of the gold flow. In any case the change in the stock of money causes an unwelcome disturbance of domestic economic affairs. If it involves a reduction in domestic prices, as could be the case when the flow of gold is outward, a considerable amount of unemployment may develop.

In the United States there arose contemporaneously a point of view quite similar to that of the currency school in England. Many writers contended that the currency should consist only of "hard" money, that is, coin. Nevertheless, partly because the federal government was then supposed not to have the constitutional authority to interfere with the issuance of notes by state-incorporated banks, no legislation comparable with the Bank Charter act was passed in the United States. However, the Independent Treasury act of 1846 provided for maintaining governmental subtreasuries for keeping the funds formerly deposited in various banks. This act also required the treasurer to accept and to pay out only coin. It was believed that the proportion of hard money to bank notes would thus be increased and the act may have had some slight influence in that direction.

No important legal limitation of the privilege of note issue was instituted in the United States until the passage of the National Bank act in 1863 and of the act of 1865. The former act provided for incorporation of national banks that might issue notes, but only against the security of federal government bonds. The latter act levied a tax of 10% per annum on the note issues of state-incorporated banks. The intent and effect of this tax was to eliminate entirely the notes of the state banks.

The currency of the United States was made yet more complicated by issue of the U.S. notes known as greenbacks (*q.v.*) during the Civil War and of gold and silver certificates, the former appearing in 1866 and the latter in 1880. As noted earlier, federal reserve notes were provided for in 1913 and after that date they became the major form of currency.

The general circulation of gold coin and gold certificates was discontinued in 1934 and the quantity of silver certificates greatly increased after that date because of the Silver Purchase act of that year. The privilege of national-bank note issue was discontinued in 1935.

In Great Britain the composition of the currency also changed after 1914, although it was not so complicated as in the United States. The issue of currency notes by the treasury was authorized at the outbreak of World War I, and the volume of these notes rose rapidly to a maximum of approximately £320,000,000 in Dec. 1920. Gold coins disappeared from circulation. The issue of the Bank of England also increased during these years but its quantity did not become so great as that of the currency notes.

The Currency and Bank Notes act of 1928 amalgamated the currency notes and the Bank of England issue by making the outstanding currency notes an obligation of the bank and transferring to the latter an equal amount of assets.

See also COUNTERFEIT MONEY and references under "Currency" in the Index volume.

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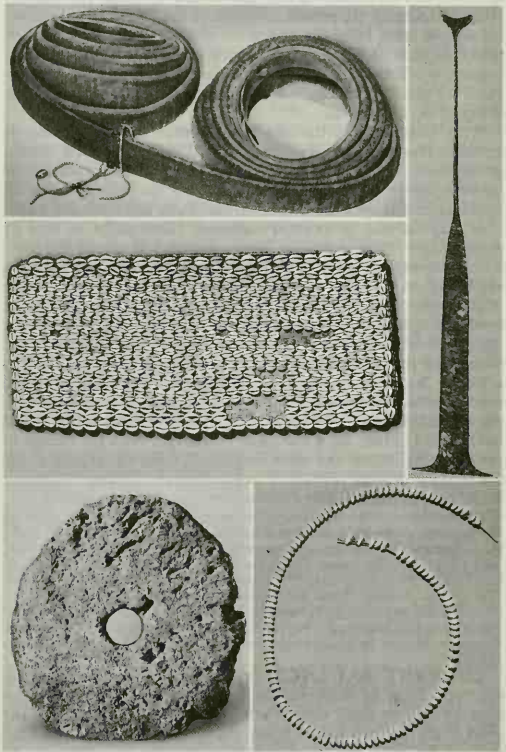
CURRENCY, PRIMITIVE. Among peoples of primitive culture is found a strange diversity of objects commonly termed "money" or "currency." These are of two main kinds, one comprising articles of practical use, the other those of which the primary purpose is ornament. The rock salt of Ethiopia, the hoes of the Dinka and Shilluk of the upper Nile, the iron and cloth of central and west Africa, the brilliant red feather bands of Santa Cruz, the dentalium shell strings of California and British Columbia, the wampum of the eastern American tribes, the tridacna-shell armlets and large stone axe blades of eastern New Guinea, the sperm-whale teeth of Fiji and the *fê* or "millstone money" of the Caroline islands have all been termed "money." Certain of these things are currency in the true economic sense; others have been dubbed so through loose definition of terms and use.

Well known among "native money" are the strings of shell disks



BY COURTESY OF (UPPER LEFT AND LOWER LEFT) CHASE MANHATTAN BANK MUSEUM OF MONEYS OF THE WORLD; (UPPER RIGHT AND LOWER RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM; (CENTRE LEFT) THE MUSÉE ROYAL DE L'AFRIQUE CENTRALE, TERVUREN

(UPPER LEFT) REO FEATHER BANDS, SANTA CRUZ; (UPPER RIGHT) KISSI PENNY, IRON ROD CURRENCY, SIERRA LEONE, AFRICA; (CENTRE LEFT) CYPRAEA MONETA, COWRIE SHELL MONEY OF THE ZANDE TRIBE, REPUBLIC OF THE CONGO, AFRICA; (LOWER LEFT) FÊ, MILLSTONE MONEY OF THE YAPESE, CAROLINE ISLANDS; (LOWER RIGHT) DIWARA, NASSA SHELLS THREADED ON STRIPS OF CANE, NEW BRITAIN

so characteristic of the Melanesian islands, as the *diwara* of New Britain, the *rongo* of Malaita or the *sapisapi* of east New Guinea. Much work is involved in their manufacture, and their value varies according to their length and colour. Red disks are worth more than white, the shell from which they are obtained being more rare. These strings, whether in coils or made up into necklaces, form most important items of wealth to the native and pass freely from hand to hand in settlement of social obligations.

But according to precise terminology such objects can hardly be correctly described as currency or money. In any economic system, however primitive, an article can only be regarded as true money when it acts as a definite and common medium of exchange, as a convenient stepping-stone in obtaining one type of goods for another. Moreover, in so doing it serves as a measure of values, allowing the worth of all other articles to be expressed in terms of itself. Again, it is a standard of value with reference to past or future payments, while as a store of value it allows wealth to be condensed and held in reserve. Strings of shell disks and similar articles are certainly a form of condensed wealth and act as a store of value. But they do not consistently perform any other function of money. They may pay for canoes or be traded against one another, but they do not facilitate everyday exchanges, as those of food or implements, nor are market values of other commodities expressed in terms of them. The use of such articles is largely ceremonial; individual pieces often have names and unique histories, and are connected with the fortune of special persons and clans. In general, the economic system of the Pacific island native, considered apart from the effects of white contact, has not been shown capable of accommodating and utilizing a full-fledged circulating medium in its system of production and exchange; references to native "money" or "currency" therefore cannot be accepted at face value.

With African tribes the case is different. The use of hoes or cattle as true money is dubious, but it is clear that such objects as iron bars (often in the form of conventionalized spearheads or knives), cowrie shells, salt and cloth serve as definite media of exchange and as common measures, standards and stores of value. This may be due to external influence, particularly to that of Arab traders. The cowrie (*Cypraea moneta*) is one of the most striking forms of native currency. Ranging in west Africa from the Sahara to the Gulf of Benin, taking in the whole basin of the Niger-Benue, and including also the upper Congo-Lualaba area, its economic sphere centres especially in Tombouctou (Timbuktu), the district of the middle Niger and the country around Lake Chad. Sometimes the shells are strung on a cord, sometimes kept loose in a leather bag, and transactions of all kinds, from simple village marketing to buying and selling on a large scale, are accomplished through this medium. In recent times the cowrie has often served as the small change for a European currency. With the change in economic conditions and ideas consequent upon the arrival of the white man, objects previously not employed as actual currency may begin to extend their function and assume that position.

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CURRENT BALANCE, or current weigher, measures an electric current by balancing the force of attraction or repulsion between two or more coils which carry the current against the force of gravity on a known mass. In the current balance credited to Lord Kelvin a coil suspended from one pan of a balance and carrying the current in a clockwise direction is repelled by the upper fixed coil in which the current is counterclockwise and attracted by the lower coil in which the current is clockwise. The resulting force on the moving coil is balanced by adding a small weight to the opposite pan. The current in absolute amperes is computed from the force on this weight, the number of turns of wire on the coils, their radii and their distance apart.

The current balance is now used only by national standardizing laboratories for determining the ratio between the absolute ampere and the international ampere, the latter being the unit in which instruments for measuring electric current are certified. In both England and the United States, 1 International ampere = 0.999835 absolute ampere. *See* INSTRUMENTS, ELECTRICAL MEASURING. (H. L. Cs.)

CURRICULUM: *see* EDUCATION, HISTORY OF: *National Systems.*

CURRIE, SIR ARTHUR WILLIAM (1875–1933), Canadian soldier and educationist, the first Canadian commander, from 1917, of Canada's overseas forces in World War I, was born at Napperton, Ont., on Dec. 5, 1875. He was educated at the Strathroy Collegiate institute and taught school in British Columbia before he went into business in Victoria, B.C., and became the senior partner in a real estate firm. Having enlisted in the militia, he rose from the ranks to command the 5th Canadian garrison artillery, with the rank of lieutenant colonel. When World War I broke out in 1914, he was given command of the Vancouver Highland battalion in the First Canadian contingent. In 1915 he was given command of a brigade, with the rank of brigadier general; in 1916 he succeeded to the command of the first Canadian division, with the rank of major general; and in 1917 he became the commander of the Canadian corps, with the rank of lieutenant general. On his return to Canada after the war he was appointed inspector general of the Canadian militia. In 1920 he accepted the position of principal and vice-chancellor of McGill university, Montreal, a post he retained until his death in Montreal on Nov. 30, 1933. He was created companion of the Bath in 1915, knight commander of St. Michael and St. George in 1917, knight commander of the Bath in 1918, and knight grand cross of St. Michael and St. George in 1919. He received honorary degrees from 17 universities in Canada, the United States and Great Britain.

See Hugh M. Urquhart, *Arthur Currie* (1950). (W. S. WA.)

CURRIE, SIR DONALD (1825–1909), British shipowner and politician, founder of the Castle line of steamers between England and South Africa and later head of the amalgamated Union-Castle line, was born at Greenock, Scot., on Sept. 17, 1825. Joining the newly started Cunard steamship line, Currie was appointed agent at Le Havre and Paris in 1849, and returned to Liverpool to the company's head office about 1856. In 1862 he established the Castle line of sailing ships to Calcutta, and ten years later the Castle line to South Africa. From 1876 the South African mail contract was divided between the Castle and Union lines, until, after intense rivalry, they were amalgamated in 1900.

Because of his intimate knowledge of South African conditions Currie was entrusted by the British government with certain negotiations concerning the Kimberley diamond fields, and was also concerned with the restoration of the Transvaal to the Boers. Entering politics, he was returned to parliament in 1880 as a Liberal member for Perthshire, and from 1885 to 1900 represented West Perthshire as a Liberal Unionist.

In 1881 Currie was knighted. He died at Sidmouth, Devon, on April 13, 1909. (H. C. C. D.)

CURRIER & IVES, U.S. lithographers, whose lively prints of 19th-century American life are collected and often used to invoke their period. NATHANIEL CURRIER (1813–1888) was born in Roxbury, Mass., on March 27, 1813. He set up business in New York in 1834. JAMES MERRITT IVES (1824–1895), born on March 5, 1824, in New York city, joined Currier as a bookkeeper in 1852 and became his partner in 1857. Ives had a flair for selecting popular subjects, such as "The American National Game of Baseball" (1867). The firm sold retail (some by mail order) and wholesale, and had distributors in many cities including London. Prints were hand-coloured by a dozen or more women in an assembly-line manner; larger ones were sent out to young artists, among them Louis Maurer, Thomas Worth and A. F. Tait. Three sizes were advertised: small folio (about 8 x 11½), 15 cents to 25 cents each; medium folio (about 12 x 17), 35 cents to 75 cents each; and large folio (about 20 x 28), $1.50 to $3 each. Over 7,000 titles were published between 1840 and 1890. Currier died on Nov. 20, 1888, and Ives on Jan. 3, 1895. The firm continued

until 1907. The most popular prints are winter scenes, scenes from the Mississippi, town views, clipper ships, steamboats, whaling, trains, sports, and flowers and fruit. Sentimental and religious subjects are less favoured. In 1924 the first auction sale of Currier & Ives prints was held in New York.

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CURRY, JOHN STEUART (1897–1946), U.S. painter, whose art reflects the social and aesthetic values of the depression decade of the 1930s, was born on Nov. 14, 1897, on a farm near Dunavant, Kan., of stanch Scotch-Irish Presbyterian parents. He studied art at the Kansas City Art institute and the Art Institute of Chicago. In 1918 he attended Geneva college, Beaver Falls, Pa., but left to become a free-lance illustrator, particularly of western stories. He gave up illustration in 1926 to spend a year of study in Europe. On his return he won recognition as one of the nation's foremost artists with "Hogs Killing a Rattlesnake," "Baptism in Kansas," "The Tornado" and others. His style revealed a new expression of the tremendous energy of American life. His subjects were the circus, the landscape and traditions of regions in which he lived, and the spectacle of American sports. The movement of which he was a leader and which came to be called Regionalism was one of the most significant of the 1930s, and included Thomas Benton, Grant Wood and many others. Curry executed several important murals, among them those for the department of justice in Washington (1936–37) and those for the state capitol building in Topeka, Kan. (1938–40), which reflected the activities of the abolitionist John Brown.

Curry taught at Cooper union in New York (1932–34), at the Art Students' league (1932–36), and was artist in residence at the University of Wisconsin (1936) until his death at Madison, on Aug. 29, 1946. (L. E. S.)

See L. Schmeckebier, *John Steuart Curry's Pageant of America* (1943); American Artists Group (Monograph 14), *John Steuart Curry* (1946).

CURTAIN, a piece of cloth or similar material suspended by the top so that it may be withdrawn sideways, commonly used as a screen or hanging to regulate admission of light at windows and to prevent drafts from door or window openings. Curtains arranged to fall in ornamental folds may be called drapery, and "drapery" also may be used to describe folds of cloth covering the human body. Since ancient times drapery has been used by artists as background to enhance the human form and to add interest to portraits; thus, during the Renaissance Carlo Crivelli, like many other artists of the period, posed the Madonna and Christ Child in front of a curtain of figured cut-pile velvet, and later Sir Anthony van Dyck established for his patrons standard poses in front of voluminous theatrical curtains, establishing a persistent portrait fashion. Though this article is concerned largely with France and England, all the countries of Europe, as well as Russia and America, interpreted the major style trends described and developed them along national or regional lines.

The history of curtain design is revealed in works of art over the centuries. Though evidence in paintings of ancient times is slight, from the beginning of the Christian era use of drapery is widely illustrated in wall mosaics, carved stone or ivory reliefs and illuminated manuscripts, showing how and where curtains were used, and actual fragments of textiles, especially tapestries, are preserved in tombs and churches. Mosaics of the early Christian period show curtains suspended from rods running across arches, and in medieval illuminated manuscripts curtains are knotted or looped up at doorways. In a manuscript of about 983, in the Trier Municipal library, the pope is represented as seated in a cubicle of white curtains with elaborate borders, while a green curtain with pink and gold edge is hung from an arch. Religious paintings often show curtains used to enclose or separate dining or sleeping areas. Gothic manuscripts show that interior walls, including window and door openings, were hung with movable tapestries or with embroidered, painted or woven cloths. By the 16th century such hangings were stretched on the walls above the dado to form continuous pictures of mythological or scriptural subjects.

Renaissance.—Until the close of the middle ages, windows were covered with utilitarian wooden shutters or a heavy cloth, but beds were curtained on all sides and covered with a tester, which, suspended from the ceiling by cords, provided a feeling of colour and warmth. Privacy in a bedchamber is a relatively modern idea, and beds during this period did not stand in separate rooms; they were used as couches and seats by day, with the curtains neatly looped up in the form of a bag, as seen in the 15th-century marriage portrait of the Arnolfinis by Jan van Eyck and the "Annunciation" by Rogier van der Weyden. Italian paintings of the late 15th century show carved and painted bedsteads. Surviving in the north, from about a century later, are wooden beds intended to be placed in alcoves (and faced as part of the room woodwork) or in the corner of a room (with two sides and the top paneled) or made like a box with a half-canopy of carved wood. All were furnished with curtains and valances made of rich velvets and damasks with fringe or appliquéd scrollwork designs. In 1590 the inventory of the household possessions of Lord Lumley (1534?–1609) listed for his three houses (England): "sutes of hangings of arras, sylke and tapistre, Turkey carpettes of sylke, carpettes of velvet for tables and wyndowes, coveringes and Quyltes of sylke, Quisshins of clothe of gold, velvet and sylke." Dutch paintings of the 17th century reveal the interiors of simpler dwellings in which windows are shaded with single half- or full-length curtains and the fireplace hood is decorated with a fringed cloth or piece of needlework. Beds in these humbler rooms are dressed with plain fabrics, some of them undoubtedly homespun and home woven. At least in northern climates woolen cloth was probably preferred for bed curtains.

Baroque.—During the reign of Louis XIV the major centre of artistic innovation shifted from Italy to France. The Royal Academy of Painting and Sculpture was founded, and the Gobelins works established, serving not only as a manufactory but also as a school for all branches of the decorative arts. Under the direction of Charles le Brun, Louis XIV's palace at Versailles and other royal seats were decorated in the greatest possible magnificence. Much of the ritual and pomp of court society centred around the state bedchamber of the monarch, where, before 1689, silver furniture, including a balustrade around the bed, was complemented by bed hangings laden with threads of silver and gold. The bed furniture consisted of layer upon layer of curtains, valances and counterpanes. The posts were entirely sheathed with fabric and capped with ostrich plumes. Drapery also figured at times of mourning, when state bedrooms were draped in black or purple—indeed, such hangings were available for hire.

Princes all over Europe sought to emulate Louis XIV's court and high style of decoration. Among the designers who made this an international style was Daniel Marot, a Huguenot closely associated with a corps of Parisian artists and craftsmen working on royal commissions, who fled to Holland in 1684 in anticipation of the revocation of the Edict of Nantes. Marot's engraved designs for William, prince of Orange, and later for William and Mary of England, include many room interiors, curtain designs and several massively draped beds of fantastic invention. The upholsterer was responsible for the fabrication of these designs, which often included valances and headboards of carved wood covered with cloth and bedecked with tassels, fringe and galloon. An account of the furnishings of a room at Hampton Court, prepared for the prince of Wales in 1715, describes a "standing bed

BY COURTESY OF THE HENRY FRANCIS DU PONT WINTERTHUR MUSEUM

FIG. 1.—CURTAIN DESIGN FOR STATE BED BY DANIEL MAROT, AMSTERDAM; *c.* 1707

of State all compleat, the furniture of a Crimson Damask and a counter paine of the same and two pair of window curtains, cornishes and vallances, two armd. chairs, eight square stools, all stuffed and covered, the damask as the bed and all trimmed with a rich arras silk lace [braid] suitable and a case curtain to the bed of Crimson taffaty."

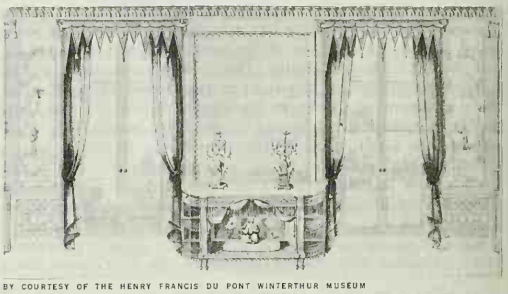
A little later many of William Hogarth's satirical prints showed curtains with scalloped, stiffened valances and applied scrolls of braid in contrasting colour. Other indications of the importance of drapery in this age are to be found in the elaborate sculptured tomb figures shrouded by curtains and palls of such realism that the textures of fur and satin can almost be identified. Countless *trompe l'oeil* wall and ceiling decorations show costly fabrics spilling over balustrades and billowing around columns.

Rococo.—The next European style to be developed, during the reign of Louis XV, was the rococo, with its playful decoration, pierced shells and frets, outward-flowing curves, restless movement, asymmetry and exotic flavour. The style was pre-eminently suited to interior decoration. Bed and matching window curtains were designed in a wide variety of fanciful forms, laden with ribbons, cords, braid, tassels and bows. The engraved work of François de Cuvilles, who helped introduce this style to southern Germany, shows beds designed to be placed lengthwise in an alcove lined with fabric to match the bed hangings. Bright yellow and silver are typical of the colours he chose for the Amalienburg, a hunting pavilion of the princes of Bavaria near Munich, considered a rococo masterpiece. Thomas Chippendale, whose name is synonymous with rococo in England, published in *The Gentleman and Cabinet Maker's Director* (1754) designs for beds in the Chinese or Gothic taste, as well as for field, dome, canopy and state beds. His "cornice for a Venetian window," his sofas and dressing tables canopied with overdrapes are characteristic of the upholsterer's art in the mid-18th century. Contemporary documents reveal the furnishing fabrics of this period—silk damask and patterned velvets in strong colours were used *en suite* for state rooms, but less expensive, strong woolen fabrics stamped with damask designs or pressed to give a moire effect were more generally used. For bed hangings and upholstery, needlework, both domestic and imported from the orient, was still fashionable. Block-printed textiles in floral patterns competed with painted and dyed cotton chintzes from India, especially for the furnishing of bedrooms.

Neoclassical and Romantic.—Soon after the middle of the 18th century Robert Adam's designs for interiors and decoration, based in large part on classical ornament, became popular in England, soon sweeping over the continent and to America as well. Adam in some cases designed not only the building and ornamentation of rooms, including elaborate plasterwork ceilings and often matching carpets, but also the furniture, lighting fixtures, hardware, drapery and colour schemes. Although the sources of his design are to be found in ancient art, he introduced a new vocabulary, harmonious and subtle, which influenced designers throughout Europe, who were ready to give up the fanciful and extravagant rococo fashion. The ornament of this lighter, more delicate and refined style consists principally of urns, arabesques, paterae, scrolling leaves or rinceau bands, garlands, swags and husks. In the arrangement of rooms, as in the disposition of veneered panels on furniture, Adam shows his mastery of invention in contrasting geometric shapes, whether lozenge, circular, rectangular or octagonal. Drapery, as used by Adam, provided contrast of texture and colour to the rich woods he employed. Bookcases with short festoons hung at the top, skirts of tables petticoated with swags, and upholstered sofas decorated with extra loops of material, often of a contrasting colour, are to be found in his designs. Indeed, wood inlay and carving often take on the form of drapery. Followers of his style in England were Thomas Sheraton and George Hepplewhite.

In the early 19th century the Directoire and Empire styles in France and the Regency in England had in common a continued interest on the part of architects and designers in archaeological discoveries and adaptations from ancient works, especially Greek but also including Egyptian. The growing romanticism led to other new fashions inspired by styles remote in space, as Indian and oriental, or in time, as Gothic. The tops of single windows were ornamented by naturalistic carved and gilded birds, leaves or bunches of grapes that held up the drapery. Bays of several full-length windows were united by a continuous pelmet of carved and gilded wood and a stiff valance with separate curtains falling to the floor. Plain, light-coloured silks were preferred, since they could be hung to good effect in swags and loops; depending ornaments were made of turned wooden buttons and spools covered with silk thread and netted together in a deep edging. With these rich draperies, curtains of fine white material with embroidered borders were hung next to the windows to diffuse the light (now called glass curtains). Four-post, French, tent and field beds were all lavishly draped, often in chintz designed in light floral patterns.

Victorian and Modern.—In the Victorian age, eclecticism was carried further, with many revivals of earlier styles. Voluminous window curtains were suspended by rings from heavy brass rods. Doors and windows were smothered with curtains and portieres, both of which further confined the already cluttered rooms, busy with floral and scroll patterns on the walls, carpets and upholstery, as well as on innumerable bits of needlework.



BY COURTESY OF THE HENRY FRANCIS DU PONT WINTERTHUR MUSEUM

FIG. 2.—DESIGN FOR WINDOW CURTAINS, FROM THOMAS SHERATON, THE CABINET-MAKER AND UPHOLSTERER'S DRAWING-BOOK, 3RD EDITION, LONDON; 1802

Beginning about the middle of the 19th century, the introduction of new building materials led to a rapid change in architecture. Covered arcades and halls were built with the entire roofs or walls of glass, held in metal frames. Windows in houses and apartment buildings as well as other structures became larger. To reduce glare and re-establish the feeling of enclosed space curtains were needed. Some mid-20th-century architects incorporated curtains as an integral part of a building in the form of concrete curtain walls designed in complex geometric patterns and "hung" outside these large expanses of glass, for ornament as well as function. Generally, however, modern draperies and curtains merely repeat 18th- and 19th-century forms in much simplified versions.

The increased use of reinforced concrete led to another 20th-century development in the erection of vast buildings with solid walls and no windows, lighted only artificially. In these, wall hangings serve important acoustic and decorative functions just as they did centuries earlier in covering rude masonry. Use of curtains to divide large open spaces into separate areas also has been revived.

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CURTEA DE ARGEŞ, a town of Rumania, administrative centre of the Curtea de Argeş district in the Argeş region, is located 32 km. (20 mi.) N.N.W. of Piteşti. Pop. (1956) 10,673.

Between the 14th and the 16th centuries it was the capital of Walachia.

The Domneasca church is said to have been erected on the ruins of a church built by Radu Negru, legendary founder of the feudal state of Walachia. The cathedral, in the Rumanian style with Byzantine influences, was founded in the 16th century by Neagoe Basarab and repeatedly reconstructed. According to the local folklore the builder of the cathedral, Master Manole, had his wife immured alive in the structure. The Sinnicoara and Cotmeana churches, the latter built by Prince Mircea the Old who is represented on the inner and outer frescoes, also date from the 16th century. In the neighbourhood are the ruins of the 13th-century Poienari citadel. Curtea de Argeş has timber-processing and clothing factories.

CURTIN, ANDREW GREGG (1817–1894), governor of Pennsylvania during the American Civil War, was born in Bellefonte, Pa., April 22, 1817. After graduation from Dickinson college (Carlisle, Pa.) in 1837, he practised law and entered state politics as a Whig. When that party foundered on the slavery issue, Curtin was elected governor of Pennsylvania in 1860 by a local party friendly to the Republicans.

From the outset of the Civil War, President Lincoln had no stronger supporter among the loyal governors. In May 1861, Curtin organized a military department for his state and rushed through an act providing for a volunteer reserve corps. Following the Union defeat at the first battle of Bull Run, he at once released this picked division to the national cause. The "Pennsylvania Reserves" fought for three years with the highest distinction. On Sept. 24, 1862, he brought together at Altoona, Pa., the governors of 16 loyal states to promote the common defense and prosecution of the war. This meeting followed Lincoln's Emancipation Proclamation by two days and thus strengthened the president's hand at a crucial time. Curtin was re-elected for a second term as governor in 1863 and served until 1867.

From 1869 to 1872 he served as minister to Russia. Later, in opposition to Pres. Ulysses S. Grant, he joined the Democratic party and represented it in the U.S. house of representatives from 1881 to 1887. He died at his birthplace Oct. 7, 1894.

See William H. Egle (ed.) *Andrew Gregg Curtin: His Life and Services* (1895); William B. Hesseltine, *Lincoln and the War Governors* (1948). (E. J. N.)

CURTIN, JOHN JOSEPH (1885–1945), Australian statesman who was prime minister during most of World War II, was born of Irish stock at Creswick, Victoria, on Jan. 8, 1885. As a young man he became active in Melbourne trade-union affairs and suffered imprisonment for campaigning against W. M. Hughes's conscription policy. In 1917 he was appointed editor of the *Westralian Worker;* his success was rewarded by election to the federal parliament in 1928. Defeated in 1931, he returned to parliament in 1934 and was rather surprisingly elected leader of the Labor party, then in opposition, in 1935. The next years were spent in a crusade to heal the divisions within the party caused by the strains of the 1930s. With this effected, Curtin was able to lead a united party into office in Sept. 1941, when his political opponents were unable to form a government. From the outbreak of World War II he had steadily refused to contemplate entering a coalition, and in the event this doubtless helped him establish a powerful government. The general election of 1943 gave Labor an unprecedented victory. As prime minister, Curtin devoted himself to the all-important task of bringing Australia safely through the war. To this end he imposed very strict controls over national manpower and resources. He clashed with Winston Churchill by withdrawing Australian troops from the middle east, but his most controversial action was his appeal to the U.S. as Australia's chief protector, Great Britain's traditional role, when the Japanese had entered the war and were advancing southward. He died at Canberra on July 5, 1945, just as the war was coming to a close. Already his government had projected the neo-Keynesian welfare-state policies which characterized Australia during its period of rapid postwar growth.

Curtin lived under intense nervous strain and tended to veer from extreme to extreme, from Roman Catholic belief to agnosticism and from pacifism to war leadership. Few politicians, however, have achieved their stated aims so completely.

See Alan Chester, *John Curtin* (1943). (O. M. R.)

CURTIS, CHARLES (1860–1936), U.S. lawyer, congressman and vice-president of the U.S. during the administration of Herbert Hoover, was born on Indian land later included in North Topeka, Shawnee county, Kan., on Jan. 25, 1860. His mother was half Indian, and his early youth was spent with the Kaw Indian tribe. He received a common school education, studied law and was admitted to the bar in 1881. He began practice in Topeka and served as county attorney (1884–88). Entering politics, he was elected in 1893 a Republican representative in congress, serving continuously until 1907 when he was elected U.S. senator. Unsuccessful in his candidacy for re-election in 1912 he was, however, elected to the senate for the term beginning March 4, 1915.

Curtis served as Republican whip of the senate (1915–24) and majority leader (1924–29). At the Republican national convention in 1928 he was nominated for the vice-presidency on the ticket with Herbert Hoover and was elected by the overwhelming majority of 444 to 87 electoral votes. He was renominated with Hoover in 1932, but the ticket went down to defeat in the November election. Curtis returned to the practice of law in Washington, D.C., where he died on Feb. 8, 1936.

CURTIS, CYRUS HERMANN KOTZSCHMAR (1850–1933), U.S. philanthropist and publisher, was born in Portland, Me., on June 18, 1850. As early as 1863 he began publishing in Portland a local weekly called *Young America.* When fire destroyed his plant, he moved to Boston, Mass., where he worked as a messenger, an advertising solicitor and as publisher of *The People's Ledger,* a magazine. He moved to Philadelphia, Pa., in 1876 and continued there the publication of the magazine. In 1879 he founded *The Tribune and Farmer,* from the women's section of which he formed a new magazine, *The Ladies' Home Journal.* In 1890, Curtis organized the Curtis Publishing company. Seven years later he purchased *The Saturday Evening Post* and in 1911 *The Country Gentleman.* In 1913 he purchased the *Philadelphia Public Ledger* and a year later began publication of the *Evening Public Ledger.* He bought the *Evening Telegraph* for its Associated Press membership, which he transferred to the *Evening Public Ledger.* Later he purchased the *Philadelphia Press* and the *North American,* both morning newspapers, and merged them with the Curtis papers. In 1924 he obtained possession of the *New York Evening Post;* in 1930, the *Philadelphia Inquirer.* He died on June 7, 1933.

CURTIS, GEORGE TICKNOR (1812–1894), prominent U.S. constitutional lawyer and historian of the mid-19th century, author of many legal treatises and several biographies.

He was a descendant of William and Sarah Curtis, who came to Boston in 1632. His grandfather's widow married Elisha Ticknor of Boston, who reared his stepchildren with the same care that he did his own son, George Ticknor. The latter became a professor of Spanish literature at Harvard and continued his father's interest in the next generation of the Curtis family, aiding and advising the two sons of his half brother, Benjamin Curtis. The elder of these children, Benjamin Robbins Curtis (1809–1874), practised law in Boston, became a justice of the U.S. supreme court and contributed one of the dissenting opinions in the Dred Scott case in 1857. In 1868 he served as legal counsel for Pres. Andrew Johnson in his impeachment trial. The younger child, George Ticknor Curtis, was born in Watertown, Mass., Nov. 28, 1812.

Curtis graduated from Harvard college in 1832, taught for a time and went to Harvard law school. He was admitted to the bar in 1836 and began to practise, first in Worcester and then in Boston. In 1862 he moved to New York where he had a large practice until his retirement in 1888. He defended Dred Scott before the supreme court on grounds that congress had the right to control slavery in the territories. He appeared also in the legal tender or greenback cases. He was patent attorney for such famous inventors as Charles Goodyear, Samuel F. B. Morse and Cyrus McCormick. In political opinion Curtis was at first a Whig and later a Democrat; he was critical of the administration during

the Civil War but remained a strong unionist. He was a member of the Massachusetts house of representatives (1840–1843) and was for some time U.S. commissioner in Massachusetts. As such it was his duty in 1852 to send Thomas Sims back to slavery in compliance with the Fugitive Slave law, despite his own antislavery sentiments. He did not later accept public office but used all his leisure time and the years after his retirement for research and writing, publishing an imposing number of legal treatises, several long biographies, and in 1889 under a pseudonym a novel, *John Chambers: a Tale of the Civil War*. He died in New York on March 28, 1894.

Curtis's best known work was in the field of U.S. constitutional history. This work, written from the classical Federalist-Whig point of view, went through many editions and revisions, the last published under the title, *The Constitutional History of the United States From Their Declaration of Independence to Their Civil War*. His legal treatises include *A Digest of Cases Adjudicated in the Courts of Admiralty of the United States and in the High Court of Admiralty in England* (1839); *Treatise on the Rights and Duties of Merchant Seamen* (1841); *Treatise on the Law of Copyright* (1847); *Treatise on the Law of Patents* (1849); and a two-volume work, *Commentaries on the Jurisdiction, Practice, and Peculiar Jurisprudence of the Courts of the United States* (1854–1858). His biographical works include the *Life of Daniel Webster* (two volumes, 1870), a *Life of James Buchanan* (two volumes, 1883) and two vindications of Gen. George McClelland (1886 and 1887). (A. F. Ty.)

CURTIS, GEORGE WILLIAM (1824–1892), U.S. author and editor and leader in civil service reform, was born in Providence, R.I., on Feb. 24, 1824. Early in life he spent two years as a boarder at the Brook Farm community and school. After living in New York and in Concord, Mass., for two years, to be near Emerson, he traveled in Europe, Egypt and Palestine. In 1850 he returned and joined the *New York Tribune*, to which, as the *Courier und Enquirer*, he had sent some letters from Europe. He became a popular lecturer and published *Nile Notes of a Howadji* (1851) and *The Howadji in Syria* (1852). As an associate editor of *Putnam's Monthly Magazine*, conductor of "The Lounger" in *Harper's Weekly* and "The Easy Chair" in *Harper's Magazine*, he wrote prolifically. Many of his essays were collected, chiefly in the *Potiphar Papers* (1853), a satire on fashionable society, and *Prue and I* (1856), a sentimental and humorous study of life.

In the period preceding the Civil War he subordinated other interests to those of national concern, beginning with a speech on current questions at Wesleyan university in 1856, and active participation in the presidential campaign. In 1863 he became political editor of *Harper's Weekly*. In succeeding years he was frequently offered nominations and appointments by the Republican party, but refused them all, until he was appointed chairman of the commission on civil service reform by Pres. Ulysses S. Grant in 1871. From then until his death he led this movement, and progress in the reform was mainly due to his sound judgment and forceful presentation of the evils of the political patronage system. In 1884 he refused to support James G. Blaine as candidate for the presidency and left the Republican party to become a typical Independent. In 1890 he was made chancellor of the University of New York. He died on Aug. 31, 1892.

See Gordon Milne, *George William Curtis and the Genteel Tradition* (1956).

CURTIS, LIONEL GEORGE (1872–1955), British administrator and author, advocate of imperial federation and of a world state, had considerable influence in the shaping of the commonwealth. He was born on March 7, 1872, and educated at Haileybury college and at New college, Oxford. He was called to the bar but began at once to take an interest in public affairs by making a study of the Poor law. He enlisted in the City Imperial volunteers in 1899 and fought in the South African War. His abilities as a student and administrator secured his appointment as secretary to Sir Alfred Milner, British high commissioner in South Africa, whose staff of gifted young men became known as "Milner's kindergarten." Curtis acted as town clerk of Johannesburg in 1901 and later filled various posts in the Transvaal government. In 1907 he resigned in order to work for the union of the four South African colonies, and began to develop his conception of a federal world order which occupied him for the rest of his life. He founded the quarterly *Round Table*, for the propagation of Liberal imperialist ideas, in 1910 and was appointed Beit lecturer in colonial history at Oxford in 1912. He published *The Commonwealth of Nations* in 1916 and was elected a fellow of All Souls college, Oxford, in 1921. After World War I, Curtis was secretary to the Irish conference (1921) and colonial office adviser on Ireland (1921–24). In 1920 he was a founder of the organization which became, in 1926, the Royal Institute of International Affairs at Chatham house, London. He also visited India and China, publishing books on both countries: *Dyarchy* (1920) and *The Capital Question of China* (1932). After 1932 he devoted himself to his major work, *Civitas Dei*, 3 vol. (1934–37), in which he described the organization of human society in a more advanced form from that of separate nations. Curtis continued to write until his death near Oxford on Nov. 24, 1955. (J. F. B.)

CURTISS, GLENN HAMMOND (1878–1930), whose contribution to the development of U.S. aviation was exceeded only by that of the Wright brothers, was born in Hammondsport, N.Y., May 21, 1878. In a curious parallel to the story of the Wrights, who began as bicycle mechanics, Curtiss began his career by building motors for bicycles. In 1904 he was asked to design and build a motor for the dirigible "California Arrow." His success brought an order to provide the motor for Dirigible No. 1 of the U.S. army. In 1908, in an airplane constructed by the Aerial Experiment Association of America under his supervision, he won the *Scientific American* trophy for the first public flight of a kilometre in the U.S., at a speed of "almost 40 miles an hour." In Jan. 1911 Curtiss took off and landed on water at San Diego, Calif., a plane that he had equipped with pontoons. A demonstration for the U.S. navy the following month brought him the first contract for U.S. navy planes. His factories, expanded in 1917, supplied military planes to Great Britain and Russia as well as the U.S. Curtiss died in Buffalo, N.Y., July 23, 1930.

CURTIUS, GEORG (1820–1885), German philologist, whose works were fundamental to the development of Greek linguistics, was born at Lübeck on April 16, 1820. He held philological appointments at Prague, Kiel and Leipzig. From 1878 Curtius was general editor of the *Leipziger Studien zur classischen Philologie*. His *Griechische Schulgrammatik*, first published in 1852, has passed through more than 20 editions and has been edited in English. In his last works, he attacked the neogrammarian school of philology. He died at Hermsdorf on Aug. 12, 1885.

His brother, Ernst Curtius (1814–1896), archaeologist and historian, was born at Lübeck on Sept. 2, 1814. After traveling in Greece he became, in 1844, an extraordinary professor at the University of Berlin and tutor to Prince Frederick William (afterward the emperor Frederick III). In 1874 he concluded an agreement by which the excavations at Olympia (*q.v.*) were entrusted to Germany. Curtius died at Berlin on July 11, 1896.

His best-known work is his *History of Greece* (1857–67). His other writings are chiefly archaeological. His collected speeches and lectures were published under the title of *Altertum und Gegenwart* (5th ed., 1903 *et seq.*).

Ernst Robert Curtius (1886–1956), romance philologist, was the son of Ernst Curtius. His work was instrumental in bringing modern European literature, particularly that of France, to the attention of the German public.

Bibliography.—See *Opuscula* of Georg Curtius, edited after his death by E. Windisch (*Kleine Schriften*, 1886–87). A full list of the writings of Ernst Curtius will be found in L. Gurlitt, *Erinnerungen an Ernst Curtius* (1902); F. Curtius, *Ernst Curtius, ein Lebensbild in Briefen* (1903); T. Hodgkin, *Ernst Curtius* (1905).

CURTIUS, MARCUS, a legendary hero of ancient Rome. It is said that in 362 B.C. a deep gulf opened in the forum, which the seers declared would never close until Rome's most valuable possession was thrown into it. Then Curtius, recognizing that nothing was more precious than a brave citizen, leaped, fully armed and on horseback, into the chasm, which immediately closed. The spot was afterward covered by a pond, dry by the

1st century B.C., called the *Lacus Curtius*. Alternative explanations of the name *Lacus Curtius* are given: (1) a Sabine general, Mettius Curtius, hard pressed by the Romans under Romulus, leaped into a swamp which covered the valley afterward occupied by the forum; (2) in 445 B.C. the spot was struck by lightning, and enclosed as sacred by the consul, Gaius Curtius.

See S. B. Platner and T. Ashby, *Topographical Dictionary of Ancient Rome*, p. 310 (1929).

CURULE, the epithet applied in ancient Rome to the chair of office, the *sella curulis*, used by the higher magistrates (and probably at one time by the king), who were termed "curule": the consul, praetor, curule aedile (*q.v.*), dictator, master of the horse, interrex and censor, and later the emperor. The chair was inlaid with ivory, had curved legs, was without a back, and could be folded. The chair was perhaps originally placed on a magistrate's chariot. A curule triumph was celebrated on a chariot. The chief municipal magistrates were also entitled to the curule chair.

(T. R. S. B.)

CURVES. A curve, in mathematics, is most easily thought of as the path of a point moving continuously with respect to both position and direction, except at special points where discontinuities of any kind may occur. Formerly the word *line* was used to include both curves and straight lines; in modern use it always means a straight line, and is a particular case of the more general term *curve* (*see* Line).

A curve may also be thought of, given in its entirety, as a single infinity of points. This point of view is the one adopted by mathematicians in the study of continuous curves (*see* Topology, *General*).

In either case, the idea becomes more definite when all the points of the curve, whether given successively or simultaneously, are regarded as obeying some sort of law. This law may be expressed by one or more equations between co-ordinates, involving certain functions of them which vanish. The curve is said to be *algebraic* or *transcendental* according to the nature of its equations in Cartesian co-ordinates. If it is algebraic, it has only a finite number of exceptional points, whereas a transcendental curve can have an infinite number (for example, *see* Curves, Special), and if its equation involves one of the highly discontinuous functions known to modern analysis it may lose all or nearly all of the properties usually associated with the idea of curve.

If P is an ordinary point of a plane curve, and Q is a neighbouring point, then as Q moves closer to P, the chord PQ approaches a definite limit called the *tangent* at P. The line through P perpendicular to the tangent is called the *normal*. Three points P,Q,R of the curve determine a circle, whose limit as Q and R approach P is the *circle of curvature* at P. The more sharply the curve bends, the smaller is this circle, and the reciprocal of its radius is the *curvature* at P, and is equal to the rate of rotation of the tangent (or normal) per unit length of arc described by P. The centre of the circle of curvature is also the limit of the intersection of adjacent normals. In the immediate neighbourhood of P, to a first approximation the curve can be replaced by the tangent, and to a second approximation by the circle of curvature.

By the principle of duality (*q.v.*) a curve can also be regarded as the envelope of its tangents. The tangent can be considered to be a line moving continuously in one plane according to some law; its intersection with a neighbouring tangent has a definite limit, which is the point of contact. Thus the tangent replaces the point as the element which generates the curve, and the point of contact replaces the tangent.

Curves in Space.—A *twisted curve*, also called *space curve* or *skew curve*, is one which does not lie wholly in one plane. If P,Q,R,S are four neighbouring points of a twisted curve, the planes PQR, QRS are in general distinct. The limit of PQR as Q and R approach P is the *osculating plane* at P. The normal is the perpendicular to the tangent in the osculating plane, and the common perpendicular to the tangent and normal is the *binormal*. The circle of curvature (limit of the circle PQR) lies in the osculating plane; but its centre is not the limit of intersection of adjacent normals, for these, lying in different osculating planes, do not meet in general. The four points P,Q,R,S determine a sphere through the circles PQR, QRS, the limit of whose centre is the *centre of spherical curvature* at P.

It is useful to think of the tangent, normal and binormal as a rigid frame of rectangular axes, with P as origin, moving forward and rotating as P describes the curve with unit velocity. At any moment, the angular velocity of the frame about the binormal is the curvature, and that about the tangent is the *torsion;* there is no instantaneous rotation about the normal.

The *degree* of an algebraic plane curve is that of its equation, and is the number of its intersections with a general line of the plane; its *class* is the number of its tangents through a general point. The degree of an algebraic twisted curve is the number of its points that lie in a general plane, and its class is the number of its osculating planes through a given point. An algebraic twisted curve has another important characteristic, the *rank*, which is the number of its tangent lines that meet a general line.

In space, the figure dual to a curve locus is a singly infinite set of planes obeying some given law. These planes form a *developable* surface (*see* Descriptive Geometry). Any plane of the set with any other one determines a line, and with any other two it determines a point.

Forms of Equations.—For the equation of a transcendental curve, there is often a simple expression in polar or other co-ordinates (for example, *see* Curves, Special: *Euler's Spiral*). In other cases (see *Cycloid* in the same article), the simplest form gives each co-ordinate in terms of a common parameter. The parametric expression is often useful for algebraic curves also. For example, by a proper choice of a system of homogeneous co-ordinates any twisted cubic can be represented by $x:y:z:w = 1:t:t^2:t^3$. Still another form of expression is in terms of the length of any arc and the angle between the tangents at its extremities; this is called the *intrinsic equation*, since it depends on no frame of reference unconnected with the curve.

Degenerations and Intersections.—The equation of a plane algebraic curve k of degree n in Cartesian or homogeneous co-ordinates contains $\frac{1}{2}(n+1)(n+2)$ coefficients, whose $\frac{1}{2}n(n+3)$ ratios are the independent parameters of the curve, regarded as a member of the whole plane family of curves of degree n. Any special type of plane algebraic curve can be obtained by making restrictions on these parameters; *e.g.*, the conditions for the three types of conic section (*q.v.*).

For certain sets of values of the parameters, the left-hand side of the equation factors, and each factor itself gives a separate curve. The product vanishes whenever any factor vanishes, and the equation is satisfied by the co-ordinates of a point on any one of these curves, and so represents their aggregate. In many cases it is convenient still to regard this as a single curve, which is then said to be *degenerate*. Thus a pair of intersecting lines is a degenerate conic. A curve which does not break up is said to be *proper*.

In the plane, any aggregate of curves can be regarded as a degenerate curve of degree equal to the sum of their separate degrees. In space this is not so unless the components satisfy certain conditions of incidence; for example, a pair of skew lines is not a degenerate conic. A conic and a line meeting it twice, and therefore lying in its plane, form a degenerate plane cubic; a conic and a line not in its plane, but meeting it once, form a degenerate twisted cubic; a conic and a line not meeting it, but meeting its plane at a point not lying on the conic, cannot be regarded as a single degenerate curve.

The common points of two curves of degrees n_1,n_2 are those whose co-ordinates satisfy both equations, and their number is n_1n_2. This continues to hold if one or both of the curves break up. Infinite curves approach one or more limiting tangents (called asymptotes).

Singularities.—The interest of any curve depends largely on its exceptional points, where the ordinary properties fail. A *singularity* or *singular point* of a curve k is a point where a unique, definite tangent does not exist. The simplest is an ordinary *double point* or *node* O, where two separate branches of k cross. Here there is not one definite tangent, but two, one belonging to each branch (*see* fig. 1). A moving point describing k comes to O

twice, on different occasions and in different directions. A general line l, passing near O but not through it, meets k at two points near O, one on each branch, both of which approach O when l moves so as to pass through O. If l is ultimately one of the tangents at O, three such intersections are absorbed—two on the branch touched, and one on the other.

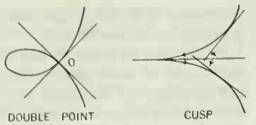

FIG. 1.—SINGULAR POINTS

In general, the *multiplicity* s of a singular point O is the number of intersections with a general line absorbed there. Through O there are always s lines, distinct or coincident, on which more than s intersections are absorbed, and which are the tangents at O. If the s tangents are distinct, the point O is *ordinary*. If O is s_1-fold on one curve and s_2-fold on another, it absorbs just $s_1 s_2$ of their points of intersection if they have no common tangent at O; if they touch, it may absorb any greater number.

If any of the s tangents coincide, O is an *extraordinary* singularity. The simplest is a *cusp* of the first kind, a variety of double point which may be thought of as the limit of a loop drawn together to its node. A point P describing k continuously comes to rest at O and reverses its direction of motion; for this reason a cusp is often called a *stationary point*. The tangent at P rotates in the same sense without reversal. A cusp is analogous to the path of an engine running past catch points to rest, and backing onto another pair of rails; that is, running forward on one branch of a Y and backing up on the other.

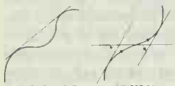

FIG. 2.—SINGULAR TANGENTS

A set of different but corresponding singularities presents itself when a curve is regarded as an envelope. A *singular tangent* is one which does not have a unique, definite point of contact. The line singularity which corresponds to an ordinary double point is a *double tangent*, with two distinct, definite points of contact, each a simple point of the curve (*see* fig. 2). That which corresponds to a cusp is an *inflection*, a singularity occurring when the two points of contact coincide and the tangent meets the curve in three coincident points. A tangent describing the envelope comes to rest and reverses its direction of rotation, but a point describing the curve goes on without reversing, for the inflection is a simple point of the curve.

Every singularity of a curve which is of higher multiplicity or more complicated nature than the four elementary kinds described above is, from a great many points of view, equivalent to a certain set of distinct double points, cusps, double tangents and inflections, and can usually be regarded as the limit of this set when certain points and lines come to coincide. Thus it is seen that a triple point can arise from three double points (*see* fig. 3).

FIG. 3.—TRIPLE POINT AS LIMIT OF THREE DOUBLE POINTS

Transformations; Genus.—Two curves, whether plane or twisted, are said to be in 1-1 correspondence, or transformations of each other, or represented upon each other, if each ordinary point of either corresponds to one and only one point of the other. If the co-ordinates of the first point are given, those of the second are one-valued and therefore rational functions of these; the equations expressing this are rationally reversible, so that the co-ordinates of the first point are also expressible as rational functions of those of the second. Any curve can be thus transformed into a plane curve having no multiple points except ordinary double points, or into a twisted curve having no singular points at all.

A plane curve of given degree n cannot have more double points or cusps than $\frac{1}{2}(n-1)(n-2)$, or their equivalent, without breaking up. Thus the only nodal conic is a pair of lines. A proper cubic can have only one node; if it had two, the line joining them would have four intersections with the cubic, which is impossible because the curve would break up into the line and a conic through the two points. The number

$$\rho \equiv \tfrac{1}{2}(n-1)(n-2) - \delta - \kappa$$

by which the equivalent number $\delta + \kappa$ of double points and cusps falls short of this maximum is called the *deficiency* of the curve, or more usually its *genus*. The fundamental property of the genus is that it is unaltered by any 1-1 transformation of the curve. If $\rho = 0$, the curve is *rational* or *unicursal*, and can be transformed into a line. The co-ordinates of its general point can be expressed as rational functions of a single parameter, the co-ordinate of the corresponding point on the line.

A 1-1 correspondence exists between a twisted curve k and its projection k' from any vertex V upon any plane. The singularities of k' are the projections of those of k and, in addition, a certain number of ordinary double points lying on lines through V which meet k at two distinct points. These latter points are called *apparent double points* of k, and their number is one of the essential characteristics of the curve, for it reduces the genus, being an additional number of singularities of k' whose genus is the same as that of k.

Plücker's Equations.—All plane curves other than lines and conics possess singularities of some sort. If they are free from multiple points, they are bound to have definite numbers of double tangents and inflections, or their equivalent in higher singular tangents. If multiple points are present, the numbers of multiple tangents are reduced. Between the degree n, class n', and the equivalent numbers δ, κ, δ', κ' of double points, cusps, double tangents and inflections there exists a remarkable set of relations known as Plücker's equations, by which any three of the six numbers can be calculated in terms of the other three:

$$n' = n(n-1) - 2\delta - 3\kappa$$
$$\kappa' - \kappa = 3(n' - n)$$
$$2(\delta' - \delta) = (n' - n)(n' + n - 9)$$

Thus the cubic with no node is of class 6 and has no double tangents and 9 inflections; the nodal cubic is of class 4 with 3 inflections; and the cuspidal cubic is of class 3 with one inflection. The quartic with no singular points has 28 double tangents and 24 inflections.

The points of contact of the n' tangents which can be drawn to k from any point P of the plane are the intersections, other than the multiple points of k, with a certain derived curve of degree $n-1$, called the *first polar* of P with regard to k. The first polar passes through each double point of k, meeting it in two points there, and touches k at each cusp, meeting it in three points there. The first of Plücker's equations expresses the fact that the total number of intersections of k with the first polar is $n(n-1)$. *See* also SURFACE; and references under "Curves" in the Index volume.

(H. P. HU.)

CURVES, SPECIAL. Partly due to the study of the Greeks in pure geometry, but largely due to the influence of analytic geometry and the calculus, there have been developed a large number of special curves which have received names more or less generally accepted by mathematicians. Such curves (*q.v.*) may be classified in various ways—curves in a plane or in three-dimensional space; algebraic and nonalgebraic; alphabetically, chronologically, etc. For the purposes of the present article, it has seemed best to give an initial alphabetical list with references to the numbers of the sections, and then to arrange the sections roughly in this order: plane algebraic curves according to degree, followed by plane transcendental curves, general classes of curves and curves of double curvature. The standard equations of the curves are given in rectangular and/or polar co-ordinates when appropriate, and the general shapes of the most important plane curves considered are shown by accompanying figures.

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Versiera, 7
Watt's Curve, 28
Witch of Agnesi, 7

A number of the more common curves are treated in separate articles (*see* CIRCLE; CONIC SECTION; ELLIPSE; HODOGRAPH; HYPERBOLA; PARABOLA).

1. Cubical Parabola, $y = ax^3 + bx^2 + cx + d$ or $y = ax^2(x - e)$, one of the canonical forms of cubics studied by Sir Isaac Newton. The special case $y = ax^3$ (fig. 1) was used by G. W. Leibniz (1675) and (for $a = 1$) by Gaspard Monge (1815).

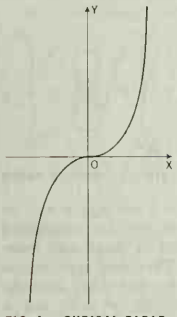

FIG. 1.—CUBICAL PARABOLA

2. Semicubical (or Neil's) Parabola, $x^3 = ay^2$. In 1687 Leibniz proposed to find the plane curve down which a particle may descend under the action of gravity so as to describe equal vertical spaces in equal times. Christiaan Huygens found that the semicubical parabola met this requirement, hence it is called an *isochronous curve*. For construction of points, *see* fig. 2.

3. Cissoid of Diocles, $y^2 = x^3/(2a - x)$ or $r = 2a \tan\theta/\sin\theta$, a curve invented by Diocles (*c.* 100 B.C.) in connection with the duplication of the cube (fig. 3).

4. Strophoid, $r = a \sin(\alpha - 2\theta)/\sin(\alpha - \theta)$ if oblique, was first considered by Isaac Barrow (1670). When $\alpha = 90°$ the strophoid is right, $r = a \cos 2\theta/\cos\theta$ or $y^2 = x^2(a - x)/(a + x)$. *See* fig. 4.

5. Folium of Descartes, $x^3 + y^3 = 3axy$, a curve with asymptote $x + y + a = 0$ (fig. 5) first discussed by René Descartes in 1638.

6. Trisectrix of Maclaurin, $x(x^2 + y^2) = a(y^2 - 3x^2)$ or $y^2 = x^2(3a + x)/(a - x)$ or $r = a \sec\theta - 4a \cos\theta = 2a \sin 3\theta/\sin 2\theta$, first studied by Colin Maclaurin (1742) in connection with the problem of trisecting an angle.

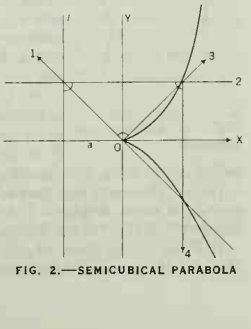

FIG. 2.—SEMICUBICAL PARABOLA

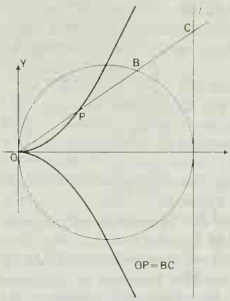

FIG. 3.—CISSOID OF DIOCLES

7. Witch of Agnesi or Versiera, $y(x^2 + a^2) = a^3$, discussed and named versiera by Maria Agnesi (1748), but treated earlier by Pierre de Fermat and Guido Grandi (1703).

8. Serpentine, $x^2y + aby - a^2x = 0$ $(ab > 0)$, studied and named by Newton (1701), and earlier (1692) by G. F. A. L'Hôpital and Huygens.

9. Trident of Newton or Parabola of Descartes, $xy = cx^3 + dx^2 + ex + f$. For one form of the curve, *see* fig. 6.

10. Cartesian or Cartesian Ovals. The locus of a point P whose distances r_1, r_2 from two points (foci, distance c between them) are connected by a linear relation $r_1 + mr_2 = a$ is a Cartesian curve or Cartesian oval (although it consists of two ovals; fig. 7). The equation of the curve in rectangular co-ordinates may be written as $[(x^2 + y^2)(1 - m^2) + 2m^2cx + a^2 - m^2c^2]^2 = 4a^2(x^2 + y^2)$. When $m = \pm 1$ the locus is a central conic; when $m = a/c$ a limaçon of Pascal results (*see* section 14). The curve originated with Descartes (1637) and was studied by Newton, Michel Chasles, Arthur Cayley, Gaston Darboux and others.

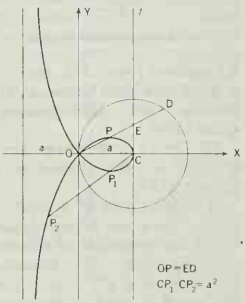

FIG. 4.—STROPHOID

11. Cassinian or Cassinian Ovals or Cassinian Ellipse, $(x^2 + y^2)^2 - 2a^2(x^2 - y^2) + a^4 - c^4 = 0$, first conceived by Giovanni Domenico Cassini (1680) in connection with the relative motions of the earth and the sun. The shape of the curve depends upon the ratio $c:a$. The curve may be defined as the locus of a point which moves so that the product of its distances from two fixed points (foci) A and B (*see* fig. 8) is a constant, c^2. When $c > a$ the curve consists of two loops; when $c = a$ the cassinian becomes the *lemniscate of Bernoulli* (*see* section 12). Those two cases, as well as two cases of $c < a$, are illustrated in fig. 8. The number of foci may be larger than two. By varying their number and their disposition, curves of odd shapes may be produced.

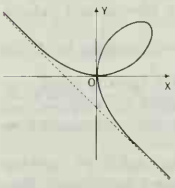

FIG. 5.—FOLIUM OF DESCARTES

12. Lemniscate of Bernoulli, first conceived by Jakob (Jacques) Bernoulli (1694), has the equation $(x^2 + y^2)^2 = a^2(x^2 - y^2)$ or, in polar form, $r^2 = a^2 \cos 2\theta$.

13. Conchoid (shell form), devised by Nicomedes (*c.* 240 B.C.) in connection with the problem of duplication of the cube. Its equation is $(x - b)^2(x^2 + y^2) - a^2x^2 = 0$ or $r = a + b \sec\theta$. Nicomedes apparently recognized the three types of the curve shown in fig. 9.

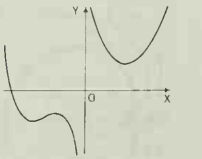

FIG. 6.—TRIDENT OF NEWTON

14. Limaçon of Pascal, discovered by Étienne Pascal (father of Blaise) and named by G. P. Roberval (1650). Its equation may be written as $(x^2 + y^2 - 2ax)^2 = b^2(x^2 + y^2)$ or $r = b + 2a \cos\theta$. The three forms of the curve shown in fig. 10 correspond to (1) $b > 2a$, (2) $b = 2a$, (3) $b = a$.

15. Cardioid (*see* curve 2 in fig. 10), a curve whose Cartesian,

polar and parametric equations are: $(x^2 + y^2 - 2ax)^2 = 4a^2(x^2 + y^2)$; $r = 2a(1 + \cos\theta)$; $x = a(2\cos\theta - \cos 2\theta)$, $y = a(2\sin\theta - \sin 2\theta)$.

16. Tricuspid or Deltoid: $x = a(2\cos\theta + \cos 2\theta)$, $y = a(2\sin\theta - \sin 2\theta)$; or $(x^2 + y^2 - 12ax + 9a^2)^2 + 4a(2x - 3a)^2 = 0$. The tricuspid (fig. 11) was first conceived by Leonhard Euler (1745).

17. Simple Folium, Double Folium, Trifolium: $(x^2 + y^2)[y^2 + x(x + b)] = 4axy^2$ or $r = -b\cos\theta + 4a\cos\theta\sin^2\theta$. The simple folium, double folium and trifolium correspond to $b = 4a$, $b = 0$, $b = a$.

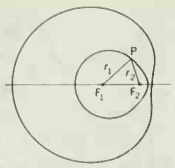

FIG. 7.—CARTESIAN OVALS

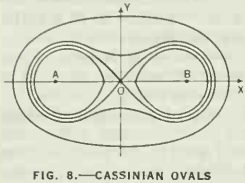

FIG. 8.—CASSINIAN OVALS

18. Bicorn or Cocked Hat (fig. 12). This term has been applied to two different quartics: (a) $2y^4 - 9y^3 - 17y^2 + 125y - xy^3 - 29xy^2 + 205xy + 72x^2y - 27x^3 - 25x^2 = 0$, named bicorn and discussed by James Joseph Sylvester (1864) and by Cayley (1867); (b) $y^2(a^2 - x^2) = x^2 + a(2y - a)^2$, referred to as a cocked hat in *Educational Times*, Feb. 1896.

19. Bullet-Nose Curve, $a^2/x^2 - b^2/y^2 = 1$, discussed by P. H. Schoute (1885). The equation $a^2/x^2 + b^2/y^2 = 1$ represents the *Cross Curve*.

20. Devil's Curve or Devil on Two Sticks (fig. 13), $y^4 + my^2 - x^4 + nx^2 = 0$, first studied by G. Cramer (1750).

21. Eight Curve, $x^4 = a^2(x^2 - y^2)$ or $r^2 = a^2\cos 2\theta\cos^4\theta$, also called the *lemniscate of Gerono*.

22. Kampyle of Eudoxus, $a^2x^4 = b^4(x^2 + y^2)$ or $r = b^2/(a\cos^2\theta)$, used in connection with the problem of duplication of the cube (fig. 14).

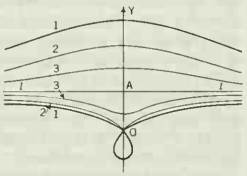

FIG. 9.—CONCHOID

23. Kappa Curve or Gutschoven's Curve, $y^2(x^2 + y^2) = a^2x^2$ or $r = a\cot\theta$, conceived by G. van Gutschoven (*c.* 1662) and studied by Newton and Johann (Jean) Bernoulli.

24. Pear-Shaped Quartic, $b^2y^2 = x^3(a - x)$, studied by G. de Longchamps (1886).

25. Nephroid (kidney-shaped), $(x^2 + y^2 - 4a^2)^3 = 108a^4y^2$ or $(r/2a)^{\frac{1}{3}} = (\sin\frac{1}{2}\theta)^{\frac{1}{3}} + (\cos\frac{1}{2}\theta)^{\frac{1}{3}}$, discovered by Huygens and Ehrenfried Walther Tschirnhausen (1678–90) and studied by Jakob Bernoulli (1692).

26. Astroid or Tetracuspid (fig. 15), $(x^2 + y^2 - a^2)^3 + 27a^2x^2y^2 = 0$ or $x^{\frac{1}{3}} + y^{\frac{1}{3}} = a^{\frac{1}{3}}$, first discussed by Johann Bernoulli (1691–92).

27. Cayley's Sextic, $4(x^2 + y^2 - ax)^3 = 27a^2(x^2 + y^2)^2$ or $r = 4a\cos^3(\theta/3)$, discovered by Maclaurin (1718) and studied in detail by Cayley.

28. Watt's Curve, the sextic curve generated by a point P of the side BC of a three-bar linkage AB, BC, CD, the points A and B remaining fixed while the others vary (fig. 16). If O is the midpoint of AD, and AO = a, AB = CD = b, BP = PC = c, the polar equation of the locus of P is $r^2 = b^2 - [a\sin\theta \pm (c^2 - a^2\cos^2\theta)^{\frac{1}{2}}]^2$, θ varying from 0 to π.

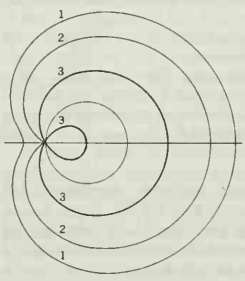

FIG. 10.—LIMAÇON OF PASCAL

29. Pearls of Sluze, $y^n = k(a - x)^p x^m$ (m, n, p are positive integers), studied by Baron René Française de Sluze (1657–58) and named by Blaise Pascal.

30. Lamé Curves, the family of curves $(x/a)^n + (y/b)^n = 1$ discussed in 1818 by Gabriel Lamé (1795–1870). The curves are algebraic or transcendental depending on whether n is rational or irrational.

31. Rhodonea, curves $r = a\cos k\theta$ or $r = a\sin k\theta$, named by Grandi (1723–28) because of their fancied resemblance to roses. When k is an integer there are k or $2k$ petals of the rose curves depending on whether k is odd or even. The number of petals is finite or infinite depending on whether k is rational or irrational. Several curves corresponding to particular values of k have attracted special attention.

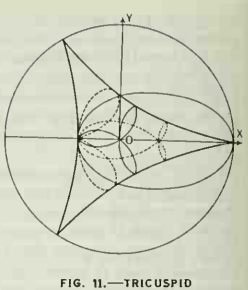

FIG. 11.—TRICUSPID

32. Curve of Pursuit or Pursuit Curve. If a point A describes a known curve (A), the curve (P) described by a point P is a curve of pursuit if the motion of P is always directed toward A and if both A and P move with uniform velocities. The problem of the pursuit curve was first formulated and solved by Pierre Bouguer in 1732. If (A) is a straight line, the equation of (P) may be put in the form $y = \frac{1}{2}[cx^{m+1}/(m + 1)/(m - 1)(cx^{m-1})]$ if $m \neq 1$, and $y = \frac{1}{2}[(cx^2/2) - \frac{1}{2}\log x]$ if $m = 1$. A study of this curve was made by Arthur Bernhart.

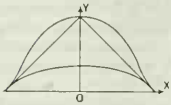

FIG. 12.—BICORN OR COCKED HAT

33. Epicycloid and Hypocycloid. The epicycloid (hypocycloid) is the curve traced out by a point P on the circumference of a circle (B) of radius b which rolls without slipping on the exterior (interior) of a fixed circle (A) of radius a. The parametric equations of the epicycloid and the hypocycloid are respectively:

$$x = (a + b)\cos\phi - h\cos[(a + b)\phi/b]$$
$$y = (a + b)\sin\phi - h\sin[(a + b)\phi/b]$$

$$x = (a - b)\cos\phi + h\cos[(a - b)\phi/b]$$
$$y = (a - b)\sin\phi - h\sin[(a - b)\phi/b]$$

When the point P lies in the plane of (B) but not on the circumference, it generates *epitrochoids* and *hypotrochoids*.

These four kinds of curves attracted the attention of Philippe de la Hire, Gérard Desargues, Leibniz, Newton and others. They admit as special cases many well-known curves such as the cardioid and the deltoid.

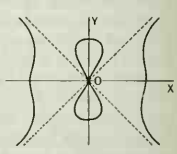

FIG. 13.—DEVIL'S CURVE

34. Bowditch Curves or Lissajous Curves (fig. 17), $x = a\sin(m_1u + n_1)$, $y = b\sin(m_2u + n_2)$, or $x = a\sin(nt + c)$, $y = b\sin t$. These curves were first considered by Nathaniel Bowditch (1815) and studied in detail and independently by J. A. Lissajous (1857–58). They find applications in astronomy, physics and other sciences.

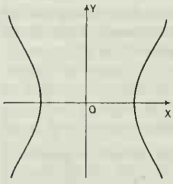

FIG. 14.—KAMPYLE OF EUDOXUS

35. Sinusoidal Spirals, $r^n = a^n\cos n$ (where n is a rational number, positive or negative), first studied by Maclaurin (1718, 1720). For $n = 1$, $+1$, $-\frac{1}{2}$, -2 and $+2$, the curve is, respectively, a line, a circle, a parabola, an equilateral hyperbola and a lemniscate of Bernoulli, a cardioid, ...

36. Cycloid, $x = a(\phi - \sin\phi)$, $y = a(1 - \cos\phi)$, one of the most celebrated of all special curves, is the locus of a point P on the circumference of a circle (C) of radius a that rolls, without slipping, along a straight line (*see* fig. 18[A]). The curve was studied by Galileo Galilei (*c.* 1599), who gave it its name, Roberval (1634), Sir Christopher Wren (1658), Huygens (1673), Johann Bernoulli (1696) and others.

If P lies in the plane of (C) at a distance h from the centre, ($h \neq a$), the parametric equations of the locus of P are $x = a\theta +$

$h \sin\theta, y = a - h\cos\theta$. The curves are *trochoids*, that is, curtate or oblate cycloids, depending on whether $h < a$ or $h > a$ (fig. 18[B]).

37. Euler's Spiral or Clothoid or Cornu's Spiral (fig. 19),

$$x = \frac{a}{2^{\frac{1}{2}}}\int_0^v \frac{\sin v\,dv}{v^{\frac{1}{2}}},\quad y = \frac{a}{2^{\frac{1}{2}}}\int_0^v \frac{\cos v\,dv}{v^{\frac{1}{2}}},$$

discovered and studied by Euler (1744).

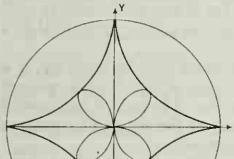

FIG. 18.—ASTROID OR TETRACUSPID

38. The family of curves $r^m = a^m\theta$ (fig. 20) includes four notable curves: (a) Spiral of Archimedes ($m = 1$); (b) Fermat's Spiral ($m = 2$); (c) Hyperbolic or Reciprocal Spiral ($m = -1$); (d) Lituus ($m = -2$).

(a) $r = a\theta$, discussed by Archimedes (*c.* 225 B.C.).

(b) $r^2 = a^2\theta$, discussed by Fermat (1636).

(c) The hyperbolic spiral $r\theta = a$, originated with Pierre Varignon in 1704 and studied in detail by Johann Bernoulli (1710–13) and Roger Cotes (1722).

(d) The lituus $r^2\theta = a^2$, originated with Cotes (1722). It is the locus of the point P moving in such a manner that the area of the circular sector POP′ remains constant.

39. Involute of a Circle, the roulette (*see* section 55) of a point P on a straight line which rolls on a circle of centre O. Its parametric equations are: $x = a(\cos\phi + \phi\sin\phi)$, $y = a(\sin\phi - \phi\cos\phi)$. It was conceived by Huygens when he was considering clocks without pendulums which might be of service on seagoing vessels.

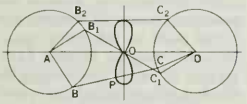

FIG. 16.—WATT'S CURVE

40. Cochleoid (snail form) (fig. 21), $r = a(\sin\theta)/\theta$. The points of contact of parallel tangents to the cochleoid lie on a strophoid (*see* section 4).

41. Logarithmic (or Equiangular or Logistic) Spiral, first discussed by Descartes (1638) as the curve cutting radius vectors from a fixed point O under a constant angle ϕ. The polar equation of the curve is $r = ke^{c\theta}$, where $c = \cot\phi$. The form of the curve depends on c and is independent of k (fig. 22).

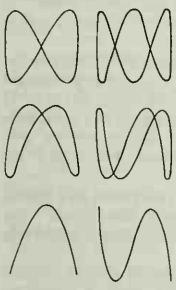
FIG. 17.—BOWDITCH CURVES

The pole O is an asymptotic point (Evangelista Torricelli, 1646). The pedal (*see* section 53) of a logarithmic spiral with respect to its pole is a logarithmic spiral and its evolute (*see* section 50) is an equal spiral with the same asymptotic point (Jakob Bernoulli, 1691–93).

42. Frequency Curve or Probability Curve or Gaussian Curve or Normal Curve of Errors, the name applied to the bell-shaped curve whose most common Cartesian equation is $y = (2\pi)^{-\frac{1}{2}}e^{-\frac{1}{2}x^2}$. This curve originated, in essence, with Abraham de Moivre (1733); it has been connected more particularly with P. S. Laplace and C. F. Gauss.

The term "frequency curves" is applied to a great variety of curves; *see*, for example, W. P. Elderton, *Frequency Curves and Correlation*, 4th ed. (1953).

43. Logarithmic (or Logistic) Curve, $x = a\log(y/m)$ or $y = me^{x/a}$. The curve originated about 1640. The subtangent of the curve is equal to a, regardless of the value of m.

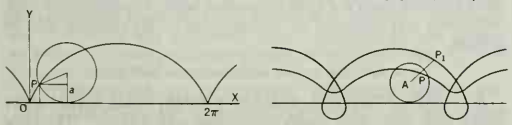

FIG. 18.—CYCLOIDS

44. Catenary or Chainette (fig. 23), the form which a perfectly flexible chain assumes when suspended by its ends and acted upon by gravity alone. Its equation, obtained by Leibniz and Huygens in 1691, can be written $y = \frac{1}{2}a(e^{x/a} + e^{-x/a}) = a\cosh(x/a)$. The tangents at P, P_1 and P_2 on the figure are concurrent. A catenary revolved about its asymptote generates a *catenoid*, the only minimal surface of revolution (Euler, 1744).

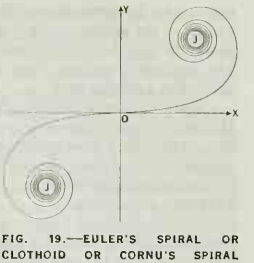

FIG. 19.—EULER'S SPIRAL OR CLOTHOID OR CORNU'S SPIRAL

45. Tractrix or Tractory or Equitangential Curve, (fig. 24), being equitangential (PN = a), is defined by the equation $y^2(1 + y^2) = a^2y^2$ or $x = a(\cos u + \log\tan[u/2])$, $y = a\sin u$. The curve was studied in detail by Huygens (1692) and by Leibniz, Johann Bernoulli and others. The evolute (*see* section 50) of the tractrix is a catenary (*see* section 44). The tractrix revolved about its asymptote generates a *pseudosphere*, a surface of constant negative curvature (Eugenio Beltrami, 1865) of interest in connection with non-Euclidean geometry.

46. Quadratrix of Hippias, $y = x\cot(\pi x/2a)$ or $r\sin\theta = (2a/\pi)\theta$, a curve discovered by Hippias of Elis (*c.* 430 B.C.) which may have been used by him and by Dinostratus (*c.* 350 B.C.) for trisecting an angle and for squaring the circle. The curve may be used for dividing an angle into any number of equal parts.

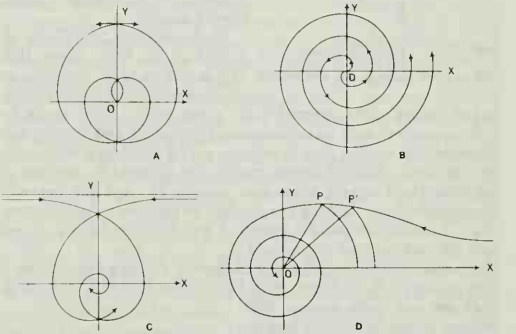

FIG. 20.—FAMILY OF CURVES DERIVED FROM $r^m = a^m\theta$: (A) SPIRAL OF ARCHIMEDES; (B) FERMAT'S SPIRAL; (C) HYPERBOLA; (D) LITUUS

47. Anallagmatic Curve, first discussed by T. Moutard (1827–1901) in 1864, a curve which is invariant under inversion (*see* section 51), such as the limaçon, cardioid, Cartesian, cassinian, strophoid, trisectrix of Maclaurin, etc.

48. Brachistochrone, the curve along which a body moves from a point A to a point B under the action of an accelerating force in the least time possible. In 1696 Johann Bernoulli proposed the question as a challenge, the accelerating force being gravity. Leibniz, Newton, Jakob Bernoulli and L'Hôpital found that the cycloid has the required property.

49. Caustic. When the light rays emanating from a source S are reflected by a given curve, the envelope of the reflected rays is the *caustic by reflection* or *catacaustic* of the given curve with respect to the source in question. When the rays from S are refracted by a given curve, the envelope of refracted rays is called

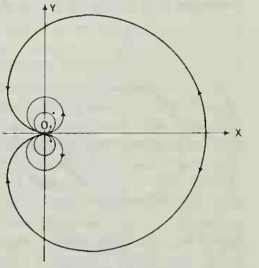

FIG. 21.—COCHLEOID

the *caustic by refraction* or *diacaustic* of the given curve for the source in question. Catacaustic and diacaustic surfaces may be defined in a similar way.

Caustic curves originated with Huygens and Tschirnhausen about 1678; they were studied by Johann and Jakob Bernoulli, L'Hôpital, Adolphe Quételet, J. L. Lagrange and others.

The catacaustic of a circle is a nephroid (*see* section 25), a limaçon (*see* section 14) or a cardioid (*see* section 15), depending on whether the source of light S is at an infinite distance (that is, when the incident rays are parallel) (Huygens, 1678), a finite distance (Thomas de St. Laurent, 1826) or on the circumference of the circle (Johann and Jakob Bernoulli, 1692).

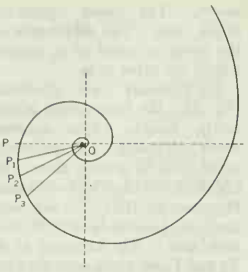

FIG. 22.—LOGARITHMIC SPIRAL

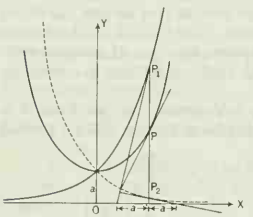

FIG. 23.—CATENARY OR CHAINETTE

50. Evolute. This is the envelope of the normals of a given curve (C) or, what amounts to the same thing, the locus of the centres of curvature of (C). The concept of the evolute originated with Huygens (1673); however, *see* Apollonius of Perga, *Conics*, book v.

If the evolute of (C) is regarded as the basic curve, then (C) is said to be an *involute;* an involute of a curve is an orthogonal trajectory of the tangents to the given curve. There are an infinite number of such trajectories to a given curve, and they are said to be *parallel curves;* that is, any two cut off equal lengths on common normals. Parallel curves may be very different in appearance; for example, Cayley's sextic (*see* section 27) and the nephroid (*see* section 25). Leibniz was the first to consider parallel curves. Fig. 25 shows two parallel curves, 3 and 4, of an astroid, 2, and also the evolute, 1, of this astroid.

51. Inverse Curves. Given a fixed point O and a constant m, if two points P_1, P_2, collinear with O, are such that $OP_1 \cdot OP_2 = m$, they are said to be inverse with respect to one another, or homologous, in the inversion (O,m) having O for centre and m for constant of inversion. The points P_1, P_2 are on the same side of O if m is positive and on opposite sides if m is negative. If one of the points, say P_1, describes a curve C_1, the curve C_2 described by P_2 is the inverse C_1 in (O, m). The relation between C_1 and C_2 is obviously reciprocal, and the two may coincide (*see* section 47).

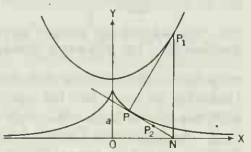

FIG. 24.—TRACTRIX OR TRACTORY OR EQUITANGENTIAL CURVE

52. Isoptic Curve. The locus of the points of intersection of tangents to a given curve (or a pair of curves) meeting at a constant angle is an isoptic curve of the given curve or curves. When the constant angle is right, the isotopic curve is said to be the *orthoptic curve*. The orthoptic of a parabola is its directrix, the orthoptic of a central conic is a circle concentric with the conic (the *Monge circle*) and the orthoptic of a deltoid (*see* section 16) is a circle.

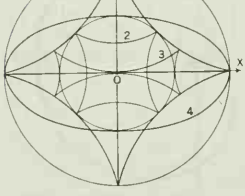

FIG. 25.—EVOLUTE

53. Pedal or Pedal Curve. The locus C_1 of the feet of the perpendiculars dropped from a fixed point O to the tangents of a given curve C is said to be the pedal curve of C for—or with respect to—the point O. The curve C is the first negative pedal curve of C_1 for the point O. The pedal curve C_2 of C_1 for O is the second positive pedal curve of C for O, and so on.

54. Radial or Radial Curve. If through a fixed point rectilinear segments are drawn equal and parallel to the radius of curvature of a variable point of a given curve C, the locus of the end points of those segments is the radial curve R of C (Robert Tucker, 1864). The degree of R is equal to the degree of the evolute of C (*see* section 50). The radial of a conic is a conic; the radial of a cycloid (*see* section 36) is a circle.

55. Roulette, the path of a fixed point—or the envelope of a fixed line—situated in the plane of a curve, which rolls, without slipping, on a fixed curve or straight line. The term is also applied to the locus of a variable point, such as the centre of curvature of the point of contact of the rolling curve.

The roulette of the vertex of a parabola rolling on an equal parabola is a cissoid of Diocles (*see* section 3). The pole of a hyperbolic spiral (*see* section 38) rolling on a straight line traces out a tractrix (*see* section 45) (A. Demoulin, 1891).

A related curve is the *glissette*, the locus of a point, or the envelope of a line, fixed in the plane of a curve made to slide between given curves. For instance, the locus of a point on a rod of fixed length whose ends slide on two fixed perpendicular lines is an ellipse. The envelope (glissette) of the rod itself is an astroid (*see* section 26).

56. Tautochrone, a curve down which a particle acted upon by specified forces will descend in the same amount of time from any initial point to the lowest point. When gravity is the force considered, Huygens showed (1673) that the inverted cycloid (*see* section 36) with axis vertical has the required property. The astroid and the cardioid are tautochrones under certain conditions.

57. Clelies. If ϕ and θ denote the longitude and colatitude of a point P on a sphere of radius a, and if P moves so that $\theta = m\phi$, where m is a constant, then the locus described by P is a clelie. The co-ordinates of P are

$$x = a \sin m\phi \cos \phi,\ y = a \sin m\phi \sin \phi,\ z = a \cos m\phi$$

The locus of P was studied by Grandi (1728), who used purely geometrical methods. Grandi also applied the term, "clelies" to the curves determined by the equations $a \sin\theta = b \sin m\phi$, $a \sin\theta = a - b \sin m\phi$.

58. Loxodrome or Rhumb Line or Spherical Helix, usually defined as the curve cutting the meridian of a sphere at a constant angle. The curve was first conceived by Pedro Nunes (1550). If β is the constant angle, and ϕ and θ the longitude and colatitude of a point on the loxodrome, its equation may be written $x = \sin\phi \cos\theta$, $y = \sin\phi \sin \theta$, $z = \cos\phi$, where $\theta = -\tan\beta \log \tan(\phi/2)$.

Nunes believed that a loxodrome joining two points on a sphere was the shortest distance on the sphere between those points. But 19th century mariners realized that great-circle sailing is preferable for short distances.

59. Helix, the curve cutting the generators of a right circular cylinder under a constant angle. If β is the constant angle, the equations of the curve are $x = a \cos \theta$, $y = a \sin \theta$, $z = a\theta \cot \beta$. The helix is mentioned by Geminus (*c.* 70 B.C.); a passage in Proclus (*c.* A.D. 460) suggests that it was known to Apollonius (*c.* 225 B.C.). It was used by Pappus of Alexandria (*c.* A.D. 300) for producing the quadratrix of Hippias of Elis (*see* section 46). The orthogonal projection of the helix on a plane parallel to the axis of the cylinder is a *sine curve*.

The curve which cuts the generators of a cone of revolution under a constant angle is a *cylindro-conical helix* or *conical loxodrome*, which was first discussed by Grandi (1701). Its equation may be written

$$x = he^{a\theta} \cos \theta,\ y = he^{a\theta} \sin \theta,\ z = he^{a\theta} \cot \beta$$

60. Skew (or Gauche, or Space, or Twisted) Cubic, a space curve which may have three points in common with a plane. The skew cubic may result from the intersection of two quadratic cones, or

of two ruled quadric surfaces having an element in common. It is in this form that the curve was first noticed (A. F. Möbius, 1827). The curve is the locus of the common point of three corresponding planes of three projective axial pencils of planes, or the locus of the common point of two corresponding and coplanar lines of two projective bundles.

A skew cubic is determined by six points, no four of them coplanar. The cone which projects a cubic from a point in space is of third degree, but reduces to second degree if the point is taken on the cubic.

A line in space may be met by four tangents to a skew cubic. A line joining two points, real or conjugate imaginary, of a skew cubic is a *secant* of the curve, while a line having one point in common with the curve is a *semi-secant* or *transversal*.

The skew cubic is also referred to as a *cubical conic section.* The three points of intersection of the curve with the plane at infinity may present the following four cases: (1) the three points are real and distinct; (2) one point is real and the other two are conjugate imaginary; (3) two of the points coincide; (4) all three coincide. The corresponding curves are: (1) *cubical hyperbola;* (2) *cubical ellipse;* (3) *cubical parabolic hyperbola;* (4) *cubical parabola.*

Bibliography.—A. B. Basset, *Elementary Treatise on Cubic and Quadric Curves* (1901); G. A. Bliss, *Calculus of Variations* (1925); J. L. Coolidge, *Treatise on Plane Algebraic Curves* (1931); Harold Hilton, *Plane Algebraic Curves*, 2nd ed. (1932); W. D. MacMillan, *Statics and the Dynamics of a Particle* (1958); Robert C. Yates, *Handbook on Curves and Their Properties* (1952). A considerable amount of information on special curves may be found in books and textbooks on analytic geometry, calculus, differential equations, calculus of variations and mechanics. (R. C. A.; N. A. Cr.)

CURWEN, JOHN (1816–1880), English music educationist and founder of the tonic sol-fa (*q.v.*) system of musical notation. Born on Nov. 14, 1816, at Heckmondwike, Yorkshire, the son of a Congregational minister, he was himself a minister from 1838 until 1864, when he began to devote himself to propagating his new method of musical nomenclature. This was designed to inculcate a sense of the relationship of notes to each other in the diatonic scale and to prepare the music student for a better conception of staff notation. Curwen adapted his system from that of Sarah Ann Glover (1785–1867), whose *Norwich Sol-fa System* (1845) used the syllables of the system of notations of Guido of Arezzo (*q.v.*), and he also adapted from the system of Aimé Paris (1798–1866) terms for the notation of rhythm. Curwen's method of teaching was founded on the attraction of notes to the tonic and, in modulation, to the principle of a shifting tonic ("the movable *doh*"). In 1853 he founded the Tonic Sol-fa association (later the English Schools Music association) and from then on his method was widely adopted in schools and choral societies. In 1863 he established a printing press for music and three years later became lecturer at Anderson's college, Glasgow. In 1879 the Tonic Sol-fa college (later the Curwen Memorial college) was opened. He died at Manchester on May 26, 1880. His son, John Spencer Curwen (1847–1916), succeeded him as director of the publishing firm and founded in England the competition festival movement for amateur musicians.

See H. W. Shaw, "The Teaching of John Curwen" in *Proceedings of the Royal Musical Association* (1950–51).

CURZOLA: *see* Korcula.

CURZON LINE, a proposed Polish-Soviet armistice line put forth on July 11, 1920, by Lord Curzon, the British foreign minister. It was based on the line established on Dec. 8, 1919, on the territory of the former Russian empire within which Poland was authorized to organize a regular administration. To the south, on the territory of the former Austrian empire, the Curzon line extended along the line A; *i.e.*, one of the two possible partition lines of Galicia between Poland and a Ukrainian state. Originally, the Curzon line was not meant to be a proposed eastern frontier of Poland. It was publicized as such during World War II. *See* Poland: *The People's Republic.*

CURZON OF KEDLESTON, GEORGE NATHANIEL CURZON, 1st Marquess (1859–1925), the last English statesman to belong in spirit to the 18th-century aristocracy, was viceroy of India from 1898 to 1905 and foreign secretary from 1919 to 1924. He was born on Jan. 11, 1859, at Kedleston hall, Derbyshire, eldest of the 11 children of the 4th Baron Scarsdale. His mother died when he was 16. His father was a silent, reserved, evangelical clergyman. Curzon as a boy came under the influence of a formidable governess who taught him hard work by her precept and parsimony by her example, and of a harsh preparatory-school master who crammed him with detailed knowledge. At Eton he was regarded as a prodigy. In 1878 he went to Balliol college, Oxford. In the same year he began to suffer from curvature of the spine, which gave him much pain all his life. It forced him to wear the steel corset from which he acquired that unbending rigidity of figure which seemed, as time went on, to communicate itself to the very processes of his mind. He became president of the Union and, although he failed to gain a first, he was elected in 1883 a fellow of All Souls college. Social life and travel engaged him for the next few years. In 1886 he entered parliament as a Conservative. In 1891 he became undersecretary for India, in 1895 for foreign affairs. Meanwhile he had traveled over America, central Asia, India, China and the middle east and published books based on his experiences. In 1895 he married Mary Leiter, the daughter of a U.S. millionaire. Her charm softened his asperity and her wealth enabled him to live in a style the splendour of which became almost legendary.

In 1898, still under 40, Curzon was appointed viceroy of India, taking office in the new year. His tenure was marked by great achievements but ended in frustration. He created the North-West Frontier province, reorganized Indian finance, established the imperial cadet corps, inaugurated the controversial policy of partitioning Bengal and set up commissions of inquiry on almost every aspect of government and administration. A believer in pomp and circumstance, he reached the apogee of his Indian career when he presided over the great durbar of 1903 held in honour of King Edward VII's coronation. He was reappointed in 1904, but a quarrel with the commander in chief, Lord Kitchener, over the powers of the military member of the viceroy's council resulted in his offering to resign. Kitchener, a past master of intrigue, had powerful allies in London. To Curzon's chagrin his resignation was accepted. He left India in Nov. 1905 bitter and disappointed. In 1906 Lady Curzon died. Curzon, a widower with three young daughters, plunged into inconsolable gloom.

There was little for an opposition peer to do, but in 1907 Curzon was able to seek distraction in the duties of chancellor of Oxford university to which position he had been elected after a contest with Lord Rosebery. He was an active chancellor and initiated useful reforms. In 1911 he was created Earl Curzon of Kedleston and Baron Ravensdale (with reversion to his eldest daughter in default of male heirs). He reappeared in politics as a leading opponent of H. H. Asquith's parliament bill, but he roused the hostility of the Tory die-hards by sensibly voting for the bill when it was clear that rejection could only result in a mass creation of Liberal peers. In May 1915 he became lord privy seal in Asquith's wartime coalition government. He strongly opposed the evacuation of Gallipoli. He as strongly supported conscription, even refusing the Garter till it had been introduced. When Asquith fell at the end of 1916, Curzon joined David Lloyd George's government as a member of the small inner war cabinet. He was kept occupied for the rest of the war, the cabinet meeting not less than 500 times between then and the Armistice. In 1917 he married Grace Hinds Duggan, daughter of a U.S. diplomat and widow of Alfred Duggan of Buenos Aires.

At the beginning of 1919 Curzon took temporary charge of the foreign office in Lord Balfour's absence at the Paris peace conference. In October Balfour resigned and Curzon became foreign secretary, thus fulfilling one of his major ambitions. He was much hampered by bad relations with the prime minister who in matters that interested him did not hesitate to conduct his own foreign policy behind Curzon's back. The worst example of this concerned conflict between Turkey and Greece. Curzon's policy of keeping the Turks out of Europe and the Greeks out of Asia was far more sensible than Lloyd George's encouragement of a Greek invasion of Asia Minor. Curzon, however, could not bring himself to resign on this issue and his threats to do so merely

earned him ridicule. Raymond Poincaré, French prime minister from early 1922, whom Curzon detested, fully exploited this weakness for his own pro-Turkish policy. In the late summer Lloyd George's philhellenic plans crashed in ruin with the utter defeat of the Greek forces and a Turkish threat to invade Europe. Lloyd George successfully threatened war with the Turks if this occurred, but on Curzon fell the task of negotiating with Poincaré arrangements for an armistice in Turkey. The coalition government was badly shaken by the crisis and the leaders, Curzon included, resolved to appeal to the electorate. A few days later, however, Lloyd George engaged in another secret maneuver behind Curzon's back and the latter resolved at last to resign. He joined Andrew Bonar Law, who became prime minister in Oct. 1922, and the foreign secretary could feel that he was at last master in his own house. He dominated the conference of Lausanne held to settle the Turkish affair during the winter of 1922–23 and, although he had to carry out his threat to leave by Feb. 4 if a treaty was not signed, he had already secured the main British interests.

In May 1923 ill-health forced Bonar Law to resign. Curzon expected to succeed him as prime minister but to his bitter disappointment he was passed over in favour of Stanley Baldwin—ostensibly on the ground that a peer could not be prime minister; in reality because Curzon's pomposity and apparent arrogance were considered handicaps in a democratic age. He showed great magnanimity in serving loyally under Baldwin till the latter's electoral defeat in the autumn of 1923. When Baldwin formed his second government in 1924 Curzon was not offered the foreign office, but he accepted the position of lord privy seal. On March 20, 1925, he died in London after a short illness. Curzon had been made a marquess in 1921. That title and the earldom now became extinct. The barony of Ravensdale descended to his eldest daughter.

If Curzon had had the gifts of character often possessed by persons of much lesser ability he might have reached the top. As it was he lacked determination; he was too inclined to lose himself in detail; he failed to realize that a memorandum, however brilliant, is not a substitute for action; and he always inspired a certain mistrust. His career, in Sir Harold Nicolson's words, was one of "successes rather than success."

See Earl of Ronaldshay, *The Life of Lord Curzon,* 3 vol. (1928); Harold Nicolson, *Curzon: the Last Phase, 1919–1925* (1934).
(R. N. W. B.)

CUSCATLÁN, most centrally located department of El Salvador. Area 283 sq.mi., pop. (1958 est.) 113,489, of which 75% was rural. The land is mostly rough, but rice, sugar, henequen and tobacco are grown. Sesame, fruits, vegetables and livestock are also produced. The departmental capital, Cojutepeque (pop. 18,247), was founded in 1571 and lies at an altitude of 2,625 ft., 21 mi. from San Salvador on the Inter-American highway. On Aug. 29 Cojutepeque celebrates the feast of St. John, which draws thousands of people to join in the festivities and to trade their wares. (C. F. J.)

CUSCO, Peru: *see* Cuzco.

CUSH, the eldest son of Ham in the Bible, from whom seems to have been derived the name of the Land of Cush, commonly rendered Ethiopia by the Septuagint and the Vulgate. The exact territory thus designated is uncertain, some maintaining that it lay in Africa, in which case it would be the country to the south of Aswan, others that it is in Arabia, while a third view associates the name with the Kassites (*q.v.*), who for several centuries dominated Babylonia. The various references suggest that the term may have been applied to districts in all three regions.

CUSHING, CALEB (1800–1879), U.S. lawyer, politician and diplomat, was born on Jan. 17, 1800, in Salisbury, Mass., of a distinguished colonial family. He graduated from Harvard at the age of 17, studied law and was admitted to the Massachusetts bar in 1821. Although retained in many important cases, he spent much of his mature career in public service. After several terms in the state legislature he was elected to congress as a Whig, holding his seat from 1835 to 1843. When Tyler succeeded to the presidency after Harrison's death in 1841, Cushing deserted the Whigs and allied himself with the Democrats. He was rewarded in 1843 with a nomination as secretary of the treasury but confirmation was refused by a hostile senate. He was then approved as U.S. commissioner to China where he negotiated the treaty of Wanghia (1844), establishing the principle of extraterritoriality. During the Mexican War he was a colonel and later a brigadier general of volunteers, marching with troops from Veracruz to Mexico City, but saw no action in the field. In 1847 and again in 1848 the Democrats nominated him for governor of Massachusetts but each time he failed of election. In 1852 he became an associate justice of the Massachusetts supreme judicial court.

Regarded as a "northern man of southern principles," he was named in 1853 by the Democratic president, Franklin Pierce, as U.S. attorney general, and became one of the most influential cabinet members. He was a natural choice as chairman of the Democratic national convention at Charleston in 1860 and continued to preside when seceders reconvened at Baltimore and nominated Breckinridge. With the outbreak of the American Civil War, however, he gave loyal support to Lincoln and the Union. He enjoyed the confidence of President Grant, who named him as counsel for the United States at the Geneva conference (1871–72) for the settlement of the so-called "Alabama" claims. In 1873 Grant nominated him as chief justice of the United States, but exposure by political foes of his earlier friendly relations with Jefferson Davis led to his rejection. From 1874 to 1877 he was U.S. minister to Spain. He died on Jan. 2, 1879, at his home in Newburyport, Mass.

Cushing published several books, the most important being *The Treaty of Washington* (1873). Scholarly in his tastes, he was also aggressive, politically ambitious and more respected than loved. He was a highly controversial figure who changed parties twice and played a conspicuous part in American affairs for half a century.

See C. M. Fuess, *The Life of Caleb Cushing* (1923). (C. M. F.)

CUSHING, HARVEY (1869–1939), U.S. surgeon noted for his work in neurological surgery, fourth in direct line of a family of physicians, was born at Cleveland, O., on April 8, 1869. He graduated from Yale university in 1891 and from the Harvard medical school in 1895. After four years at Johns Hopkins hospital he studied abroad under Kocher at Berne and Sherrington at Liverpool. On his return to Baltimore he held various positions in the department of surgery at Johns Hopkins university, becoming associate professor in charge of cases of surgery of the central nervous system. He wrote numerous monographs on the surgery of the brain and developed the method of operating with local anesthesia. His work on the pituitary body (1912) gave him an international reputation. He also made important contributions to the study of blood pressure in surgery and to the classification of brain tumours. From 1912 to 1932 Cushing was professor of surgery in the Harvard medical school and surgeon-in-chief at the Peter Bent Brigham hospital in Boston. During World War I he was director of a U.S. base hospital in France, and in 1918 was made senior consultant in neurological surgery to the American Expeditionary Forces. His *Life of Sir William Osler* (1925) received the Pulitzer prize for biography. From 1933 to 1937 he was Sterling professor of neurology at Yale university. Cushing died at New Haven, Conn., on Oct. 7, 1939.

CUSHING, WILLIAM BARKER (1842–1874), U.S. naval officer, noted for his exploits during the American Civil War, was born in Delafield, Wis., on Nov. 4, 1842. His father's early death forced him and his two brothers, who later displayed great gallantry in the army, to assist their mother. He was for a time a congressional page, but in 1857 received an appointment to the U.S. naval academy, from which he was obliged to resign in 1861 as the result of a prank played on one of his professors. The outbreak of the Civil War gave him, however, an opportunity to redeem himself, of which the self-styled "ex-midshipman, ex-master's mate, hare-brained scapegrace" took the fullest advantage. Coolness, daring, exceptional resourcefulness and good fortune, which caused the more superstitious of the sailors to believe him invulnerable, made him the hero of a series of spectacular feats. Foremost among them was the destruction of the Confederate ironclad "Albemarle" in the Roanoke river on Oct. 27,

1864. This vessel, which had done much damage to the Federal naval forces, was at anchor when Lieutenant Cushing in a steam launch succeeded in eluding the Confederate lookout and in exploding against her a spar torpedo with such success that she sank. Cushing's own launch was destroyed and the crew compelled to take to the water, only he and one other man escaping capture or death. For that achievement he was thanked by congress and made lieutenant-commander. He was promoted to commander at the early age of 30. Cushing died at Washington, D.C., on Dec. 17, 1874.

See a sketch by C. F. Stewart, which contains autobiographical material, in U.S. Naval Institute, *Proceedings*, vol. xxxviii, pp. 425–491, 913–991 (1912); T. W. Haight, *Three Wisconsin Cushings* (1910).

CUSHITE LANGUAGES, the name given to a group of languages spoken from the Red sea littoral to the area south of the Horn of east central Africa. *See* AFRICAN LANGUAGES: *The Hamito-Semitic (Afro-Asiatic) Languages.*

CUSHITIC PEOPLES, the Hamitic and partly semiticized inhabitants of the Horn of Africa. Physically like the Hamites (*q.v.*), the Cushites are generally of above-average stature, their facial features showing Caucasoid and Semitic rather than Negroid characteristics although the skin colour is often very dark. Despite a presumed common origin, their economy, culture and social organization vary widely, partly in relation to local climatic and ecological conditions and partly as a result of mixing with Semitic and Negroid peoples. They include peoples of such different culture as the egalitarian Somali nomads, the Tigre- and Tigrinya-speaking peoples, and the Amhara (*q.v.*) of the Eritrean and Ethiopian highlands with their highly developed agricultural system and complex hierarchical political structure. The Galla (*q.v.*), partly pastoralists and partly cultivators, occupy an intermediate position and, with their age-set political organization, differ sharply from their closely related neighbours, the Somali. The Sidama, an agricultural tribe in southwest Ethiopia, grow a wide range of crops and are traditionally organized in states ruled by divine kings.

Some "Cushitic" peoples speak Semitic languages. These are the Tigre-speaking peoples (the Beni 'Amer and Bait Asgade, Marya and Mensa); the Tigrinya speakers (the tribes of Akala Guzay, Hamasen, and Serae in Eritrea, and others in Ethiopia); and the Amharic-speaking Amhara and the Gurage. There are equally wide variations in material culture. In religion, however, a common strain is discernible in the cult of the Cushitic sky god (*zar* or *waq*), although submerged or transfigurated among the strongly Christian and Muslim communities. *See* also AFRICA: *Ethnography (Anthropology), Northeast Africa;* for the Cushitic languages *see* AFRICAN LANGUAGES: *The Hamito-Semitic (Afro-Asiatic) Languages.*

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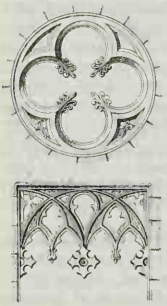
CUSHMAN, CHARLOTTE SAUNDERS (1816–1876), in her prime the foremost actress in the United States, was born in Boston, Mass., on July 23, 1816. At the age of 19 she made her operatic debut as Countess Almaviva in *The Marriage of Figaro,* and is said to have possessed a fine contralto voice. Her singing voice failed, however, and she switched to the dramatic stage, appearing successfully as Lady Macbeth in New Orleans, La. In 1837 she first played Meg Merrilies in *Guy Mannering,* her most popular role. Miss Cushman accompanied W. C. Macready on an extensive American tour, developing into a polished actress. In 1845 and again in 1854–55 she fulfilled successful engagements in London, where her Romeo, played opposite her sister Susan's Juliet, was applauded. Her best parts were Lady Macbeth, Hamlet, Cardinal Wolsey, Queen Katherine and the ever popular Meg Merrilies. Retiring to Italy in 1852, she spent the subsequent 18 years in farewell tours. She returned to the U.S. in 1870 and died in Boston on Feb. 17, 1876. Her acting was in the grand manner of David Garrick, and her commanding figure and voice were admirably suited to the rhetorical style. Although she was sometimes criticized for lacking femininity on the stage, she was generally regarded as being unsurpassed in the evocation of powerful emotions and sympathy.

See Emma Stebbins, *Charlotte Cushman* (1878); William Winter, *Other Days* (1908). (S. W. H.)



CUSPS: (ABOVE) EARLY ENGLISH; (BELOW) GOTHIC

CUSP, technically, the intersection of two curves; hence, in architecture, the intersections of lobed or scalloped forms, particularly in arches (cusped arches) and tracery. Thus the three lobes of a trefoil (clover-leaf form) are separated by three cusps. Cusped forms appear commonly in early Islamic work, as in the mosque of Ibn Tulun at Cairo (*c.* 875), and were especially common in the Moorish work of north Africa and Spain. The cusp is found occasionally in the Romanesque work of France, as in the chapel of St. Michel de l'Aiguille at Le Puy en Velay (probably late 11th century), due perhaps to influence from Spain, but it did not become popular until the Gothic period, during which it was used universally and frequently enriched with representations of leaves, flowers or even human heads at the tip.

CUSTARD APPLE, a name loosely applied to the fruit of various species of the genus *Annona* (family Annonaceae), shrubs or small trees of the new world tropics and Florida. The fruit of *A. reticulata,* the common custard apple, or bullock's heart of the West Indies, is dark brown in colour, and marked with depressions, which give it a quilted appearance; its pulp is reddish yellow, sweetish and very soft (hence the common name); the kernels of the seeds are said to be poisonous. The soursop (*q.v.*) is the fruit of *A. muricata,* native of the West Indies. The sweetsop (*q.v.*) is produced by *A. squamosa,* a native of tropical America and widely cultivated in the tropics. *A. cherimola* yields the Peruvian cherimoya, which is a much esteemed fruit of superior flavour. *A. glabra,* alligator apple or corkwood, a native of South America and the West Indies, is valued for its wood, which serves the same purposes as cork; the fruit, commonly known as the alligator apple or pond apple, is not eaten fresh but is sometimes used for making jellies. *See* ANNONACEAE; CHERIMOYA.

CUSTER, GEORGE ARMSTRONG (1839–1876), U.S. cavalry officer who was killed, along with all his men, in a battle with Indians in 1876. He was born in New Rumley, O., attended the U.S. military academy at West Point and graduated at the foot of his class in 1861. With the American Civil War then under way Custer was assigned to the cavalry, with which he took part in the first battle of Bull Run. From the very outset of the war Custer revealed daring and brilliance as a cavalry officer, and promotions were numerous and rapid. He was attached to the staff of Gen. George B. McClellan and later became brigadier general of a Michigan volunteer cavalry brigade that distinguished itself in the battle of Gettysburg. In 1864, when the cavalry corps of the Army of the Potomac was reorganized under Gen. Philip H. Sheridan, Custer was assigned to Sheridan, and throughout the remainder of the fighting the long-haired, dashing Custer skyrocketed in rank and in national renown. During the closing two weeks of the war it was Custer's relentless spearhead pressure on Gen. R. E. Lee that helped to hasten the surrender at Appomattox. Custer emerged from the war as one of the most brilliant cavalry leaders in the Union army.

In 1866 Custer was made lieutenant colonel of the 7th U.S. cavalry in the regular army and ordered to Kansas to take part under Gen. W. S. Hancock in an expedition against the Cheyenne Indians. A crushing defeat was inflicted upon the Indians at the Washita river in Nov. 1868. After five leisurely years during which he wrote *My Life on the Plains* (1874), Custer and the 7th regiment were ordered against the Sioux, led by Sitting Bull and Crazy Horse, in Dakota and Montana. Custer, in command of one

of two columns of a projected two-pronged attack, under the command of Gen. A. H. Terry, arrived near the huge Indian encampment on the Little Bighorn river on the night of June 24, 1876. The other column, commanded by Terry, was due to join the Custer forces two days later. But Custer disobeyed orders. Instead of effecting the rendezvous with Terry, Custer, on the morning of June 25, divided his command into three units and attacked the Indians. The central unit, commanded by Custer and consisting of 267 officers and men (including 5 civilians and 3 Indian scouts), rode into the midst of the enemy and was slaughtered. A single horse, "Comanche," survived and for years thereafter appeared at 7th cavalry parades, saddled but riderless.

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CUSTOM, in general, a practice that has become habitual. Thus a tradesman calls those who are accustomed to deal with him his customers and the resulting trade their custom. In the plural, the word is used for a tax or toll levied upon goods at the time of importation (*see* TARIFF).

In English law, a custom is an ancient rule of law for a particular locality, differing from the common law of the country. Traditionally, much of the common law was based on what had become customary in the country at large, and in this sense custom is indeed the mother of all institutions. But judges and lawyers probably contributed to it more of their own ideas of what was just and proper than is generally admitted, and in any case the term custom soon became confined to its modern meaning of local custom. As such, it tended to limit the growth of the universality and omnipotence of the central government. This state of affairs may be contrasted with the position in medieval Europe, where the legal systems were at first largely systems of local customary laws. At least in Spain, Germany and northern France, compilations had by the end of the 13th century reduced such customary law to writing, with many minor reforms; and this provided much support for a people's local law against the rulers' encouragement of the Roman legal tradition.

At common law the principal requirements for a valid custom are: (1) that it has been enjoyed as of right, peaceably, continuously and uninterruptedly from time immemorial; (2) that it is reasonable, certain and obligatory (*i.e.,* not such that persons may choose whether or not to be bound by it); (3) that it is confined to some defined locality. In some respects these requirements seem more stringent than they are. Thus, enjoyment from time immemorial (*i.e.,* from 1189) will be presumed from evidence of continuous enjoyment as far back as living testimony can go. A wide variety of customary rights may exist; *e.g.,* for the inhabitants of a parish or town to use certain land for games or recreation, or to pass over a path or road over certain land, or to repair roads, or to draw water. There can, however, be no custom to take soil or its produce, for this would be unreasonable, as tending to the destruction or exhaustion of the subject matter itself.

Custom must be distinguished from usage. A usage need not have existed from time immemorial, and it applies to a particular trade, business, profession or occupation and not to a locality. A usage must be certain, generally known, reasonable and not inconsistent with any positive rule of law. The usual effect of a usage is to annex certain terms and provisions to any contracts made between persons affected by it, or to attach particular meanings to terms used in those contracts. Usages exist in great variety and often relate to matters such as the payment of commissions, the delivery of goods, the operation of ports, the terms of employment and the payment of legal costs.

In the United States, custom played a small part. The developed English law was readily available, and except in Louisiana it was received throughout the country. The procedure was to modify the common law to suit American conditions rather than to accept customs as local exceptions to the common law. As settlers advanced further west, the novel conditions of life in mining communities and in desert country, and many fiercely competing interests, gave rise to a rapid growth of informal rules, many of which the courts and the legislatures soon turned into formal law. Usages, however, have a wide scope.

See COMMON LAW; *see* also references under "Custom" in the Index volume. (R. E. My.)

CUSTOMS: *see* TARIFFS.

CUTCH (KUTCH, KACHH), a former chief commissioner's state of India (area 17,060 sq.mi., including 8,424 sq.mi. of the Rann of Cutch), became a district of Bombay state in 1956 and of Gujarat in 1960. It is a peninsula lying between the Sir river, Sir creek and the Great Rann of Cutch on the northwest and the Gulf of Cutch on the east. A range of rocky hills crosses it from east to west and the country is bare and wild with a few cultivated fields near the villages. Summer temperatures are high, often 100°–105° F.; there are dust storms in April and May and the monsoon is unreliable. The many hill streams are almost dry except during the rainy seasons when they are full and rapid. Wells and springs near the Rann are saline, and elsewhere water is scarce and brackish. Eleven dams begun during the 1950s were designed to increase the irrigated land by 67,800 ac.

Some millet, barley, wheat, pulses and cotton are grown, and there are deposits of gypsum and beds of limestone and marble. Bhuj, the district capital (pop. [1961] 40,180) is inland, 190 mi. W. of Ahmedabad. The natural harbour of Kandla on the Gulf of Cutch has been developed as a major port to serve the northwest part of the republic of India. Bhuj is connected with the main Western railway (Delhi-Bombay) via Kandla and Palanpur.

The Gulf of Cutch, to the south, leads to the Little Rann of Cutch. An ocean port established at Okha at the western end of its southern shore was not a success and in 1948 the Indian government began the development of Kandla.

The Ranns (or Runns) of Cutch are two large areas of salt marsh bordering the state: the Great Rann to the north and the Little Rann to the southeast. They are dry in the hot season but flooded by brackish water during the southwest monsoon. There is some salt production. (*See* THAR DESERT.)

The People.—Tyranny, and famine and pestilence resulting from the uncertain rains, have contributed in the past to thin the population of Cutch. The inhabitants numbered 696,440 in 1961. One-quarter were Muslims and the remainder Hindus of various castes. The Jadeja Rajputs are the aristocracy of the country, claiming connection with the former rulers and descent from a prince who reigned in Sind about A.D. 900. These Rajputs were much influenced by their contacts with Islam. The artisans are celebrated for their ingenuity. The palace at Mandvi and a tomb of one of their princes at Bhuj are examples of their architectural skill. There are special manufactures of silverwork, silk and cotton and embroidery. The maritime population supplies good sailors. The language is Kachhi (or Kacchi), an Indo-Aryan tongue transitional between Sindhi (Sindi) and Gujarati (*qq.v.*).

History.—Little is known of the early history of Cutch. In the 13th century Samma Rajputs fleeing from Sind found asylum with the Chavada Rajputs of Cutch and about 1320 they overthrew their hosts. From 1540 to 1760 there was a United Rajput rule. Thereafter Muslim invasions from Sind led to a brief period of Muslim rule, and in 1813 a Rajput returned to power. In 1815 a British army invaded the Ranns and concluded a treaty with the ruler Maharao Bharmulji, stipulating that Anjar be ceded to them in perpetuity. Following this ruler's deposition in 1819 his infant son Rao Desalji II was enthroned. During his reign much was done to suppress infanticide, suttee (*q.v.*) and the slave trade in the state. Under British rule Cutch was first subject to the governor of Bombay. Later it was placed under an agency, and following Indian independence it was administered for the central government by a chief commissioner.

CUTHAH, an ancient city of Mesopotamia, mentioned in the Old Testament (II Kings xvii, 24), correctly identified by Sir Henry Rawlinson with the mound Tall Ibrahim, 20 mi. N. of the site of Kish and 35 mi. S.E. of the site of Sippar in central Iraq. A canal named the Irninna flowed past it. The mound is 60 ft.

high and 2 mi. in circumference. Cuthah was devoted to the cult of Nergal, the god of the lower world, who was worshiped in every Sumerian city. Cuthah, because of its sanctity, seems to have been kept in repair by all Sumerian and Semitic rulers down to the last few centuries before the Christian era.

See *Cambridge Ancient History,* vol. i, 2nd ed. (1924).

(M. E. L. M.)

CUTHBERT, SAINT (d. 687), prior and then bishop of Lindisfarne (*see* HOLY ISLAND), was a firm supporter of the synod of Whitby's decision about the date of Easter although himself trained in the Celtic church tradition. Probably a Northumbrian by birth, he was a shepherd before entering the monastery of Melrose in 651, where he became prior ten years later. In 664 he was transferred to Lindisfarne as prior after the departure of Colman (*q.v.*), but in 676 retired to Farne Island to devote himself to prayer. In 684 he was persuaded by Egfrith, king of Northumbria, to become bishop of Hexham, a see which he exchanged in 685 for that of Lindisfarne. In 687 he again retired to Farne Island, where he died on March 20, which is kept as his feast day. After many moves his remains finally were deposited in Durham (999). Cuthbert left on his contemporaries a deep impression of spirituality and love of his neighbours, fully vouched for by the sources for his biography, which are exceptionally good.

See B. Colgrave (ed.), *Two Lives of St. Cuthbert,* a life by an anonymous monk of Lindisfarne and Bede's prose life (1940); C. F. Battiscombe (ed.), *The Relics of St. Cuthbert* (1956).

CUTLASS FISH (HAIRTAIL), a marine fish of the family Trichiuridae, whose characteristics are a long bandlike body terminating in a threadlike tail, and strong prominent teeth in both jaws. One of the most widely distributed forms is the five-foot Atlantic cutlass fish (*Trichiurus lepturus*). *See* also FISHES.

CUTLER, MANASSEH (1742–1823), U.S. Congregationalist clergyman and a leading figure in the second Ohio company (*q.v.*), was born at Killingly, Conn., on May 13, 1742. He graduated from Yale in 1765, worked as a schoolteacher, whaling merchant and lawyer, and in 1771 entered the Congregationalist ministry, his major service being given to the congregation at Ipswich hamlet (now Hamilton, Mass.). He was cited for heroism as a Revolutionary War chaplain. In later years he supplemented his ministry by practising medicine and conducting a private boarding school. A versatile man, Cutler took a prominent part in organizing the Ohio company in 1786, and as its agent negotiated in 1787 a contract with the Continental Congress for the purchase of 1,500,000 ac. of public land around Marietta, O. It is frequently claimed that during these negotiations Cutler also acted as a leading author of the Northwest ordinance of 1787, but the available evidence does not support the claim. Cutler was a Federalist member of congress (1801–05), conducted investigations in astronomy, meteorology and botany, and won election to various learned societies. He died in Ipswich hamlet, July 28, 1823.

See W. P. and Julia P. Cutler, *The Life, Journals, and Correspondence of Manasseh Cutler* (1888). Edward Channing's *History of the United States,* vol. iii, pp. 541–543 (1912), says all that can be fairly said about Cutler's part in the Northwest ordinance. (Z. E. M. H.)

CUTLERY is the name given to various types of knives and cutting instruments used for domestic and manufacturing purposes. It includes razors, scissors, butchers' and cooks' knives, carving forks and steels used for sharpening knives. Table forks and spoons form another trade, although many manufacturers produce the whole range (*see* FLATWARE).

Early History and Development.—In prehistoric times, cutting tools and weapons used for hunting and defense were made from stones and flint. When man acquired a knowledge of the use of metals, cutting tools were made of bronze and iron. The Romans taught the early Britons how to work iron, and the Norman invaders are said to have brought with them many smiths and skilled metalworkers. Some of the early knives and weapons became famous for their perfection; for example, the skilfully produced Toledo and Damascus blades.

The bulk of the world's cutlery is produced in certain cities in the United Kingdom, France, Germany, Sweden, Italy and the United States. In the first three cases, this localization was largely due to the natural resources of Sheffield, Thiers and Solingen respectively. In each of these towns swiftly flowing streams were available for turning water wheels, the first major power units in the cutlery industry.

The name of Sheffield was associated with cutlery by the poet Chaucer (1328–1400) when, in describing a miller, he wrote: "A Scheffield thwitel baar he in his hose." A "thwitel" was the single-bladed "all-purpose" knife that every man carried.

In the United States there are important centres of cutlery manufacture, especially in the New England states. An interesting feature in the development of American cutlery production was the rapid adoption of machine processes and the passing of certain branches of the industry into the hands of some of the leading U.S. engineering firms. A similar movement in the direction of extended employment of machine methods also took place at Sheffield, Solingen and Thiers, notably at Sheffield between 1918 and 1923, following the discovery of stainless steel (*q.v.*) in 1912 by Harry Brearley. Previously, steel for cutlery, although of a high quality suitable for making into cutting implements, was easy to forge when red hot, either by means of mechanical hammers or by hand. (There were several thousand hand forgers of knife blades in each centre of production. The clanging of their hammers on the anvils set in stone blocks close to coke hearths blown by hand bellows was a feature of the industry.) Stainless steels, however, have to be heated to much higher temperatures than ordinary carbon steels before they become sufficiently malleable to be forged and this necessitated the redesigning of heating equipment. Coke hearths were superseded by gas and electric furnaces, by molten "salt" baths and later by electrical induction heating coils. Furthermore, stainless steels may be forged satisfactorily only within a small range of temperature. When stainless steels begin to cool, partial hardening in air takes place and forging must be stopped. Therefore, high-speed mechanical forging hammers were designed and developed to enable forging to be completed rapidly before the stainless steel could have time to cool and harden. Concurrently, better-quality steels were developed for the forging dies, which had to withstand harsher treatment. Between 1920 and 1930 the techniques of forging were revolutionized and the substitution of stainless steels for carbon steels spread rapidly from Sheffield to all the other manufacturing centres.

Types of Cutlery.—There are many types of cutlery, each having distinctive uses. They vary from small wafer blades used in safety razors to such larger cutting instruments as carving knives or tailors' shears, and they may be divided into the following classes: table knives, butcher and kitchen knives, pocketknives, scissors, razors, safety razors and miscellaneous cutting tools essential in other industries and trades such as rubber-tapping knives, machetes, knives for painters and leatherworkers, shears for weavers, etc.

In all these types the blade is the part that determines the usefulness of the tool or instrument. The sharpness of the blade depends on the quality of the steel employed in its production, and on the skill with which it is manipulated during manufacture. The quality of blade material and workmanship determines the final cost, although the cost also varies according to the material used for the handle and the amount of ornamentation it bears.

In the early days of the manufacture of high-grade cutlery both cast steel and shear steel were used, and the cutlery made from these steels is specially notable for the quality and durability of its cutting edge. Cutlery steel is iron with 0.35%–1% of carbon dissolved in it. Up to the 18th century partial solution of carbon in iron was achieved by repeatedly spreading charcoal on red-hot bars and hammering the carbon in, causing the iron to absorb it gradually and turn into steel. A more refined technique was to arrange bars of steel in layers with charcoal between and surrounding them and then to heat the whole stack for many hours. It was by this method that shear steel, famous for its cutting properties, was made.

In 1740 Benjamin Huntsman opened a steel works in Sheffield in which crucible-cast steel was made by dissolving carbon in molten iron. The local cutlers declared this steel to be too hard and refused to use it until they discovered that the cutlery coming from

continental Europe, made from Huntsman's crucible steel, was far superior to their own products.

In the 19th century open-hearth steel began to be used for table knives and scissors, but stainless steel came to be almost universally demanded. The word stainless is not a strictly accurate description of the properties of this steel, though it does resist corrosion from common household acids and alkalies to a remarkable degree. The resistance by the blade to corrosion depends on the chromium content of the steel (usually about 14%), on correct hardening and tempering and on the proper manipulation of the grinding and finishing processes.

Production of Table Cutlery.—Blades for table cutlery are produced in five successive production steps: (1) forging the steel into the desired shape, (2) hardening and tempering it correctly, (3) grinding the steel to a cutting edge and removing all traces of forging and heat treatment, (4) polishing the steel and (5) making, fitting and polishing the handle. The fifth step is also known as cutling.

Forging.—The better-quality knife blades are forged by mechanical hammers from bars of steel. By one method the ends of several bars are heated together in a gas-fired or electric furnace. One at a time the bars are removed and the red-hot end placed between forging dies that rapidly hammer out the rough blade shape desired. The first part of the forging operation is completed by "parting off" each blade on a knife edge incorporated with the forging dies, leaving a small portion of steel to be reheated and stamped into the bolster, or shoulder, shape selected. Usually each bar of steel remains red-hot long enough for two or three blades to be roughly forged and parted off. The cooling bar is returned to the furnace and one of the other red-hot bars is drawn out to be forged. The amount of steel utilized is so calculated beforehand as to leave a further small piece beyond the bolster that is forged out into the "tang," to which the handle will be attached later. The final blade shape is obtained by trimming the forgings with a pair of cutting tools in a machine press. Some knives are made as complete forgings of blade and handle by one stroke of a large drop-forging hammer; others, cut out from sheet steel so that a short flat tang without a forged bolster is left, are called "whittle tangs."

In Sheffield the mechanical forging of blades is called "goffing," said to be derived from the household goffering iron of the 16th century used to produce pleats in ruffles. The term was applied derisively to blades produced by the old tilt hammers because of the unevenness of the blades' surfaces compared with those of blades hand-forged by craftsmen. With the improvement in forging technique these defects were overcome but the term "goffing" continues in Sheffield to denote the mechanical forging of table-knife blades.

Hardening and Tempering.—After the blades are forged or cut out they are hardened by heating in either a gas or electric furnace, a molten "salt" bath or a magnetic induction coil to a temperature of 1,400° F. for ordinary steel or 1,740° F. for stainless steel and then quenched, that is, immersed, in a cooling liquid. The liquid may be oil, brine or water. Alternatively, the blades may be quenched between metal plates cooled by an internally circulating liquid.

The blades are now hard but too brittle to be ground to a cutting edge. They are therefore tempered by reheating to 390° F. and again quenching, which reduces the hardness and gives the blades the correct degree of flexibility and toughness.

There are several types of instruments for obtaining the exact measure of hardness of the material and for reading and controlling temperatures in furnaces. Toward the middle of the 20th century automatic machines were introduced for these heat-treatment processes.

Grinding and Polishing.—Machine grinding largely superseded hand grinding although many craftsman grinders were employed in the early 1960s at all the manufacturing centres for the production of small quantities of special shapes. Grinding consists of applying the blades to the rapidly revolving periphery of an abrasive wheel. The grains of the abrasive act like tiny cutting tools, removing the steel until the desired tapers from the back to cutting edge and from bolster to point are attained. The blade is kept cool with water or a "cutting fluid" to maintain its temper.

Accurate jigs for holding the blades and machine motions for achieving the correct forms have been developed but the highly skilled craftsmen, grinding by hand, still maintain their traditional customs. In Sheffield they sit astride a saddle-shaped wooden seat called a "horsing" mounted over the grindstone, which revolves away from them; in Solingen the wheels revolve toward them; in Thiers they lie flat upon boards placed over the wheels, which revolve toward them. Large blades are held in the hands and extra pressure is applied through a stick hinged to the wheel mountings. Care must be taken not to apply sufficient pressure to cause overheating of the steel, which would soften or "burn." Small blades are mounted in a variety of holders. The grinders must be ambidextrous for the blade has to be ground on both sides.

Sandstone grinding wheels were superseded by wheels made of synthetic materials in a wide range of grits and bonds. The 20th-century grinding wheel has eliminated the dangers of contracting respiratory diseases, such as silicosis, caused by inhaling sandstone dust.

The surface of a blade after grinding, either by machine or by hand, is given a finer finish by successive finer grinding operations known as glazing and buffing, followed if desired by mirror polishing or "satin" finishing. The bolsters are also ground, glazed and polished to fit the desired handle. The maker's name is applied by acid or electric-arc etching.

Cutling.—Natural materials for handles include animal horns and tusks, various woods, mother-of-pearl and bone; manufactured handles range from gold, silver and porcelain to stainless steel, silver plate, nickel alloys, compressed wood and plastics. Some of these materials are processed mechanically, others by the cutler. Natural stag horn handles have to be matched to each blade individually since no two are alike. Cellulose adhesives, cements or resin mixtures are used to fix the tangs securely in the handles but hollow metal handles are secured by hard soldering.

The final hardness of the blade is ascertained by a machine that applies a pointed diamond or a small steel ball to the surface at a known pressure and measures the resulting indentation. The smaller the size of the indentation the greater the hardness.

By varying the processes, a wide range of knives can be produced. Among the better-known varieties are carving knives, steak knives and bread knives with plain, scalloped or serrated edges, barbecue knives, and specialized knives used by butchers, cooks, farriers, artists and farmers. Knives of special shapes and sizes are made for many industrial processes.

Since the introduction of stainless cutlery steel and the general development of scientific knowledge and manufacturing techniques, cutlery making has been transformed from a handicraft to a highly specialized industry, with its own design, research and laboratory services.

Shapes of Knife Blades.—The earliest table-knife blades were sharply pointed, probably for carrying food to the mouth before the use of forks became general. In the 18th century the points were rounded to render them less dangerous. A curved or scimitar-shaped blade was preferred in the 18th century and a straight one in the 19th century. The knife having a short 3½-in. blade and a long 5-in. handle was introduced about 1929 in the United States and the United Kingdom. Twentieth-century designers in all the cutlery-producing countries introduced many variations of blade shapes that harmonized with the lines of the handles.

Pocketknives.—The earliest known pocketknife had a blade about three inches long hinged to a slotted handle into which it folded. It is uncertain at what date a spring was added but rare examples of old spring knives now in the Sheffield Cutlers' company collection were made in the 17th century.

The forging of pocketknife blades is similar in its essentials to that of table-knife blades and similar materials are used for the hafts (handles) or scales.

The cutling or assembling of pocketknives may be done mechanically for the mass-produced cheaper products or by hand for the better and more expensive ones. In each case precision is essential, for the blades and other articles incorporated in the knife

must pass each other and always snap into their correct positions, whether open or closed. The spring must be carefully adjusted to achieve this. The cutler himself usually polishes the haft, and other workers glaze, polish and sharpen the blades.

A great variety of pocketknives is made. Most have one or two blades, or one blade and another article. A penknife has blades at both ends. A "lobster" knife has articles at both ends but both sides of the knife are utilized by providing a divided spring known as a lobster spring because of its similarity to the claw of a lobster. A "sports" knife is usually larger and may contain a variety of articles such as a can (tin) opener, a gimlet, bottle opener, corkscrew, screw driver, saw, leather gouge, marlinespike, etc . Special knives are made for particular uses: for example, a gardener's and horticulturist's knife may contain a pruning blade, an implement for budding or a secateur; a yachtsman's knife a marlinespike and a shackler; a fisherman's knife small folding scissors and a file or a disgorger for removing hooks from the mouth of the fish; an electrician's knife an insulation stripper and a screw driver; and for outdoor pursuits a knife may contain a folding saw, can piercer, corkscrew, wire cutters and gralloching blade. Huntsman's or bowie knives are made with fixed or folding blades.

Care of Cutlery.—The edge of a knife loses its sharpness as it is used. Stainless and ordinary steel blades should be sharpened regularly with a "steel," carborundum stick or wheel sharpener.

Cutlery, whether it is made of stainless or ordinary steel, should be washed as soon as possible after use and care should be taken to ensure that detergents are dissolved in the hot dish water before cutlery is put into it. At least one of the constituents of some detergents, in the presence of salt, will cause instantaneous corrosion. Prolonged soaking of blades in ordinary water is also a frequent cause of pitting and corrosion. Nonmetallic handles should never be placed in hot water.

Pocket knives and scissors require lubrication regularly at the moving joints.

The Craftsman.—In the early 1960s considerable work was being done by hand in the making of better-quality cutlery. In the early part of the 20th century the use of mechanical methods increased and by the middle of the century much of the former toil had been eliminated. Nevertheless, a considerable degree of craftsman skill continued to be essential in the assembling and final processes, especially where natural materials were used for the handles or where metal handles were ornamented. Young craftsmen were trained in the making of accurate tools for the production of the necessary components. Each cutlery-producing country in the western world had a number of highly modern factories in which scientific control and research superseded the "rule of thumb" methods of former years.

Control of the personnel by craft guilds was replaced by governmental regulations coupled with trade associations for employers and trades unions for employees. Special training was organized for young people desiring to enter the industry in the United States, the United Kingdom, Germany and France.

(W. R.; W. G. I.)

CUTTACK, a city and a district in Orissa, India.

Cuttack City lies at the bifurcation of the Mahanadi and its main distributary the Katjori. It is 220 mi. S.W. of Calcutta, 45 mi. from the sea, and is served by the South Eastern railway and the Calcutta-Madras National highway. Pop. (1961) 146,590. The city was founded by King Anangabhima Deva III (1211–38) who built the fort of Barabati and possibly the stone revetment along the banks of the Mahanadi and the Katjori to protect the city from floods of those turbulent rivers. It continued to be the capital of Orissa till the end of the British rule. The fort of Barabati was made into a nine-storied structure by the time of Mukunda Deva (1559–68), the last Hindu king of independent Orissa. The Afghans occupied the city in 1568 but ceded it to the Moguls in 1590. The Marathas got it in 1751 from the Moguls and the British occupied it on Oct. 14, 1803, driving out the Marathas.

Notable monuments in Cuttack city are the Lalbag palace (1633), the Jama Masjid (1690), the Quadam Rosul (1715), Amareswar temple and the Jain temple (18th century), the Baptist church and the Catholic church (19th century), Barabati stadium (1946) and Sahid Bhavan (Martyrs' memorial). Important educational institutions are Ravenshaw college (1863), founded in memory of T. E. Ravenshaw, the then commissioner of Orissa division, Christ college (1944), Stewart Science college (1944), Shailabala women's college, Sri Ram Chandra Bhanj medical college (1949) and Radhanath Training college, all affiliated to Utkal university, centred in Cuttack. The city also has the Orissa high court and the Central Rice Research institute with a big agricultural farm. Cuttack is famous for filigree and horn work and various cottage industries. At Chauduar to the north there are textile and paper mills as well as a flourishing factory for steel tubes. At Barang to the south there is a glass factory situated between two rivers. Standing at the head of several lines of canals and connected, by roads and railways, to all parts of Orissa, Cuttack is the natural commercial capital of Orissa.

Cuttack District comprises the delta areas of the Mahanadi and Brahmani rivers and a hilly hinterland. Area 4,237 sq.mi. Pop. (1951) 2,529,244; (1961) 3,064,474. Density 723 per square mile. The natural divisions are (1) a marshy salt-impregnated strip 3 to 30 mi. in breadth along the coast; (2) an intermediate rice-producing alluvial plain which stretches inland about 40 mi. and has an extensive system of irrigation; and (3) an upland region with a series of hills running east-west, having wooded slopes and valleys between. The district is intersected by the Mahanadi river with its numerous bifurcations and by the Brahmani, while the Baitarani forms its northern boundary. Staple products are rice and pulses. Jute is also largely grown.

Jajpur on the Baitarani is a noted centre of pilgrimage. It is mentioned even in the Mahabharata (book iii, ch. 85) and it was the capital of several ruling dynasties under different names. Notable antiquities of the place include bodhisattva and Matrika images, a 16-sided monolithic pillar, 33 ft. high, of excellent workmanship, and the mosque of Nawab Abu Nasir Khan (1686). To the south lies the Assia range comprising the Udayagiri, Lalitagiri, Almgiri and Ratnagiri hills, which are famous centres of Bhuddhist art. Excavations at Ratnagiri (1958) brought to light a magnificent Buddhist monastery of early medieval times.

(Ma. M.; N. K. S.)

CUTTLEFISH, a name given to a large group of marine cephalopod mollusks related to the octopuses and squids. The term properly denotes any member of the family Sepiidae, especially *Sepia officinalis,* the common cuttlefish of Europe. The most characteristic feature of sepiids is a thick, internal, calcified shell, the cuttlebone of commerce.

Distribution.—The sepiids or true cuttlefish include, besides the large genus *Sepia, Sepiella, Hemisepius* and a few other genera. The sepiids are confined to the old world, no member of the family occurring in North or South American waters. A squid, *Sepioteuthis sepioidea,* that superficially resembles a cuttlefish has often been recorded as such in the literature, but it possesses a thin, horny internal shell (gladius) instead of a calcified one.

About 100 species of cuttlefish are known. They are found in most tropical and temperate seas but are uncommon in colder waters. They are distributed throughout Asia; the Indo-Malayan region and the Japanese islands possess a large number of species. G. Grimpe states that the European species are not found north of the Skagerrak, the arm of the North sea south of Norway. *Sepia pharaonis* and *Sepia latimanus* are widespread Indo-Pacific species. *Sepia officinalis,* the best known of the European cuttlefish, attains lengths of about two feet. The genus *Sepiella,* consisting of

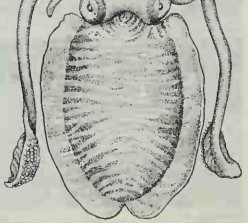


FIG. 1.—COMMON EUROPEAN CUTTLEFISH (SEPIA OFFICINALIS), TOP VIEW

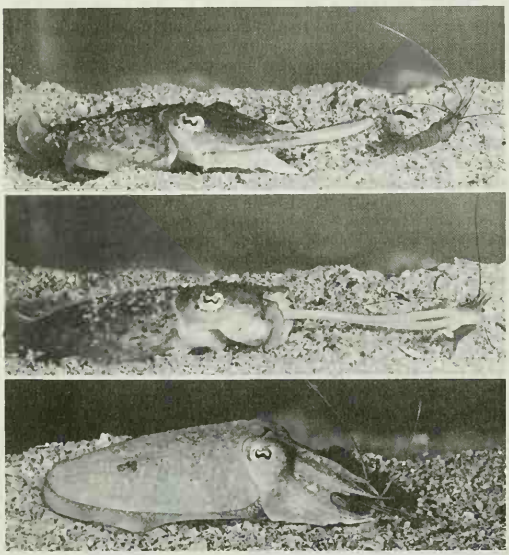
smaller cuttlefish, is distributed from Africa to Japan. *Doratosepion* is a poorly known subgenus of squidlike sepiids.

Form and Function.—Cuttlefishes have a somewhat flattened body, edged by a pair of narrow fins extending from the head to the tail end. In the common cuttlefish the mantle is ornamented with zebralike stripes. The remarkable *Sepiella ornata* has a series of longitudinal patches ("ocelli") along each side. All cuttlefish have ten appendages, eight arms and two tentacles, encircling the mouth. The tentacles, specialized for capturing prey, are longer than the arms and can be withdrawn into two pouches. The suction discs or suckers are arranged transversely in rows of four along the entire length of each arm, except in one of the ventral arms of the male (the "nuptial" or hectocotylized arm), from which they are absent toward the base. On the tentacles the suckers are restricted to an expanded pad or club at the tip.

Cuttlefish are active animals. They usually swim by means of the fins, which perform undulating movements, aided by slow jets from the funnel. On being alarmed or attacked, however, the animal can violently dart backward by expelling a jet of water from the mantle cavity through the funnel. In common with the majority of the Cephalopoda, the cuttlefish secretes an "ink" (*see* below), the value of which as a means of protection is discussed in the article CEPHALOPODA.

Natural History and Reproduction.—Cuttlefish are inhabitants of shallow, coastal waters; however, they usually migrate to deeper waters during the winter. The common cuttlefish breeds during spring and summer in shallow water. The eggs, about ½ in. long, are coated at spawning with a tough capsule that is darkened by ink from the ink sac. About 100–300 eggs are laid in a season; they are attached in clusters to submerged branches, coral fragments, tubes of marine worms and underwater growths in general. Newly hatched *Sepia*, as big as their eggs, are immediately capable of swimming and feeding. Grimpe studied cuttlefish in captivity and found them monogamous, *i.e.*, the pairs mated for life; however, this does not appear to be the case in nature.

Sepia feed mainly upon crustaceans, small fish and even upon each other. D. P. Wilson has described the feeding habits of *Sepia officinalis* in the aquarium of the Plymouth Marine Biological laboratory in England. Upon sighting its prey, such as a shrimp, the cuttlefish undergoes remarkable colour changes; it then stalks the victim, closing in until the prey is within reach of its tentacles. The latter suddenly shoot out—quicker than the eye can see—and pull the shrimp to the embrace of the sessile arms that convey it to the beaks. Apparently the main enemies of cuttlefish are sharks, whales, porpoises and dolphins, in all of whose stomachs they have been found. Large fish also feed upon them.



DOUGLAS P. WILSON

FIG. 2.—COMMON EUROPEAN CUTTLEFISH (SEPIA OFFICINALIS) FEEDING ON A PRAWN: (TOP) APPROACHING, (CENTRE) SEIZING AND (BOTTOM) INGESTING THE PREY

Economic Importance.—Cuttlefish are eaten in many parts of the world. In China, they form an important fishery and thousands of tons are landed annually. They have also been eaten for centuries in Italy and Greece, and large numbers are canned in Spain and Portugal. In the Mediterranean, cuttlefish are most often caught on artificial lures or by the use of night lights that attract them to the surface. During the breeding season, the Neapolitan fishermen tow a female cuttlefish behind the boat in order to catch the males that flock to her.

The ink secreted by these animals is the well-known rich brown pigment, sepia (*q.v.*). Although it is still used as a water-colour pigment, substitutes are replacing it, since it tends to fade in light.

The cuttlebone or shell has been used, either pulverized or whole, as a dentifrice, for fine polishing, for taking casts in jewelry and metalwork, as an agricultural fertilizer and for pouncing (dusting unsized paper to prevent ink spreading). It is also used medicinally in the far east. It was formerly used as a cosmetic by Roman women of fashion. Its main economic use today is as a dietary supplement providing calcium for cage birds (canaries, lovebirds, etc.). Over 100 tons of cuttlebone are exported annually from Tunisia.

Relationships.—The Sepiidae are included in the suborder Sepioidea along with a number of small bottom-dwelling species that have a degenerate horny shell (*Sepiola, Rossia, Euprymna*) or have lost it completely (*Idiosepius*). The relationship of these bottom dwellers with the true cuttlefish has been determined by a study of their anatomy and embryology. They are short, squat animals with separate, paddlelike fins.

The peculiar bathypelagic genus *Spirula* is also related to the cuttlefish. *Spirula spirula* has an entirely internal, coiled, chambered shell whose main function apparently is hydrostatic, maintaining the animal in a head downward position in the middle depths.

The modern cuttlefish made their appearance in the Miocene epoch (about 21,000,000 years ago). They are undoubtedly derived from a belemnite-like ancestor *Belosepia*, which lived in the earlier Eocene seas. *See* CEPHALOPODA.

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CUTTS OF GOWRAN, JOHN CUTTS, BARON (1661–1707), British soldier whose blind recklessness and indifference to enemy fire earned him the devotion of his troops and the nickname of the "Salamander," was heir to an Essex landed family and a man of some wealth. In 1686 he took service under Charles of Lorraine and was present at the storming of Buda (July). In March 1688, still in Europe, he ignored James II's proclamation recalling his subjects in the service of foreign powers; instead he took the colonelcy of a Dutch regiment and accompanied William of Orange on the invasion of England later that year. He served with distinction in the Irish campaign of 1690, and was created Baron Cutts of Gowran in the peerage of Ireland. Promoted brigadier, he was in the thick of the desperate fighting at Steenkirk (1692) and, having been wounded, retired to the governorship (1693–1707) of the Isle of Wight. He returned to active service on the expedition to Brest in 1694 and at the siege of Namur in 1695, where he again distinguished himself by his reckless, romantic bravery. In 1694 he was appointed colonel of the Coldstream guards. He served under the duke of Marlborough in the opening campaign (1702) of the War of the Spanish Succession, and at the siege of Venloo he ordered the Anglo-Irish brigade into a "suicide" assault on the guns of Ft. St. Michael.

The attack was successful, but Cutts was widely criticized for his apparent indifference to the lives of his men as well as his own, and he was bitterly lampooned by Jonathan Swift in his *Ode to a Salamander*.

Many contemporaries regarded Cutts as a thick-skulled butcher, a man of limited imagination and overweening vanity, who had been startlingly successful in an early act of folly and had no more sense than to keep on repeating it; and it is perhaps significant that despite his great military experience, his social rank and the high regard in which he was held by William III and Marlborough, he was never entrusted with an independent command. Similarly, though he was a member of parliament from 1693 to 1707 and played a small part in the negotiations leading up to the treaty of Rijswijk (1697), he enjoyed no discernible political influence. He fought with customary distinction in Flanders in 1703 and at Blenheim in 1704, then retired from active service in the rank of lieutenant general. In 1705 he was appointed commander in chief in Ireland and one of the lords justices of the kingdom. He died suddenly in Dublin on Jan. 25, 1707, when his titles became extinct. (J. P. K.)

CUVIER, GEORGES LÉOPOLD CHRÉTIEN FRÉDÉRIC DAGOBERT, Baron (1769–1832), one of the great French naturalists of the early 19th century, founder of the studies of comparative anatomy and paleontology, was born on Aug. 23, 1769, at Montbéliard. While still a child he copied the illustrations of the works of Buffon, drawing and colouring them with great precision, which stimulated in him an intense interest in natural history. After spending four years at the Academy of Stuttgart, he accepted the position of tutor in the family of the Comte d'Héricy near Fécamp. There he studied marine fauna and fossils. It thus came about that he made the acquaintance of the agriculturist A. H. Tessier who was then living at Fécamp. Tessier wrote strongly in favour of his protégé to his friends in Paris, with the result that Cuvier, after corresponding with the well-known naturalist E. Geoffroy Saint-Hilaire, was appointed in 1795 assistant to the professor of comparative anatomy at the Muséum National d'Histoire Naturelle. The Institut National was founded in the same year and he was elected a member. In 1796 he began to lecture at the École Centrale du Panthéon, and, at the opening of the Institut National in April, he read his first paleontological paper, which was subsequently published in 1800. In 1798 his first separate work, the *Tableau élémentaire de l'histoire naturelle des animaux*, which was an abridgment of his course of lectures at the École du Panthéon, was published; it may be regarded as the foundation and first general statement of his natural classification of the animal kingdom. In 1799 he succeeded L. J. M. Daubenton as professor of natural history in the Collège de France, and in the following year he published the *Leçons d'anatomie comparée*, a classical work in which he expounded his theory of "the correlation of parts" (*i.e.*, the interdependence of functions and structure—as the function of an organ changes, so will its structure). In this production he was assisted by A. M. C. Dumeril in the first two volumes and by G. L. Duvernoy in three later ones.

In 1802 Cuvier became titular professor at the Jardin des Plantes, and in the same year he was appointed commissary of the Institut National to accompany the inspectors general of public instruction. In this latter capacity he left for the south of France; but in the early part of 1803, when he was chosen perpetual secretary of the Institut National in the department of the physical and natural sciences, he abandoned the appointment of commissary and returned to Paris.

Cuvier then devoted himself more especially to three lines of inquiry—one dealing with the structure and classification of the Mollusca, the second with the comparative anatomy and systematic arrangement of the fishes and the third primarily with fossil mammals and reptiles and secondarily with the osteology of living forms belonging to the same groups. His papers on the Mollusca began as early as 1792, but most of his memoirs on this branch were published in the *Annales du muséum* between 1802 and 1815. They were subsequently collected as *Mémoires pour servir à l'histoire et à l'anatomie des mollusques*, published in one volume at Paris in 1817. In the department of fishes Cuvier's researches, begun in 1801, finally culminated in the publication of the *Histoire naturelle des poissons*, which contained descriptions of 5,000 species of fishes. This work was the joint production of Cuvier and A. Valenciennes, its publication (as far as the former was concerned) extending over the years 1828–31. The department of paleontology dealing with the Mammalia may be said to have been essentially created and established by Cuvier. In this region of investigation he published a long list of memoirs, partly relating to the bones of extinct animals and partly detailing the results of observations on the skeletons of living animals specially examined with a view toward throwing light upon the structure and affinities of the fossil forms.

The results of Cuvier's principal paleontological and geological investigations ultimately appeared in the form of two separate works. One of these is the celebrated *Recherches sur les ossements fossiles de quadrupèdes*, published in Paris in 1812, with subsequent editions in 1821 and 1825; the other is his *Discours sur les révolutions de la surface du globe*, originally published as *Discours préliminaire* to the above. But none of his works attained a higher reputation than his *Le Règne animal distribué d'après son organisation*, the first edition of which appeared in four octavo volumes in 1817 and the second in five volumes in 1829–30. In this classical work Cuvier embodied the results of the whole of his previous researches on the structure of living and fossil animals. He divided animals into four types: vertebrate, mollusk, articulate and radiate. The whole of the work was his own, with the exception of the Insecta, in which he was assisted by his friend P. A. Latreille. Cuvier believed that the extinction of species was brought about by some local catastrophe and that the area concerned was repopulated by types coming in from other parts. He maintained that each species was created for its own special purpose and each organ for one specific function. In this he came into direct opposition with Geoffroy Saint-Hilaire (*see* Geoffroy Saint-Hilaire, Étienne).

Apart from his own original investigations in zoology and paleontology Cuvier carried out a vast amount of work as perpetual secretary of the Institut National and as an official connected with public education generally; much of this work appeared ultimately in published form. Thus in 1808 he was placed by Napoleon upon the council of the Imperial university. In this capacity he presided (in the years 1809, 1811 and 1813) over commissions charged to examine the state of the higher educational establishments in the districts beyond the Alps and the Rhine, which had been annexed to France, and to report upon the means by which these could be affiliated with the central university. Three separate reports on this subject were published by him. In his capacity, again, of perpetual secretary of the institute he not only prepared a number of *éloges historiques* on deceased members of the Académie des Sciences, but also was the author of a number of reports on the history of the physical and natural sciences, the most important of these being the *Rapport historique sur le progrès des sciences naturelles depuis 1789*, published in 1810.

Prior to the fall of Napoleon (1814) he had been admitted to the council of state and his position remained unaffected by the restoration of the Bourbons. He was elected chancellor of the university, in which capacity he acted as interim president of the council of public instruction, while he also, as a Lutheran, superintended the faculty of Protestant theology. In 1818 he was elected a member of the Académie Française.

In 1819 he was appointed president of the committee of the interior and retained the office until his death. In 1826 he was made grand officer of the Legion of Honour; and in 1831 he was raised by Louis Philippe to the rank of peer of France, and was subsequently appointed president of the council of state.

In the beginning of 1832 he was nominated to the ministry of the interior, but on May 13 he died in Paris after a brief illness.

See also references under "Cuvier, Georges Léopold Chrétien Frédéric Dagobert" in the Index volume.

Bibliography.—Mrs. Sarah Lee, *Memoirs of Baron Cuvier* (1833); M. J. P. Flourens, *Cuvier. Histoire des travaux. (Éloge historique de G. Cuvier)*, 3rd ed. (1858); H. Ducrotay de Blainville, *Cuvier et Geoffroy Saint-Hilaire* (1890).

CUXHAVEN (KUXHAVEN), a seaport of Germany which after partition of the nation following World War II was in the *Land* (state) of Lower Saxony in the Federal Republic of Germany. It lies on the south bank of the Elbe mouth, 133 km. (83 mi.) W.N.W. of Hamburg by road (114 km., or 71 mi., by rail). Pop. (1959 est.) 42,975. Interesting buildings include the 13th-century Ritzebüttel castle containing the museum; the 13th-century St. Abundi church; and the lighthouse (1803). Railways run to Hamburg and Bremen. Cuxhaven is a leading pilot station and a fishing port with a large fish market. Shipbuilding and fish canning are carried on. The town is also a tourist centre. Part of the county of Stade during the middle ages, Cuxhaven was conquered by Hamburg in 1394 and remained under that port until united with Hanover in 1937. In World War II it was captured by the Allies in May 1945. (W. J. H. H.)

CUYAHOGA FALLS, a city of Summit county, O., U.S., is located on the Cuyahoga river, 5 mi. N.E. of Akron. Founded in 1812, it was incorporated as a village in 1868 and as a city in 1921. It began as a mill town, using the power of the Cuyahoga river at a place where it falls more than 100 ft. in one mile. Local coal supplemented the water power for a time, but was soon exhausted. Small industries, including a flour mill, a paper mill (the first west of the Allegheny mountains), a clay products plant (until local clays were exhausted), a rolling mill and a wire mill, succeeded for a time, then were discontinued. During World War I the demand for rubber tires for motor vehicles was so great that that industry, in Akron, recruited workers from Cuyahoga Falls. The Akron transit system included Cuyahoga Falls in its local service, and while the city has some important manufactures, including machinery, tools and dies, plastics and rubber products, it became primarily a residential suburb.

A municipal park of several acres, located on the east side of the river, includes a swimming pool where the National Swimming meet, regional meet of the Amateur Athletic union, has been held several times. The city supports a civic art centre, and a civic music association. For comparative population figures *see* table in OHIO: *Population*. (E. G. WE.)

CUYP, the name of a family of Dutch artists, settled in Dordrecht, or Doort, during the 17th century, of which seven members in three generations were painters. The family was largely employed in glass painting, but produced in Aelbert Cuyp (*see* below) one of the great masters of landscape painting in oils.

GERRIT GERRITSZ CUYP, the Elder (d. 1644), the founder of the family, came originally from Venlo, and entered the Dordrecht Guild of St. Luke as a glass painter in 1585. In the same year he married, and of six children of this first marriage, two sons, Abraham and Jacob, were painters. His first wife died in 1601, and he married again in 1602. Two more sons, Gerrit and Benjamin, grew up to be artists. Gerrit Cuyp, the elder, died at Dordrecht in 1644.

ABRAHAM GERRITSZ CUYP, the dates of whose birth and death are unknown, was the eldest son of Gerrit Gerritsz, the elder. He, too, was principally a glass painter. He married in 1612 and died before 1644. His son, JACOB ABRAHAMSZ CUYP, followed in his steps as a glass painter, being admitted to the Dordrecht guild in 1636.

JACOB GERRITSZ CUYP (1594–after 1651), best known for his portraits, was the second son of Gerrit Gerritsz, the elder, and father of Aelbert. He was born at Dordrecht in Dec. 1594. He broke with the family tradition of glass painting, and painted historical pictures, portraits and animal subjects. He entered the Dordrecht Guild of St. Luke in 1617. According to A. Houbraken, he had studied under Abraham Bloemart in Utrecht, and this is probably true, since he married a girl from Utrecht in 1618. He was a man of substance in Dordrecht, and held various offices in the guild.

There are examples of Jacob's portraits in many of the principal European galleries. They are soundly painted, sure in draftsmanship and firm in modeling, and though they lack the vitality of a Hals or the insight into character of a Rembrandt, they are imbued with that honesty and integrity which, allied to technical competence, are characteristic of the best tradition of Dutch painting.

Besides many simple bust or half-length portraits on a monochrome background, he painted some full-lengths, including several pleasing portraits of children, and some more ambitiously designed group portraits, with interior or landscape backgrounds. There are fine single portraits of women in Amsterdam, Berlin and Vienna, and a pair of a husband and wife in Budapest. An interesting but not very successful experiment is the double full-length portrait of "A Young Couple as Damon and Phyllis" in Berlin, in which a stolidly Dutch husband and wife are represented as a shepherd and shepherdess with their sheep in an Arcadian landscape. Far more suited to the temperaments of the painter and his sitters is the delightful "Family Group" in the Rijksmuseum, Amsterdam, which portrays a man and his wife, an elderly woman, five children, a pet goat and a horse and trap, in front of a house which stands, surrounded by trees, in a level landscape. As a painter of animal subjects and landscapes, Jacob undoubtedly exerted a powerful influence on his more famous son, for there is a degree of atmosphere and luminosity in his work unusual among the painters of his generation. Indeed, it is likely that several of his landscapes with herdsmen or shepherds and their animals are still wrongly attributed to Aelbert. Of his work in this vein there is an example, dated 1628, in Amsterdam. Jacob Cuyp died soon after 1651.

GERRIT GERRITSZ CUYP, the Younger (born 1603), third of the artist sons of Gerrit Gerritsz, the elder, entered the guild at Dordrecht as a glass painter in 1631, at the same time as his younger brother, Benjamin. He moved from Dordrecht in 1644.

BENJAMIN GERRITSZ CUYP (1612–1652), youngest son of Gerrit Gerritsz, the elder, was born at Dordrecht in Dec. 1612. Houbraken states that he studied under his uncle, Jacob Gerritsz. He was admitted to the guild in Dordrecht in 1631. Benjamin Cuyp was a painter of some talent, and had a large output in a short life, including landscapes, genre scenes, biblical subjects and battle pieces. His characteristic style, in which he employs a powerful chiaroscuro, appears to have been influenced by Rembrandt. He died on Aug. 28, 1652, at Dordrecht.

AELBERT JACOBSZ CUYP (1620–1691), famous for his landscapes in oil, was baptized at Dordrecht on Oct. 20, 1620. After the death of his father, Jacob Cuyp, soon after 1651, and of his mother in 1654, he came into a considerable property, and was a leading citizen in the affairs of the town. In 1658, he married Cornelia Boschman, a well-connected widow with three children, who in the following year bore him his only child, a daughter. He sold his father's house on the Nieubrugge in 1659, and in 1663 moved into the house in the Wijnstraat which he occupied, together with a property at Dordwijck, until shortly before his death. Apart from records of his name in the archives of Dordrecht, where he held a variety of civic offices, the known facts of his life are extremely sparse.

It is reasonable to suppose that, as Houbraken says, he first studied under his father, whose influence is visible in both the style and the subject material of his art. Whether he also studied under Jan van Goyen, with whom his early style has much in common; remains a subject of speculation. He does not appear ever to have traveled far from Dordrecht, but from the internal evidence of his pictures we may presume that he knew the country around Nijmegen, and that at some period he journeyed farther up the Rhine or Meuse to reaches where the banks are hillier and more picturesque than in the neighbourhood of his native town. The theory that he worked for a while in Utrecht, though it cannot be substantiated, provides a plausible explanation of the Italianate elements in his mature style, the feeling for simple and noble form, and the warm, rich rendering of atmosphere.

In Utrecht, the artistic centre which, more than any other in Holland, looked to Italy for its stylistic nourishment, he would have known the work of Jan Both, a direct link with Cuyp's only peer in the 17th century as a painter of light and atmosphere, Claude Lorrain. As a portrait painter, Cuyp follows the example of his father. Though many portraits are attributed to him, only the "Portrait of a Man" in the National gallery, London, can be assigned to him with certainty.

Cuyp did some pictures of animals and domestic birds, influencing such younger artists as Johannes Spruyt, and an occasional history piece, but by far the most numerous and important branch of his art is the landscapes. Cuyp signed many but dated few of his paintings, and it is difficult to establish a chronology of his stylistic development. However, it is clear that up to the early 1640s he painted usually on a small scale, in a style deriving partly from his father and partly from Jan van Goyen. These are mostly landscapes with cattle and figures, executed with a small, firm but flowing touch. An example, dated 1639, is in the museum at Besançon, and another, of a "Castle by a River Bank," in the Liechtenstein collection, Vienna.

To the later 1640s and 1650s belong most of his finer and more typical works, the views of the banks of the Maas and Waal near Dordrecht, with shipping on calm waters, or resting cattle silhouetted against an evening sky, and the bolder Rhenish landscapes, with groups of horsemen or peasants. Whether the composition is simple or expansive, he bathes these subjects in a subtle glow of light, a poetry of atmosphere that is unmatched among his contemporaries. It is the soft, gray light of early morning or the soft, golden light of evening, and his characteristic colour harmonies are based on luminous grays and golds, with accents of red, warm brown or black. Enveloped in atmosphere as if imprisoned in pale amber, the forms of cattle, ships and the distant towers of Dordrecht have a timeless, monumental quality rare in northern art. Some larger and more artificial compositions, in which this spirit of delight in simple nature becomes diluted, probably belong to the later years of his activity in the 1660s. During the last 20 years of his life he probably painted little or nothing at all.

Aelbert Cuyp died at Dordrecht in Nov. 1691. There is room for much research into his work, particularly into the distinction between his own work, that of other members of his family and that of his one close follower, Abraham Calraet, whose signature, "A.C.," was long mistaken for a variant of his own. Cuyp is well represented in galleries throughout Europe and North America, but a remarkable proportion of his best works are, or were once, in England, where the aristocratic collectors of the 18th century appreciated his qualities much earlier than their counterparts in other countries. Many works of outstanding excellence are still in British private collections.

See H. de Groot, *A Catalogue of Works of Dutch Painters,* vol. ii (1909); F. Cundall, *The Landscape and Pastoral Painters of Holland* (1891). (R. E. W. J.)

CUZA, ALEXANDRU ION (1820–1873), prince of Rumania from 1859 to 1866, was born at Husi, Moldavia, on March 20 (new style; 8, old style), 1820, a descendant of an old boyar family. In his youth he came into contact with the progressive ideas of his time. He studied in Paris, Pavia and Bologna and took part in the 1848 revolutionary movement in Moldavia. On Jan. 17 (N.S.; 5, O.S.), 1859, he was elected prince (*hospodar*) of Moldavia and on Feb. 5 (N.S.; Jan. 24, O.S.), prince of Walachia. His double election brought about the unification of the two Rumanian principalities. (*See* RUMANIA: *History.*) Cuza's reign saw some useful reforms in agrarian and electoral law and in public education. New civil and penal codes were introduced and a court of audit founded. The properties of monasteries were nationalized. These democratic reforms did not please the ruling landowner class. A military conspiracy engineered by great landowners, with some sympathy from a section of the bourgeoisie, forced Cuza to abdicate on Feb. 23, 1866, and to leave the country. Cuza died in Heidelberg on May 15, 1873.

See Paul Henry, *L'Abdication du Prince Cuza et l'avènement de la dynastie de Hohenzollern au trône de Roumanie* (1930). (G. G. Bu.)

CUZCO (Cusco), a department in southern Peru, bounded on the north by Loreto, on the east by Madre de Dios and Puno and on the southwest by Arequipa, Apurímac, Ayacucho and Junín. The area is 32,487 sq.mi., and the population (1958 est.) 782,432. Most of the department lies within the Andes mountain range, with much of its land over 11,000 ft. in altitude. The chief ranges of high mountains are the Cordillera de Vilcanota, the Cordillera de Carabaya and the Cordillera Vilcabamba. The department is drained by the Río Apurímac and the Río Urubamba. The capital city, Cuzco (*q.v.*) occupies a basin a little south of the Río Urubamba at an elevation of over 11,000 ft.

Most of the inhabitants of Cuzco are farmers or herders. The farmers are concentrated along the upper Urubamba around Sicuani, and in the basin of Cuzco and nearby Anta. At elevations between 11,000 and 14,000 ft. the chief crops are potatoes, barley, wheat and maize. At lower elevations along the Urubamba, farmers grow sugar cane, cotton, coffee, cacao, rice and coca. A large part of southern Cuzco is used for the pasture of sheep and alpacas. There is some mining of gold and silver and other minerals. The department was formed in 1822. (P. E. J.)

CUZCO (Cusco), a city in south central Peru, capital of the department of the same name. Pop. (1958 est.) 68,483. It stands at 11,207 ft. above sea level in lat. 13° 31′ S. at the west end of Cuzco valley, a basin extending 20 mi. E. to Huambutio. It is watered by the Huatanay river, a tributary of the Vilcanota. The air is dry and frost is rare even during the coldest months, June and July. Rainfall is about 32 in. annually, the rainy season being from November to mid-March. The average annual temperature is 51.2° F. with a range of about 7°.

As capital of the Inca empire, dating from the 11th century (*see* ANDEAN CIVILIZATION), Cuzco was the political centre of an empire extending southward from Quito to the Maule river in the present Republic of Chile. The population of the empire at the time of the Spanish conquest may have numbered 10,000,000. Cuzco and the surrounding area contain extensive pre-Inca and Inca ruins that reflect unusual competence in engineering, stonework and architecture. The architecture of the Incas comprised fortresses, religious sanctuaries and dwellings. Construction resembling the configuration of the Andes and the pyramidal shape was characteristic of the architectural style. Entrances, recesses and openings in general were in the form of a geometrical figure with sides narrowing toward the top.

Francisco Pizarro (*q.v.*) took possession of Cuzco in the name of Emperor Charles V in March 1534, inaugurating the colonial history of the city. Most of the Incan structures were demolished and replaced with Spanish edifices. The city was largely destroyed by an earthquake in 1650 but was rebuilt. During the colonial period, under the influence of strong religious spirit, Cuzco was the centre of a notable and prolific artistic production, mainly painting, sculpture, jewelry and ornamental woodworking.

Significant religious and public buildings of colonial origin include the cathedral, completed in 1654 upon the site of the Inca palace of Huiracocha, the National University of Cuzco, founded in 1692, and a number of churches, convents and monasteries. Evidence of the pre-Inca and Inca civilizations is prevalent throughout the city in the form of foundations of the Spanish structures, walls of fine stonework and the remains of the Temple of the Sun. In the environs of Cuzco are situated the fortress of Sacsahuamán, one of the great achievements of primitive man, the Inca bath, or Tombomachay, the Kenco amphitheatre, the Inca throne and lesser ruins. The citadel of Machu Picchu, "The Lost City of the Incas," is accessible by rail from Cuzco. In May 1950 Cuzco was badly shaken by an earthquake that damaged many of its old buildings and churches.

As capital of the department, Cuzco is the official residence of the highest administrative and ecclesiastical officials in the area. Potatoes and grains are cultivated for local consumption, and sheep, alpaca and llama are grazed there. Important local industries are the production of cloth, rugs, tapestries and fine metalwork. The population is chiefly Indian and mestizo. Cuzco is reached from the port of Mollendo by the Southern Railway of Peru and is connected with Lima by a motor road and an airline. (J. L. Tr.)

CWMBRAN ("valley of the crow"), a New Town mainly in the Cwmbran urban district and partly in the Pontypool rural district of Monmouthshire, Eng., lying about 5 mi. N. of Newport. Through the town from north to south run two railway lines, the fast-flowing Afon Lwyd and the disused Monmouthshire and Brecon canal, while along its eastern edge is the Newport-

Abergavenny trunk road. The area, designated as one of the New Towns (*q.v.*) in 1949, partly because of good rail and road communications, covers 4.9 sq.mi., and had a population of about 13,000. Development began in 1951 and by 1961 the population had risen to 21,690, the proposed final population being 55,000.

Coal was formerly mined in the area and the older industries comprise a foundry, tinplate and brick works (using the local red marl). After 1939 a greater diversity of employment was achieved by the establishment of factories for making brake linings, valves, dairy machinery and biscuits (cookies), and in the mid-1950's a large bakery and a milk distribution centre were set up. Nearby are steelworks and glass, nylon and ordnance factories.

CYANAMIDE, CALCIUM, is an organic chemical ($CaNCN$), sometimes referred to simply as cyanamide, commercially important as a fertilizer and as the parent substance of many chemical products. When used as a fertilizer, its nitrogen is changed in the soil to the ammonia form and, as such, it is very resistant to leaching. Its lime supplies soluble calcium as a plant nutrient and corrects soil acidity.

On contact with soil moisture, calcium cyanamide is hydrolyzed to form free cyanamide, which is highly toxic to vegetation but is rapidly converted to the ammonium form. Harm to crop plants or seeds is avoided by placing calcium cyanamide deep in the soil before planting so that the necessary chemical changes are complete before the seedling roots have contact with it. If, because of special cultural operations, it is necessary to place the cyanamide close to the row of seeds or plants, the application should precede planting by a few days.

Economic advantage is taken of the temporary toxic properties of calcium cyanamide for the control of certain weeds and soil-borne diseases. To kill the broad-leafed annual weeds in small grain crops, only 100 lb. per acre of the pulverized form need be dusted on the plants when they are quite small. Two and one-half to three tons per acre of the granular form of cyanamide, worked into the soil three or four months ahead of seeding, are used to kill weeds in tobacco and vegetable transplant beds. Sclerotiniose, a fungous disease of certain vegetable crops, is often controlled by applying one-half ton per acre of calcium cyanamide.

Calcium cyanamide is the active ingredient in a chemical dust which, when used at only 35 lb. per acre, will cause defoliation of cotton and certain other plants, preparatory to harvest.

Calcium cyanamide has assumed considerable importance in the chemical industry as a raw material for the preparation of numerous products. Calcium cyanide is made on the large scale from calcium cyanamide. Other products of commercial importance derived from calcium cyanamide are dicyanodiamide, melamine and guanidine derivatives (*see* HYDROCYANIC ACID).

Calcium cyanamide has found limited use as a carburizing agent in the steel industry. A more important potential use appears to be the desulfurization of iron, to replace calcium carbide, the use of which presents certain serious hazards.

A valuable plastic is made by the condensation of melamine with formaldehyde. This is used very extensively in the form of a laminate in the manufacture of table tops, furniture, wall panels and the like. It is also used for the manufacture of molded articles, especially tableware. It is noted for its great decorative value and its excellent lasting qualities. Partial condensation products of melamine and formaldehyde are used for imparting wet strength to paper used for the preparation of towels, napkins, shipping bags, food wrappers, tea bags and photographic and blueprint paper. A special methylated melamine resin is used in textile finishes for imparting wrinkle resistance to cotton goods, a woollike texture to spun rayon, and for shrinkproofing wool. The resin is also used for tanning white leather. A butylated melamine resin is used widely in protective and decorative coatings for automobiles, refrigerators, etc.

Manufacture.—Commercially, calcium cyanamide is made from calcium carbide and nitrogen. The process was the outgrowth of an extended series of experiments by Adolf Frank and Nikoden Caro, begun in 1895 and aimed at the development of a process for the fixation of atmospheric nitrogen. These investigators discovered that commercial calcium carbide, though not the pure carbide, reacts readily with nitrogen at temperatures in excess of 800° C. The reaction of calcium carbide with nitrogen, which takes place according to the equation $CaC_2 + N_2 = CaNCN + C$, is exothermic. The rate of reaction and the degree of conversion increase with increase in temperature. Decomposition of the cyanamide takes place at temperatures in excess of 1,200° C., and at 1,400° C. loss of calcium and nitrogen becomes appreciable. The optimum reaction temperature would appear to be 1,100°–1,130° C. Calcium chloride, or a mixture of calcium chloride and calcium fluoride, has been used as a catalyst to facilitate the reaction.

The nitrogen used in the preparation of calcium cyanamide is obtained by fractionally distilling liquid air, by the Linde or Claude process, and should be at least 99.7% pure. The carbide is ground to a fine powder in an inert atmosphere.

Discontinuous Process.—The greater part of calcium cyanamide produced commercially is made by a discontinuous process originated by Frank and Caro. In the more modern works, ovens of four to ten tons in capacity are used. One large manufacturer makes use of more than 1,000 such units. The ovens consist of an iron casting internally insulated with diatomaceous earth and firebrick. A heavy paper cylinder is placed in the oven cavity to receive the carbide. A small amount of fluorspar is mixed with the carbide; this acts both as a catalyst and as a regulator of the reaction. The oven is closed with an insulated cover made tight with a sand seal. The heating electrode is inserted through a central hole in the cover into a tubular opening in the centre of the charge, and it makes contact with a grounded graphite block at the bottom. Nitrogen is admitted to the oven through the bottom and also through the side. The reaction is initiated by heating the centre of the charge to about 1,000°–1,100° C. by the passage of an electric current through the electrode. Thereafter the reaction proceeds automatically until the entire charge is azotized; complete azotization may require 24–40 hr. The azotized mass is removed from the ovens and transferred to a storage room where it is allowed to cool in an inert atmosphere.

Continuous Processes.—In the Polzeniuss-Krauss process the carbide, mixed with 10% calcium chloride, is charged in perforated iron vessels mounted on trucks which are moved through a tunnel filled with nitrogen. A section of the tunnel is externally heated; there the charge is brought to the reaction temperature. The next section is provided with controlled air-cooling which serves to maintain the proper reaction temperature. The last section serves as the cooling chamber.

The Carlson oven consists of a vertical iron shaft about 70 ft. high, lined with firebrick and divided internally into sections by shelves. The carbide mixed with fluorspar is fed in at the top and is heated to the reaction temperature as it passes through an arc between carbon electrodes. It meets an ascending stream of nitrogen and is made to fall slowly from shelf to shelf by scrapers until it is discharged at the bottom.

The cooled lump cyanamide is ground to a fine powder and the powder is treated with just sufficient water to decompose the residual carbide and to hydrate the calcium oxide present. To prevent dustiness, the powder is oiled or granulated by moistening with the proper quantity of water or solutions of various salts, compressing and comminuting the resulting flakes to the desired size.

In the kiln process of Knapsack, granular carbide mixed with 50% calcium chloride is introduced into a rotary kiln, while a stream of pure nitrogen is passed in a countercurrent direction. The material remains in the kiln a total of about 24 hr. The heat of reaction is sufficient to maintain the temperature at the desired level. Control of temperature is achieved by regulating the flow of nitrogen through the kiln. This process produces cyanamide in the desired granular form.

Pure Calcium Cyanamide.—White calcium cyanamide analyzing 92% actual is obtained when a mixture of ten parts of ammonia and two parts of carbon monoxide by volume is passed over calcium carbonate heated to 750° C.

Free Cyanamide.—Free cyanamide, H_2NCN, is a white solid melting at 46° C. It is unstable and gradually polymerizes to its dimer, dicyanodiamide, $H_2NC(=NH)NHCN$. Polymerization proceeds more rapidly in aqueous solution in the presence of al-

kalies. The reaction may occur with explosive violence. Polymerization is apparently the result of the reaction of undissociated cyanamide, H_2NCN, with the cyanamide ion, $HNCN^-$. The lack of stability of cyanamide is shared by monosubstituted cyanamides, such as CH_3NHCN, but disubstituted cyanamides, such as $(CH_3)_2NCN$, are comparatively stable. (V. M.; X.)

CYANIDE: *see* HYDROCYANIC ACID.

CYANIDE PROCESS, the best-known and most widely adopted method for extracting gold and silver from their ores. It comprises the steps of contacting the finely ground ore with a weak cyanide solution as a solvent, separating the solids from the clear solution and recovering the metals in the form of a black precipitate by means of zinc dust.

Invented in 1887 by J. S. MacArthur and R. W. and W. Forrest, the process is remarkable because of the nature of the solvent—a highly poisonous compound; the effectiveness of extremely weak solutions (0.01% to 0.10% potassium cyanide, KCN, equivalent); and because it made possible the economic treatment of large tonnages of low-grade ore (0.2 oz. per ton in South Africa).

This process had a tremendous impact on the gold mining industry, which, in spite of the rich discoveries on the Rand in the Transvaal, South Africa, in the 1880s, was obtaining poor extractions by the amalgamation and gravity concentration processes then available. At first the cyanide process was used mainly for the treatment of tailings from amalgamation, but later it replaced amalgamation altogether in the Transvaal and in the majority of plants the ore is cyanided directly. Various steps usually are taken to recover the coarse gold or silver before it enters the cyanide plant (to minimize the treatment time) and some plants employ concentration by flotation with cyanidation of the concentrates and occasionally the tailings as well. Roasting the concentrates before cyanidation often is necessary in cases where the precious metal is associated with arsenic, antimony or sulfotellurides. Directly or indirectly, however, much of the world's gold supply is dependent on the cyanide process. In the United States more than one-third of the gold produced is as a by-product of base metal ore; in the case of silver a very large part of its production results from the smelting of base metal ores (*see* COPPER; LEAD).

Chemistry.—The chemistry of cyanide solutions is extremely involved due to side reactions with various elements present in the ore but it is known that both gold and silver are dissolved as double cyanides of the precious metal and the alkali metal. Expressed in chemical symbols, it is generally agreed that the following equation represents the dissolving action (for gold):

$$4\ Au + 8\ NaCN + O_2 + 2\ H_2O = 4\ NaAu\ (CN)_2 + 4\ NaOH;$$

and the precipitation with zinc dust:

$$NaAu(CN)_2 + 2\ NaCN + Zn + H_2O = Na_2Zn\ (CN)_4 + Au + H + NaOH.$$

It will be noted that in the dissolving reaction oxygen is required, and in plant operation care is taken to see that the solutions are well aerated during this step. In the precipitation reaction the presence of free sodium cyanide is an important consideration. The solutions are first deoxidized by vacuum treatment.

Silver reacts with sodium cyanide to form a water-soluble sodium silver cyanide from which the silver is precipitated by treatment with zinc dust. (*See* also GOLD: *Other Compounds;* SILVER:

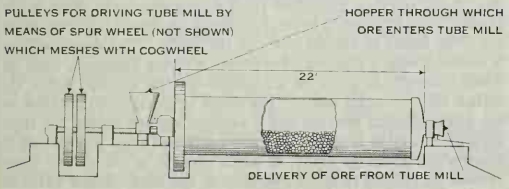
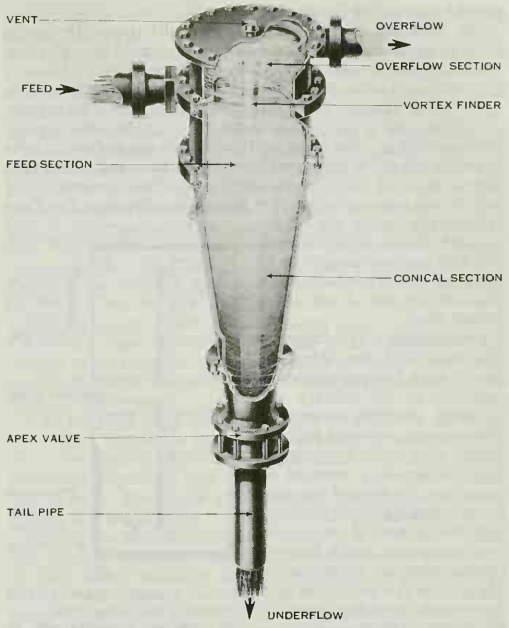


FIG. 1.—SECTION OF TUBE MILL SHOWING HOW THE BROKEN GOLD ORE, SCREENED TO A MAXIMUM SIZE OF ½ IN., IS GROUND WITH PEBBLES OR UNBROKEN ORE TO A MIXTURE OF SAND AND SLIME



BY COURTESY OF DORR-OLIVER INC.

FIG. 2.—CUT-AWAY VIEW OF HYDROCYCLONE

Metallurgy, Mining and Production, Uses.)

Crushing and Cyaniding the Ore.—The initial stages of crushing are carried out in jaw or gyratory-type crushers, and then the ore is delivered to the wet grinding mills after passing screens having about a ½ in. square opening. In most parts of the world cylindrical mills partly filled with steel balls are used in the wet grinding operations, but tube mills charged with pebbles or mixed loads of pebbles and balls (fig. 1) are still used extensively on the Rand because of the nature of the ore. A grinding mill consists of a steel cylinder, provided with suitable liners, placed in a horizontal position and made to revolve on its own axis. The grinding charge (flint pebbles or pieces of unbroken ore in the case of a tube mill) rolls through and over the mixture of ore and solution which is fed to the mill continuously and grinds it to a mixture of sand and slime. This product is discharged to a classifier, the purpose of which is to separate out the particles of ore that are crushed to the desired fineness and return the oversize to the mill. A number of machines are used for this closed-circuiting operation including the stationary cone classifier, Dorr rake classifier, the Akins and Wemco spiral classifiers, and the hydrocyclone, which operates on the same principle as the dry dust collector and is illustrated in fig. 2. While the latter have the advantage of simplicity and lower capital investment, operating and maintenance costs are higher as compared with mechanical classifiers. (*See* also ORE DRESSING.)

Batch Treatment.—The cyanide process up to the early 1900s was a batch process and separate sand and slime treatments invariably were used. While this system is still used to some extent, the majority of plants operate on a continuous basis, called all-sliming. Where sand is separately treated the ore is ground in water and the sand is separated from the slimes in a classifier, discussed above, and discharged into large circular vats with filter bottoms. After draining off the water, cyanide solution is pumped on top, dissolving the gold as it sinks through the sand bed, and is drawn off at the bottom. Oxygen is supplied by periodically draining the charge completely. The sand tailings are then discharged either manually or mechanically through bottom ports,

and the vat readied for another charge.

The slime portion of the ore was originally treated by paddle agitators alone, then compressed air was introduced through tubes reaching to the bottom of the tanks and later by air lifts in tall, cone-bottomed tanks, of which the Pachuca tank (fig. 3), used on silver ores at Pachuca, Mex., is the best known. Air is forced into the central tube at the bottom and bubbles up the tube carrying the slime with it. The latter overflows at the top and recirculates to the bottom of the tube repeatedly, the aeration and mixing continuing until the metal is dissolved. The whole content of the tank is then pumped to the filter section (*see* below). The Dorr agitator (fig. 4), in general use in most plants, combines aeration with mechanical agitation by means of slowly revolving rakes attached to, and driven by, a central shaft.

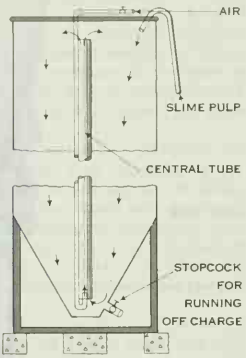


FIG. 3.—SECTION (INCOMPLETE) OF A PACHUCA AGITATING TANK
The slimed ore is charged with air while the gold is being dissolved. Aeration is an important factor in the solution of gold by the cyanide process.

Continuous Treatment.—The invention of the Dorr thickener in 1905 brought continuous treatment to the industry with its many attendant advantages. While certain attempts had previously been made to settle and wash the slimes by repeated decantations, the method was cumbersome and inefficient compared with the system of countercurrent decantation which the continuous thickener made possible (fig. 5). In this system the slime is pumped through a series of thickeners while the clear overflow moves in the reverse direction, starting with wash water which is mixed with the incoming thickened pulp flowing into the last thickener and ending with the rich (pregnant) solution overflowing the first thickener of the series. The solids finally discharged are practically free of gold-bearing solution and 98%–99% washing efficiency is not unusual.

Filtration and Gold Recovery.—In the batch treatment system, after the gold has been dissolved the next step is to pump the mixture of solids and solution to vacuum filters. The earliest large-scale filtering operations were performed in Moore type and Butters filters, the latter still being used in some Rand plants. Filter presses were also tried but have survived in only one, and in this respect unique, operation in the United States.

Both Moore and Butters filters employ large numbers of closely spaced filter leaves or frames immersed in a rectangular tank with a V-bottom. Each leaf consists of a vertical frame supporting

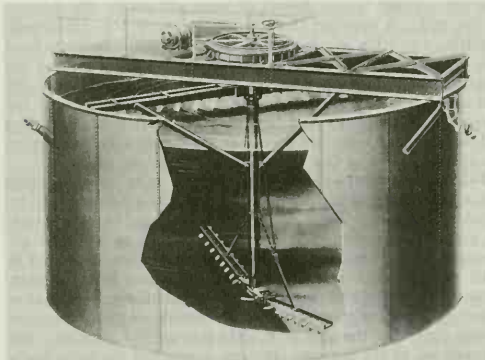


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FIG. 4.—CUT-AWAY VIEW OF DORR AGITATOR

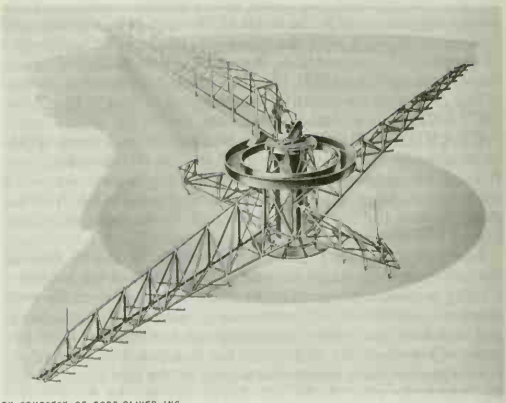

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FIG. 5.—CUT-AWAY VIEW OF CENTRE-PIER THICKENER

a canvas bag that is wide and deep but nearly flat. A vacuum is applied to the inside of the frame, so that the solids form a cake on the outside while the clear solution is sucked through. The principal difference between the Moore filter and the Butters lies in the method of washing and discharging the cake of solids. In the former, a whole block of frames is removed from the tank and lowered into a second tank where they are given a water wash and

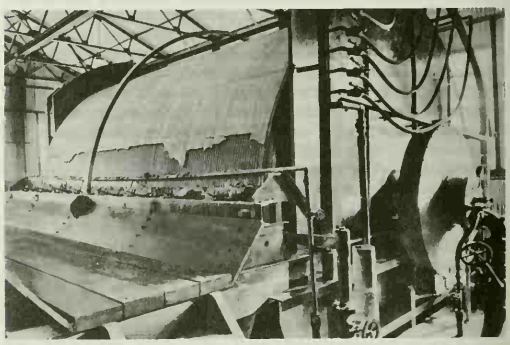

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FIG. 6.—OLIVER DRUM FILTER

finally discharged by breaking the vacuum and applying compressed air to the bags. In the Butters filter the frames are stationary, and washing, transfer and discharging operations are performed by centrifugal pumps.

Just as the Dorr thickener brought about continuous decantation, so the invention in 1907 of the segmental rotating Oliver drum filter (*see* fig. 6) made continuous filtration and washing possible. Not only is it common practice to employ drum filters for dewatering the final underflow from a countercurrent decantation system, but plants using several stages of countercurrent filtration are to be found in various parts of the world. The drum surface is covered with a number of separate filtering elements, each of which connects to ports on a multiple-opening circular valve attached to the central shaft. The drum is partially submerged in the solids-solution mixture and a vacuum applied during the time each filter section is submerged and continued until just before it reaches the discharge blade, at which point it is cut off and compressed air applied to assist discharge of the cake. Wash water in the form of sprays can be applied before the cake passes the uppermost point in the draining cycle.

For the recovery of gold or silver from the cyanide solution,

the dissolved air is first removed by applying a vacuum to thin streams of the liquid in a closed tank (Crowe process). A regulated flow of zinc dust is then added to the deaerated solution, and the gold or silver precipitated as slime (not to be confused with the ore slime mentioned previously), while most of the zinc is dissolved. The slime is then collected in vacuum or pressure-type filters, and the clear solution pumped to a storage tank for re-use in the plant. The slime is purified by furnace methods and is finally melted and cast into bars.

See also GOLD: *Gold Mining and Refining;* METALLURGY.

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CYANITE: *see* KYANITE.

CYAXARES (d. *c.* 585 B.C.), king of Media, reigned 40 years according to Herodotus (book i, 106); *i.e.,* from *c.* 625–585 B.C. The Babylonian Chronicle calls him Umakishtar; his Iranian name was probably Huvakhshthra. Herodotus narrates that he renewed the war against the Assyrians after his father, Phraortes, had been slain in battle and that, while he besieged Nineveh, he was attacked by a great army of Scythians. According to Herodotus, the Scythians defeated Cyaxares and ruled Media for 28 years (652–625), till their chiefs were slain by Cyaxares at a banquet. It was probably Cyaxares, not his father, Phraortes, as is maintained by Herodotus, who united the tribes of Iran. He also reorganized the Median army, which hitherto had consisted of tribal and local levies, and once more renewed the war against Assyria. In 614 the Medes took Ashur and in 612, aided by the Babylonians under Nabopolassar, occupied and sacked Nineveh. About the same time they seem to have conquered the kingdom of Manna in modern Iranian Azerbaijan, and in 609 invaded and afterward subjected Urartu in the Armenian highlands. The Median army took part in the final defeat of the Assyrians in northern Mesopotamia (612–605), and when the territory of Assyria was divided between Babylonia and Media, the latter took Assyria proper and northern Mesopotamia, with Harran. War between Media and Lydia (590–585) was ended when these countries accepted the Halys river as their boundary. Cyaxares died shortly afterward. Herodotus' apparent mistake in confusing the solar eclipses of 585 and 610 has cast some doubt on the chronology of Cyaxares' reign. (I. M. D.)

CYBELE, the favoured name of an ancient deity, whose worship arose in Asia Minor and spread to Greece and Rome. *See* GREAT MOTHER OF THE GODS.

CYBERNETICS, the science of control and communication processes in both animals and machines. The word was introduced and the field popularized by the mathematician Norbert Wiener in a book called *Cybernetics* published in 1948. The field of cybernetics deals with the theory of such systems as the nerve networks in animals, electronic computing machines, servo systems for the automatic control of machinery and other information processing systems. Consequently, it overlaps the fields of neurophysiology, computing machinery, information theory and automation, and seeks to find features common to these diverse disciplines.

In the Industrial Revolution of the 19th century, men's muscles were replaced by the power of steam engines. Men were still required, however, for all important control functions in connection with machines. In the 20th century, machines rapidly took over many of these functions; machines came to control other machines. Instrumental in this trend toward automation has been the expanding technology of electronics and its offspring, high speed automatic computing machinery. While the chemical industry and the telephone system were among the first to be highly automatized, such other industries as automobile manufacturing rapidly followed suit. Cybernetics called attention to this widespread movement and named it the second Industrial Revolution.

These control and communication devices bear the same relation to the steam engines of the first Industrial Revolution that brain bears to muscle. The control systems operate with a low expenditure of energy and their mechanical efficiency is of little importance. Their basic function is not the transformation of energy but rather the processing of information. The inputs of such systems are often the electronic equivalent of sense organs—thermostats, photoelectric cells, microphones or strain gauges. The outputs are the equivalent of an animal's muscles or communicating organs—loud-speakers, electric typewriters or electric motors.

In cybernetics, information is treated as a statistical quantity; a signal is considered to be a particular choice from a statistical ensemble of possible signals. The effectiveness of a control system in processing information must generally be measured by some kind of an average for all the possible signals in the ensemble. *See* also AUTOMATION; CONTROL SYSTEMS; INFORMATION THEORY.

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CYCAD, any of the palmlike woody plants of the family Cycadaceae, order Cycadales. They are primitive gymnosperms, thought to be evolutionary offshoots from the seed ferns (order Cycadofilicales or Pteridospermae). *See* GYMNOSPERMS: *Cycadales;* PALEOBOTANY.

CYCLADES (mod. Gr. KIKLADHES), 24 islands in the Greek archipelago, around the island of Syros (*q.v.*) or Syra, the principal town of which, Hermoupolis (Ermoupolis), is the capital of a *nomos* (prefecture). Pop. (1961) 99,959. Area 2,577 sq.km. (995 sq.mi.). The islands are interesting and picturesque; many of them bear traces of the feudal rule of Venetian families.

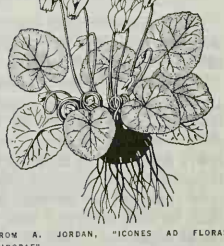
In antiquity the islands were the centre of a distinctive Bronze Age culture (Cycladic), notable for the production of white marble idols. They flourished again in the 8th to 6th centuries B.C., but later only Delos (*q.v.*) remained important. It was a great centre of ancient religious, political and commercial life. It was excavated by French archaeologists. Melos (*q.v.*) was an important ancient source of obsidian. It has Hellenic and Roman remains, and the prehistoric town of Phylakopi was excavated by the British school at Athens. In the volcanic Thera (*q.v.*) the ancient capital was explored by Baron Hiller von Gärtringen.

Naxos (*q.v.*), largest and most fertile, contains the highest mountain (Zia, 3,304 ft.) and exports emery. Keos (*q.v.*), or Zea, and Ios furnish valonia. Kimolos produces fuller's earth. The marble of Paros and Naxos has been practically abandoned; that of Tenos was worked by a British syndicate. Iron ore is exported from Serifos, manganese and sulfur from Melos and pumice for cement (pozzuolana) from Thera. However, the mineral wealth of the Cyclades is, in general, poorly exploited. Though of rugged and barren aspect, the islands export wines, brandy, tobacco and hides. Kythnos (Kithnos), Melos and other islands possess hot medicinal springs. Tenos has a pilgrim church, modern but famous throughout Greece. The islands were occupied by the Germans in 1941 and liberated in 1944. (J. Bo.)

CYCLADIC CIVILIZATION: *see* AEGEAN CIVILIZATION.

CYCLAMEN, the common and scientific name for a genus of perennial herbs belonging to the family Primulaceae (*q.v.*), containing 20 species native in the mountains of central Europe and the Mediterranean region. One species, *C. indicum* (or *persicum*), is a well-known florists' plant.

The plants are low-growing herbs with large tuberous roots from the surface of which spring a number of broad, generally heart-shaped or kidney-shaped, long-stalked leaves, which in cultivated forms are often beautifully marbled, ribbed or splashed with white. The flowers are nodding, and white, pink, lilac or crimson in colour. The corolla has a short tube and five large



FROM A. JORDAN, "ICONES AD FLORAM EUROPAE"

WILD CYCLAMEN (CYCLAMEN EUROPAEUM), A STEMLESS PLANT, SOMETIMES CALLED SOWBREAD BECAUSE ITS CORMS ARE RELISHED BY SWINE

reflexed lobes. After flowering the stalk becomes spirally coiled, drawing the fruit down to the soil.

C. europaeum (sowbread) is found as an introduced plant in copses in Kent and Sussex, Eng. A reasonably hardy species for outdoor culture in the U.S., especially in California, is *C. coum* from the eastern Mediterranean region. It is a tuberous-rooted perennial, the roundish leaves of which appear before the spotted, carmine flowers unfold. Related to it, but not quite so hardy, is *C. neapolitanum* from southern Europe, whose fall-blooming flowers are rose coloured or whitish but carmine blotched. Both should be started from tubers. *C. indicum* and its horticultural varieties are the most popular cyclamens as pot plants. Among them are varieties having flowers doubled, crested, shredded or greatly enlarged. All cyclamens prefer cool, moist situations with good drainage.

CYCLING, the sport or exercise of riding a bicycle, provides the simplest and most economical means of personal mechanical transport and is widespread throughout the world. Cycle racing, at one time a major sport in the United States, has been represented by several events in each of the modern Olympic games (since 1896) and by events in the British Empire and Commonwealth games and the Pan-American games, and has remained a major sport in Europe and Japan.

This article deals with cycling as a recreation and with touring clubs and racing. For a historical account of the invention and development of the bicycle and for descriptions of various types, *see* BICYCLE.

Recreation.—As a pastime, cycling's popularity owes much to its cheapness, but it is also recognized as a beneficial as well as enjoyable light exercise. It is easily mastered by children and adults and is relatively safe. The bicycle is a popular touring vehicle because of its simplicity and lack of noise, and in many countries clubs have been organized with touring in mind. Typical are the Cyclists' Touring club of Great Britain and the Touring Club de France (see *Touring Clubs,* below).

Also involved with cycle touring is the youth hostels movement, since in most countries it is a rule that hostelers must reach the hostel under their own power, which disallows cars and motorcycles.

THE BETTMANN ARCHIVE, INC.

FIG. 1.—EARLY CYCLES: (LEFT) HIGH WHEELER OR ORDINARY, *c.* 1860; (RIGHT) YANKEE UNICYCLE, PATENTED *c.* 1870

In Europe, provision is often made for cyclists on trunk roads: some countries, like France, build separate cycle tracks and others, like the Netherlands, reserve a portion of the highways.

Following the needs of different countries, many types of cycling and cycles have been developed. Britain, where club life is strong, is known for the lightweight, fully equipped touring roadster. In underdeveloped countries, such as Africa, extremely strong and heavy machines are in demand to carry exceptional loads on unimproved roads, often providing transport for two. On the European continent the prevalence of heavy stone *pavé* led to simple light bicycles equipped with wide low-pressure tires and an internal expanding brake in the rear hub, impervious to weather conditions. A similar machine also became popular in the United States.

Tandem cycling enjoyed a vogue that has had several revivals. Other variations kept some popularity, and tricycles and even tandem tricycles have adherents in Britain, there being a Tricycle association for those who ride "barrows," as those machines are known.

In all parts of Britain small cycling clubs are found and these are often individualistic—the Vegetarian, the North Road Cycling club for men only, the Rosslyn Ladies, the Buckshee Wheelers for men who served in the forces in the Suez Canal Zone—and they hold social events as well as club runs divided into slow (potterers) and fast (hardriders) sections. Most clubs are affiliated to one or more of three bodies, the Cyclists' Touring club, the British Cycling federation or the Road Time Trials council, which between them organize and control cycling for touring or sport in Britain.

Cycling is also used, as it is in the United States, to teach road safety through the co-operation of police and schools in organizing campaigns and competitions to educate children.

After World War II motorized bicycles called mopeds were made in quantity: several millions were made in France and Italy but production was smaller in Britain where, in 1960 for example, only about 80,000 mopeds were made as compared with 2,200,000 bicycles. Often made from standard cycle parts, mopeds generally need pedal assistance to start. Many countries require no licence for those with very small motors, and this makes them popular with utility riders. In Europe the moped in fact largely replaced the bicycle and was used in such large numbers that public transport was affected. (AL. H. G.)

Touring Clubs.—Cycle tours were taken and cycling clubs established almost as soon as the cycle appeared, the Pickwick Bicycle club in London, founded in 1870, being the oldest in the world. The organization of these clubs was chiefly of a social character. To a great extent they were superseded by large organizations. The Cyclists' Touring club (C.T.C.), organized in England in 1878 as the Bicycle Touring club, has members scattered throughout Europe and North America. Many other countries possess national clubs, as for instance the now extinct League of American Wheelmen, organized in 1880, and the Touring Club de France, founded in 1895, of whose objects cycling is only one, though the chief.

The aim of these national associations, which form an international touring league, is the promotion of cycle touring. To this end they publish roadbooks, maps and journals. They recommend hotels, with fixed rates, in their own and other countries. They appoint representatives to aid their members when touring, and they succeeded in inducing most governments to allow members to travel freely across frontiers without paying duty on their machines. In all countries they have erected warning signs at dangerous places.

Another important part of the work of these clubs, both directly and indirectly, was the improvement of roads. In Belgium, for instance, the cycle worked a veritable revolution in the national life. The paved roads, before the advent of the bicycle, were so bad as to be impossible for even light traffic. A cycle tax was introduced and devoted at first to the construction of paths on which cyclists have equal rights with pedestrians, and next to the replacement of the old paving by macadam.

There are a great many touring cyclists in the United States, riders who are not interested in speed but concentrate upon piling up mileage in a calendar year. These enthusiasts are associated with colleges, clubs and youth hostels. Some of the country's most active touring groups are the New York Cycle club, the Western Wanderers of San Francisco and the Long Island Wheelmen's association. The L.I.W.A. has a long history of conducting centuries, as 100-mi. runs are called. These are a remnant of the era before the automobile arrived upon the scene, when mixed groups pedaled along leisurely and enjoyed the beauty of the countryside. The members of the touring groups write and tell of their experiences, and many are camera enthusiasts who give lectures with the aid of colour slides and motion pictures taken on their rides.

The automobile parking problem has resulted in a revival of bicycle riding at many college and university campuses. The University of Southern California student council suggested that

students use bicycles; four out of five girls at Smith college ride bicycles; there have been as many as 4,000 bicycles at one time on the University of Michigan campus; and a large proportion of students at Yale, Harvard, Vassar and Dartmouth use bicycles. The University of Indiana raises funds for scholarships by attracting as many as 25,000 spectators to its annual "Little 500," which it calls its 50-mi. bicycle race held in the stadium at Bloomington, Ind.

According to statistics compiled by the bicycle manufacturers of the United States, 27,000,000 Americans ride bicycles. Many are members of the C.T.C., which publishes logs of persons who ride more than 10,000 mi. a year. (W. RA.)

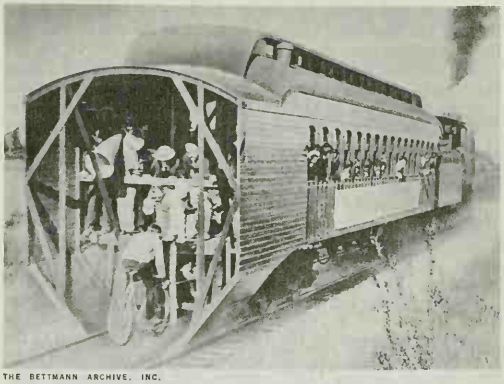
Racing.—The man who made the first ridable bicycle, Kirkpatrick Macmillan, undertook the first race. He had cycled from Thornhill, Dumfriesshire, Scot., to Glasgow in 1842, and after a sensational appearance in court for knocking down a child he set off for home again. He met his friend the coachman of the Glasgow-Carlisle mail coach and wagered him that he would reach Sanquhar on his machine before the coach did. This was taken up by the driver and the race was on. It was neck and neck for many miles but Macmillan had the advantage of not having to stop at the halting places for the mail and passengers. At Old Cumnock the coach was well behind and the cyclist easily reached Sanquhar a well-established winner. But Macmillan's crude steed of wood with swinging treadles, rods and cranks on the back hub was forgotten before it had established itself as a machine for personal propulsion.

The bicycle was reinvented even more crudely in Paris in the 1860s when Pierre and Ernest Michaux put cranks on to the hub of the front wheel and started the real cycling era with the *vélocipède* or, as it was called in Britain, the boneshaker. On May 31, 1868, Napoleon III offered a gold medal for a cycle race and James Moore, an Englishman then resident in Paris, won. The date is interesting as it is the day before the first boneshaker race was staged in England: on Whit Monday, June 1, there was a cycle race near the "Welsh Harp," Hendon, Middlesex.

There followed many such racing events. The racing cycle needs a bigger gear to move fast and, as the gear of the boneshaker was the diameter of its driven wheel, the makers increased the size of the front wheel until it would just go under the crotch of the rider. Slender metal wheels with wire spokes replaced the cart-wheel design and the gracious high "ordinary" was evolved. Some of the most famous men of the early racing days were efficient pedalers on the ordinary, and the chief use of the big wheel was as a racing machine. British high-wheel developments were quickly copied in Europe, especially in Germany and Bohemia, and the largest modern cycle-making firm in the U.S. was founded as an ordinary manufacturer in Germany.

Championship races on the high bicycle were established in 1878 when the National Cyclists' union, originally the Bicycle union, was founded and the universities of Cambridge and Oxford recognized the new sport. The ordinary championships continued until 1892 after the safety machine had been introduced in 1885. In 1882 H. L. Cortis won all four titles, 1, 5, 25 and 50 mi., and in that year on an ordinary he was the first man to ride over 20 mi. in an hour on the same type of machine. Title racing in the U.S. commenced in 1883 when G. M. Hendrie won a challenge road race from W. G. Rowe and was declared the first cycling champion. A great ordinary performer in Britain was G. Lacy Hillier, who became one of the earliest cycling journalists. He opposed the pneumatic tire and the transition of the ordinary to the safety (and invented the word "aeroplane," prophesying that flying, when it came, would reach 200 m.p.h.). There were also Maj. C. E. Liles; H. Synyer, who practised secretly to start his sprint from an earlier starting point than he had been known to use, and on the big race day brought out his surprise tactics; R. J. Mecredy from Ireland; and the most famous pedaler of them all, J. H. ("Johnny") Adams.

From the U.S. came the phenomenal A. A. Zimmerman, who pedaled as small a gear as was currently possible on the high bicycle and won by his unbelievable ability to get the pedals round at speed. In 1899 there was a sensation in America when Charles



THE BETTMANN ARCHIVE, INC.

FIG. 2.—CHARLES M. ("MILE A MINUTE") MURPHY DURING THE RACE IN WHICH HE RODE FOR A MILE BEHIND A LONG ISLAND RAILROAD TRAIN IN 57⅘ SEC.: JUNE 30, 1899

M. ("Mile-a-Minute") Murphy rode on a wooden track between the rails behind a train with a wind shield at the back. At the first attempt to cover a mile within a minute, the engine could not reach the required speed. On the actual record ride behind a larger engine its weight rocked the track and nearly brought Murphy to disaster. He was shaken out of his shelter and got back only with great difficulty. At the end of the mile, which he covered in 57⅘ sec., the engine driver shut off steam too soon and the helpers on the rear of the pullman caught Murphy as he ran into the train and hauled him aboard.

In response to the growing interest in racing in the 1880s and '90s, organizations for the government of the sport were established in many countries. Among the most important, in addition to the National Cyclists' union in England, were the National Cycling association (N.C.A.) in the U.S. (the Amateur Bicycle League (A.B.L.) of America was not founded until 1921), The Canadian Wheelmen's association in Canada and the Union Vélocipédique in France.

The British National Cyclists' union founded an international organization for world racing and championships, but England, Scotland, Ireland and Wales were given separate representation and Britain dominated the international scene and British riders were supreme on road and track. Other countries resented this situation and in 1900 France, Belgium, Italy, Switzerland and the United States founded the Union Cycliste Internationale (U.C.I.) without Britain, which country had later to apply for membership with a single representation. In the 1890s Britain had won 6 of the 17 international title races and the U.S. provided four of the winners, but Britain did not win again for another eight years.

France, the country to which the founding of the U.C.I. was chiefly due, in 1903 established the Tour de France, covering about 3,000 mi. in approximately 25 days. Other European countries followed suit with similar "tours." In 1893 the founder of the Tour de France, Henri Desgrange, had established an unpaced hour record with 21 mi. 1,614 yd.; this blue ribbon classic record was improved by French, Belgian, U.S., Swiss, German, Italian and Dutch riders until, by 1960, Roger Rivière of France held the record with 29 mi. 739 yd.

The road race has been divided into two major styles. In Britain the main class of racing is the time trial wherein the riders start individually and are timed home again, so that the rider with the shortest elapsed time is the winner. This style was evolved after the 1890s, when the police prohibited racing in line. Elsewhere the massed-start road race is the most popular, and the first over the line at the finish is the winner. The Tour de France is run in that fashion with an occasional time trial section and the daily times of the riders are aggregated. At mid-20th century the race in line came into vogue again in Britain, but legal regulations were issued in 1960 to control the timing and

location of such events because of the growing weight of motor traffic. The time trial, although included in the regulations, was left to continue generally in its own way. (H. H. EN.)

By 1900 bicycle racing had become a major sport in the United States and Canada. A troupe of English professionals inaugurated it in the U.S. about 1870 when they introduced the high wheel. The dirt tracks used for trotting races served for the first set of cycling events, staged near Springfield, Mass. With the widespread adoption of the safety bicycle about 1889, board tracks were introduced.

For a time cycling was extremely popular all over the country. Manufacturers of bicycles and accessories kept the sport alive by organizing competing racing teams. With the coming of the automobile about 1895 cycling as a utility began to die out, only to return later as a sport, especially where tracks were located.

The first six-day bicycle race at Madison Square Garden in New York city was held in 1891, and this branch of cycling for many years attracted people by the thousands to the Garden and to the Coliseum in Chicago. In 1927 Detroit, with the completion of its new Olympia, holding 17,000 persons, saw its first six-day race, and that city joined the six-day circuit. In New York city six-day racing was witnessed by sports enthusiasts twice a year, in December and March, while Chicago had its two races in October and February. Six-day racing in North America spread from New York to San Francisco and Los Angeles, from New Orleans to Toronto (in 1912) and Montreal (in 1929).

Almost as rapidly as the sport had grown, however, the interest waned, and by 1938 the average weekly attendance at the New York races had dropped from more than 100,000 to about 50,000. As a result Madison Square Garden dropped six-day racing from its sports calendar, and other cities followed.

New records continued to be made. In 1940 Raymond Bryan rode from New York city to San Francisco, a distance of 3,149 mi., in 27 days 11 hr. In 1941 Alf Letourner, a professional rider, traveled at the rate of 108.92 m.p.h. behind a midget auto racing car on a California state highway. Letourner was officially timed by an American Automobile association representative.

In the United States, the N.C.A. controls professional racing. This body succeeded the League of American Wheelmen. All six-day races are held under N.C.A. sanction.

Since World War II bicycle racing in the United States has been confined almost exclusively to amateur riders, who compete under the sanction of the A.B.L. of America. With the disappearance of the banked, outdoor board tracks used by the professionals, the amateurs were forced to compete on the highways, in the early morning hours, or occasionally through town streets, and also on automobile race tracks and trotting horse tracks. Rarely is admission charged for any of these contests. The only professional racing has been a sporadic six-day race.

The A.B.L.'s program is financed by the American bicycle industry. The A.B.L. conducts state and national championships annually, but less than half of the states have an organized program. There are 15 to 20 states represented in the annual national title events, and the greatest concentration of activity may be found in New York, New Jersey, California, Michigan, Wisconsin, Massachusetts, Connecticut, Maryland, Illinois, Missouri, Pennsylvania and Washington. The many divisions in the national championships are: senior men, women, junior men (under 17), junior girls (under 17), boys and girls (over 15), boys and girls (over 10), midgets (9 to 10) and cubs (7 to 8).

The outstanding United States amateur road races are the Tour of Somerville (N.J.), the Grand Prix of Long Island, the Connecticut Valley championship and the Eastern Seaboard championship. United States amateurs also compete regularly in the two big Canadian races, the Tour du St. Laurent at 794 mi., and the 170-mi. Quebec to Montreal race. These races, and the Tour of Mexico, are rated the major road racing events in the western hemisphere.

Yale University's bicycle club revived intercollegiate bicycle racing in 1960. However, bike racing at the colleges is recognized only as a club sport by the institutions and intercollegiate athletic associations.

As for professional racing, the U.C.I. has more than 70 nations in its membership. The United States is the only country represented by two groups, the N.C.A. (professional) and the A.B.L. (amateur). The A.B.L. was admitted to membership in 1941 when it severed relations with the professionals. Among the members admitted in 1960 were the Republic of Korea, Mongolia, Kenya, Cameroon, the Philippines and Malaya. World professional and amateur championships have been enlarged to include three titles for women.

Parimutuel betting on bicycle racing is permitted in Japan, Denmark and Central America, and the races attract great crowds as a result of the wagering, but millions still attend the sport in Europe, Asia, South America and Australia every year. Six-day racing continues to draw heavily in Milan, Berlin, Dortmund, Frankfurt, Cologne, Zürich, Antwerp, Copenhagen, Aarhus, Brussels and Münster.

The Tour of Egypt and the Tour of Tunisia, for professionals, attract the world's biggest racing names and are considered rival events to the more ancient Tour de France and Giro d'Italia, also for professionals. The Tour de France, started officially in 1903, still remains, however, perhaps the most important event of cycling.

See also OLYMPIC GAMES. (W. RA.)

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CYCLONE. A name variously applied to rotating wind systems of a stormy character. In meteorology the term is applied to an area of relatively low pressure, usually 50 to 1,000 mi. in diameter, together with its revolving wind circulation; in common meteorological parlance these often are referred to as "lows." In popular usage the name cyclone sometimes is given to the small, extremely violent, twisting cloud appendage which is more properly called a tornado (*q.v.*). Meteorologists classify cyclones as (1) tropical cyclones and (2) extratropical cyclones. The first are called typhoons in the far east and hurricanes or cyclones elsewhere. For a complete discussion of them, *see* TROPICAL STORM. The second type, the extratropical cyclone, is the common rain- and snow-producing disturbance of middle and high latitudes. In England this type is commonly called a depression.

Both types of cyclones have a counterclockwise wind circulation in the northern hemisphere and a clockwise rotation in the southern hemisphere. The areas of low pressure appear on weather charts as oblong or nearly circular systems of isobars which stand out in sharp contrast with the areas of high pressure or anticyclones (*q.v.*).

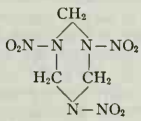
The extratropical cyclones generally move from west to east with the prevailing winds of their latitude, producing large areas of precipitation and relatively strong winds. The approach of an extratropical cyclone is recognized by an increase in the wind and a change in its direction from southwest through southeast to northeast, accompanied by falling pressure, increasing cloudiness and precipitation. As the centre moves eastward away from the observer, the pressure rises and the wind comes in from a direction between southwest and north. In most cases the weather then improves, although rain and snow of the shower type and general cloudiness may prevail. Warm air usually precedes the cyclone and cold air moves in somewhat suddenly behind. There is a typical pattern of these warm and cold air currents having distinct boundaries between them, known as fronts. It is in these contrasting temperatures that an extratropical cyclone is most clearly differentiated from a tropical cyclone, which contains horizontally homogeneous air.

On climatic charts as well as on most weather maps relatively permanent cyclonic centres are found in the northern Atlantic and Pacific oceans, known respectively as the Icelandic and Aleutian lows. In summer, semipermanent low-pressure centres exist over warm continental regions. They are in some places belts of low pressure, such as that which extends from the Sahara desert through the Red sea and Asia Minor to the Persian gulf, northern

India and Burma. A belt of low pressure also is found near the equator between the circulations of the oceanic anticyclones of the northern and southern hemispheres.

See METEOROLOGY; WIND; *see* also references under "Cyclone" in the Index volume. (H. R. B.)

CYCLONITE (cyclotrimethylenetrinitramine, $C_3H_6O_6N_6$, RDX, hexogen, T_4) is one of the most powerful explosives known. It was discovered by Hans Henning in 1899 but was not used prior to World War II. During that war most of the major warring nations introduced it into military use, but it was manufactured on a large scale only in the U.S. Its structural formula is:



The manufacture by the conventional process involves the nitration of hexamethylenetetramine, $C_6H_{12}N_4$, by a large excess of 98% nitric acid, during the course of which a considerable fraction of hexamethylenetetramine is oxidized. A secret manufacturing process which was developed in the U.S. and Canada and used in large-scale production during World War II made cyclonite into a rather inexpensive explosive available in large quantities to the Allies.

Cyclonite is a white, hard, crystalline substance, melting at 204° C. (with decomposition); specific gravity 1.82. It is insoluble in water and only slightly soluble in some other solvents.

Cyclonite is relatively sensitive to percussion and is used therefore largely in mixtures with other substances, such as TNT and beeswax, to decrease its sensitivity. These mixtures are known as Compositions A, B and C in the United States. Composition A is a semiplastic explosive which is pressed; Composition B is poured in molten form in the loading of ammunition. Composition C is a plastic explosive resembling putty which is used mainly for demolition purposes.

The name RDX was coined by the British as a contraction of "Research Department Explosive" and gained acceptance in the United States. The term hexogen was used by the Germans and the term T_4 by the Italians.

See W. A. Noyes, Jr. (ed.), *Chemistry*, vol. vi of *Science in World War II* (1948); T. L. Davis, *The Chemistry of Powder and Explosives* (1941–43). (G. B. K.; R. O. BE.)

CYCLOPEAN MASONRY, a term in architecture, used to define the rude polygonal masonry employed by the early Greeks, the Etruscans in Italy, in Tiahuanaco in Peru, etc. (from the Cyclopes, the supposed builders of the walls of Mycenae).

In the earliest examples it consists only of huge masses of rock of irregular shape piled one on the other and depending on their great size and weight for cohesion; sometimes smaller pieces of rock filled up the interstices. The walls of Tiryns, Mycenae and early Athens were so constructed. Near the gates the blocks were well squared to fit one another.

The date cannot be determined by the type of construction; where stratified rocks were obtainable, horizontal coursing may in some cases have been adopted early; in fact, there are instances in Greece of a later wall of cyclopean construction being built over one with horizontal courses.

CYCLOPS ("Round-eye"), a word having several uses in Greek legend and history. In Homer the Cyclopes are one-eyed cannibal giants, living a rude pastoral life in a distant land (traditionally identified with Sicily), having no social unit larger than the family (*see* ACIS; POLYPHEMUS). In Hesiod they are sons of Heaven and Earth, three in number—Arges, Brontes and Steropes (Bright, Thunderous, Lightener)—who forge the thunderbolts of Zeus; later authors say Apollo killed them for making the thunderbolt which slew Asclepius, and make them the workmen of Hephaestus.

The walls of several ancient cities (*e.g.*, Tiryns) of Mycenaean architecture are sometimes said to have been built by Cyclopes, perhaps the same as those of Hesiod. Hence in modern archaeology the term cyclopean is applied to walling of which the stones are not squared.

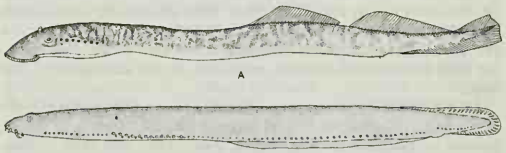
See W. Roscher, *Lexikon* (1924); *Larousse Encyclopedia of Mythology*, p. 141 (1959).

CYCLORAMA: *see* PANORAMA.

CYCLOSTOME, any of the lampreys and hagfishes, roundmouthed, eel-shaped, jawless fishes that compose the class (or order) Cyclostomata (Marsipobranchii or Cyclostomi). Together with fossil ostracoderms (*q.v.*; armoured, jawless fishes), these primitive vertebrates are often grouped in a superclass (or class) Agnatha.

Cyclostomes are all aquatic creatures, smooth, slimy and scaleless, with a cartilaginous skeleton. The known species—about 50—inhabit the waters of the temperate zones. Most are marine, but a few lampreys are confined to lakes and streams, and the sea lampreys spawn in fresh waters. The maximum size ranges from less than six inches to about three feet.

Importance.—Most of the cyclostomes are regarded as harmful to man because they destroy food and game fishes. The larger lampreys attach themselves to fishes and drain their blood. In the Great Lakes vast damage is thus inflicted by the sea lamprey, *Petromyzon marinus* (fig. 1[A]), which entered these waters by way of a canal and soon became very abundant, feeding extensively on lake trout and spawning in the lake tributaries. Efforts are made to control the increase of these lampreys by destroying the mature adults, which are caught in a weir placed in the spawning stream, and by the use of chemicals to destroy the larvae.



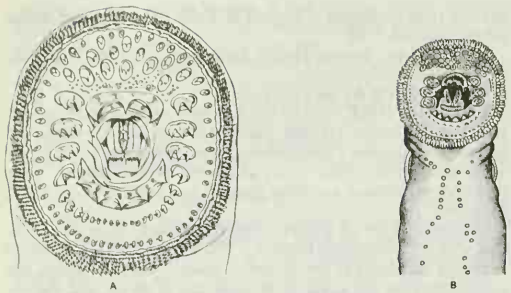
(A) AFTER DEAN; (B) BY COURTESY OF CARL L. HUBBS

FIG. 1.—TWO PRINCIPAL TYPES OF CYCLOSTOMES: (A) SEA LAMPREY (PETROMYZON MARINUS); (B) PACIFIC HAGFISH (EPTATRETUS STOUTII)

Marine food fishes are bled by seagoing lampreys, but suffer greater damage from the attacks of the hagfishes (fig. 1[B]), which eat their way into and through the flesh of food fishes. Large numbers of valuable fish are thus destroyed. Fish that are caught in nets or on set lines are particularly subject to such loss. On the other hand lampreys are esteemed as food in many places, and their larvae are extensively used as bait by fresh-water anglers. Adult brook lampreys, which are harmless because they do not feed, furnish, along with the larvae of all lampreys, considerable natural food for trout and other game fishes.

Scientifically the cyclostomes are of great significance, because they are the most primitive of the living vertebrates. The lamprey larva or ammocoete in particular is regarded as providing the closest facsimile of the ancestor of the backboned animals. For this reason the ammocoete is recommended as one of the types to be studied in comparative anatomy courses. Adult lampreys and the hagfishes depart from the ancestral form since many of them are specialized for parasitic existence.

Distinctive Characters.—The cyclostomes differ from all other living vertebrates in many important respects. None of their gill arches have been converted into jaws, for which reason they are classified among the jawless vertebrates, or Agnatha (a group that contrasts with the jaw-bearing vertebrates or Gnathostomata). The cyclostomes are also devoid of any trace of the paired fins (pectorals and pelvics), which, except for occasional loss through degeneration, are present in all other fishes and, in the form of limbs, are represented in all higher vertebrates. The muscular, protrusible tongue in all cyclostome fishes, and in the adult lampreys the buccal disc or funnel (fig. 2) as well, bear teeth that are composed of thin horny tissue rather than dentine or enamel. Instead of forming partitions between slits, the gills lie in spherical pouches that connect with the pharynx and with the exterior through tubes. The internal ear has only one or two



A B

(A) BY COURTESY OF CARL L. HUBBS; (B) FROM D. S. JORDAN, "FISHES"

FIG. 2.—BUCCAL DISCS AND TEETH OF (A) PARASITIC PACIFIC SEA LAMPREY (ENTOSPHENUS TRIDENTATUS) AND (B) NONPARASITIC AMERICAN BROOK LAMPREY (ENTOSPHENUS LAMOTTENII)

semicircular canals, not three as in typical vertebrates (the horizontal canal is missing). The brain is small, primitive and distinctive, and the brain case is incomplete, especially in the hagfishes. The skeleton is wholly cartilaginous, without any trace of calcification. The notochord is persistent throughout life and is nowhere constricted. No vertebrae proper (centra) are formed. The olfactory organ is a single median sac with an internal opening into the cavity of the pituitary and an external opening that lies on the midline either on the top or at the front of the head. On the basis of the narial structure some authorities classify the cyclostomes, along with certain extinct groups discussed below, as the Monorhini. All other vertebrates are said to be diplorhine, for they have paired nostrils, with one sac on each side of the head.

Life History.—All lampreys spawn in the spring on gravel beds in streams. The marine species migrate into the streams to breed, passing over dams and other obstructions. They inch their way up the sheer vertical walls by adhering by their sucking mouth disc. A lamprey life cycle is shown in fig. 3.

The males arrive first on the spawning grounds and start to prepare the nest. By adhering to and tugging out pebbles, the lamprey fashions a shallow depression. The newly arrived female then maintains a hold on a stone while the male clamps onto the female and twists around her, fertilizing the eggs as she extrudes

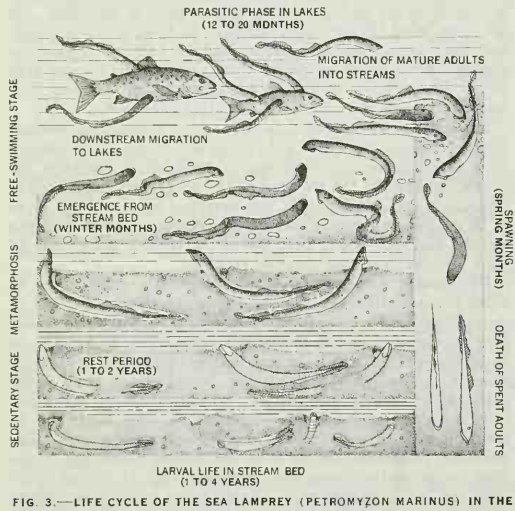


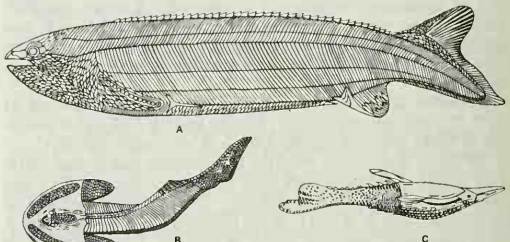
FIG. 3.—LIFE CYCLE OF THE SEA LAMPREY (PETROMYZON MARINUS) IN THE GREAT LAKES. THE LIFE SPAN OF THE LAMPREY MAY BE AS LONG AS 6½ TO 7½ YEARS, MOST OF THIS TIME SPENT IN THE SEDENTARY LARVAL STAGE; THE ADULT LAMPREY DIES SOON AFTER SPAWNING

them. The parents then loosen the pebbles lying on the rim of the nest so that the particles fall into the depression, thus surrounding and covering the eggs. By the time the spawning act is completed the adults are emaciated, and in a short time they die.

After about two weeks the eggs hatch and the larval or ammocoete life begins. The several size groups, each resulting from one year's spawning, indicate that the larval stage lasts several years. The wormlike, toothless, nearly blind larvae live in burrows in the bottom of mixed sand and mud, coming out at night to feed on the organic ooze, which is strained through the thick cirri in the hoodlike mouth.

After at least three years (often more) of such life the ammocoete rapidly transforms in the late summer and fall into the adult form. Many changes take place simultaneously: the eye becomes much larger and better developed; the hood is replaced by the disc and the cirri by teeth; the nostril opening moves from the front to the top of the head; and the body becomes rounder in cross section, the flesh firmer and the colour brighter. During this transformation, or metamorphosis, the lamprey shrinks considerably in length.

Soon after metamorphosis the sea lampreys become silvery and



A B C

(A) FROM J. KIAER, "THE DOWNTONIAN FAUNA OF NORWAY;" (B) AFTER A. S. WOODWARD, "PROCEEDINGS," BY COURTESY OF GEOLOGIST'S ASSOCIATION; (C) FROM A. S. ROMER, "VERTEBRATE PALEONTOLOGY"

FIG. 4.—FOSSIL RELATIVES OF CYCLOSTOMES: (A) PHARYNGOLEPIS OBLONGUS (ANASPIDA) FROM THE UPPER SILURIAN OF NORWAY; (B) CEPHALASPIS MURCHISONI (OSTEOSTRACI) FROM THE DEVONIAN OF HEREFORDSHIRE, ENG.; (C) PORASPIS (HETEROSTRACI) FROM SILURIAN OF SPITSBERGEN ISLANDS

large-eyed in preparation for life in the ocean, to which they promptly migrate. Some of the nonparasitic brook lampreys pass through this same stage, known as the macrophthalmia, as though in racial remembrance of the former seaward journey, though this trip has been abandoned for millenniums.

All parasitic lampreys feed and grow rapidly on their nutritious diet of fish blood. Those that remain in fresh water live thus for a year or more. A larger size is reached in the sea, presumably because of faster growth rather than a longer life span. After they become sexually mature, the parasitic species spawn once and then die, to complete the life cycle.

The nonparasitic species metamorphose at a size at least as large as do their parasitic relatives, but the teeth are poorly developed and the gut shrinks to a solid strand. Without taking any food they complete, overwinter, the ripening of the sex cells that had begun before the metamorphosis. Like the parasitic species they then spawn and die.

The hagfishes deposit a large, yellowish, yolk-filled egg. This is enclosed in a protective horny shell and is attached to the bottom of the sea by threadlike tendrils. The development is slower than in lampreys, and the young are much larger when hatched. They look very much like the adults, into which they gradually develop without a metamorphosis. In life history as well as in structure the hagfishes are very much unlike the lampreys.

Evolutionary History.—The fossil record as well as the evidence from comparative anatomy indicates that the Cyclostomata are cousins of the earliest and lowest vertebrates. The oldest fossilized remains of vertebrate animals, found in the Silurian deposits with traces in the yet more ancient Ordovician rocks, prove on close study to be similar in many respects to lampreys

and hagfishes. Superficially the fossils (fig. 4) bear little resemblance to their modern relatives, which, in correlation with their parasitic habits, are highly specialized in some respects and in other ways much degenerated. In fundamental anatomy, however, they were much alike. Thus the extinct forms resembled the cyclostomes in lacking jaws, for the anterior gill arches remain unaltered. They appear also to have lacked true paired fins, though in some species flipperlike flaps were developed in place of pectoral fins. The extinct forms agreed further with the cyclostomes in gill structure and in having had only two semicircular canals in the internal ear. Most of the extinct groups had, like the cyclostomes, a single median nostril.

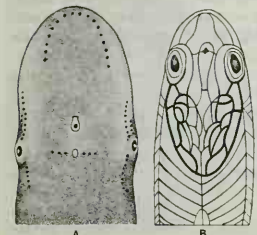
Most of these early fishes, and naturally those that are best known because most thoroughly preserved, were heavily armoured with dermal bone—hence the group name Ostracodermi that has often been applied to them as a whole. On these grounds many paleontologists have regarded the bizarre armoured fishes as the direct ancestors of the more ordinary modern types. It is more logical to assume, however, that both the armoured and the progressive types were derived from unarmoured fishes with the usual fish form. The highly specialized mailed kinds were probably evolved to provide protection from such enemies as the gigantic "water scorpions" of early times. Furthermore, such types had a much greater chance than their slender, soft-bodied and probably free-swimming ancestors to be fossilized and well preserved in the rocks. The more highly evolved, heavily armoured types persisted throughout Late Silurian time and all of the Devonian, along with the earlier jawed or gnathostome fishes which are classified as the Placodermi. None of the Ostracodermi is known to have survived beyond the end of the Devonian, but some primitive member of the Agnatha must have persisted, to give rise to the living group with which we are dealing. In conformity with an evolutionary rule, the highly specialized group died out while some generalized relative lived on.

Fossil Relatives.—Since the cyclostomes are the only living Agnatha or jawless vertebrates, their relatives are to be sought exclusively among the extinct fishes. Three groups, commonly treated as orders, all Paleozoic and none persisting beyond the Devonian, show evidence of relationship with the lampreys and hagfishes: they are the Osteostraci, Anaspida and Heterostraci, composing the Ostracodermi. The common feature of all ostracoderms is their plated or armoured skin (*see* OSTRACODERM).

In some ways the most lampreylike of the fossils were the Anaspida (fig. 4[A]). These Silurian and Devonian creatures seem primitive because of their small size (none exceeding ten inches), their almost ordinary fish form and their small scales, which apparently overlaid the muscle segments.

As in the cyclostomes, they had the eyes lateral and a single nostril in front of the third or pineal eye (fig. 5), and the gill openings formed a row of pores on each side.

The Osteostraci (fig. 4[B]) also had a median, superior nostril and a row of porelike gill openings, but differed from the Anaspida (and from the cyclostomes) in having the head enclosed in a flat bony shield.



A B

FROM J. KIAER, "VIDENSK. SKRIFT.," OSLO

FIG. 5.—HEAD OF LIVING LAMPREY COMPARED WITH A FOSSIL RELATIVE: (A) SEA LAMPREY (PETROMYZON); (B) SILURIAN ANASPIDA (RHYNCHOLEPIS)

The Heterostraci were armoured fishes (fig. 4[C]) that closely resembled the Osteostraci. Both groups were abundant in Late Silurian and Early Devonian times and disappeared completely by the end of the Devonian. In this group the armour lacked the bone cells that were characteristic of the Osteostraci. The paired eyes were far apart, and there was no dorsal nostril. The olfactory organs, which were close together but paired, are supposed to have opened into the mouth cavity.

The Devonian group known as Cycliae or Palaeospondyloidea is

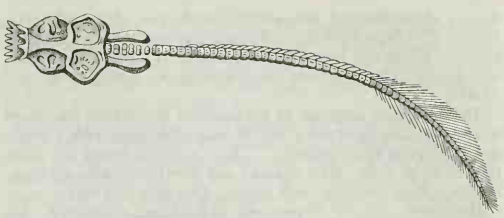


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FIG. 6.—FOSSIL REMAINS OF PALAEOSPONDYLUS GUNNI FROM THE SILURIAN OF SCOTLAND (TWICE NATURAL SIZE)

recognized for one of the most problematical of the fossil vertebrates, *Palaeospondylus* (fig. 6), which by some has been thought to be an ancient lamprey or lampreylike animal. If so, the living lampreys must be very degenerate, for they lack the vertebral centra that are well developed in the fossil. Other zoologists have regarded it as a larval arthrodire. The remains of this one- to two-inch fishlet abound in one quarry in Scotland and have been very thoroughly studied. Nevertheless, opinions differ as to whether or not the group had gills or paired fins, and relationships of the group remain uncertain.

CLASSIFICATION

The Cyclostomata are divided into two subgroups, which are different in anatomy, appearance and habits:

	Hyperoartii (lampreys)*	*Hyperotreti* (hagfishes)
Nasal opening	On top of head	At front of head
Pituitary canal	Closed internally	Opening into pharynx
Cartilaginous rings around this canal	Lacking	Developed
Pineal eyes	Easily visible	Degenerate
Eyes	Well developed	Vestigial
Oral funnel	Developed	Not present
Teeth	On disc also	Only on tongue
Tentacles about mouth and nostril	Lacking	Six, supported by cartilage
Number of gills	Always 7	5 to 14
Gill openings	Close to head	Remote from head
Internal gill tubes	United	Separate
Duct on left side, pharynx to exterior	Lacking	Developed
Branchial skeleton	A conspicuous basketwork	Greatly reduced
Dorsal fin	One or two well developed	None or only a trace
Neural arches	Present	Lacking
Dorsal and ventral roots of spinal nerves	Distinct	United
Kidneys	Compact organ	Separate
Eggs	Minute, without horny shell	Very large, with horny shell
Development	With larva and metamorphosis	Direct (young much like adult)
Spawning place	Gravel in streams	Ocean floor
Feeding on	Fish blood	Fish flesh, etc.
Type of parasitism	External	Internal

*The characters are those of adult lampreys. In several respects the lamprey larvae agree with the Hyperotreti.

The differences between the lampreys and the hagfishes are so extensive and so fundamental as to lead some authorities to think that the two groups are unrelated. They appear, however, to have had a remote common ancestor.

Lampreys.—The Hyperoartii, or lampreys, may be classified into three families. The chief family, Petromyzonidae, comprises all the northern hemisphere species. The well-known sea lamprey, *Petromyzon marinus*, occurs on both sides of the Atlantic. Three related genera, *Eudontomyzon, Entosphenus* and *Lampetra,* occur in Eurasia as well as in North America. The primitive genus *Ichthyomyzon,* with more species than any other, inhabits only the fresh waters of eastern North America. *Caspiomyzon* is confined to the Caspian sea basin. About half the species of Petromyzoni-

dae are of the dwarfed, nonparasitic brook type, with weak teeth. Nearly all of these have arisen through degeneration from different parasitic kinds, and hence they are named as distinct species (in the genera *Ichthyomyzon, Eudontomyzon, Entosphenus* and *Lampetra*).

The distinctive lampreys of the southern hemisphere are placed in two families, Geotriidae and Mordaciidae, each with a single genus (*Geotria* and *Mordacia*). These southern genera live along the coasts of Chile, New Zealand and Australia. Like all other lampreys they spawn in fresh water. (*See* also LAMPREY.)

Hagfishes.—All the Hyperotreti, or hagfishes, are marine. Except for a few species in deep water within the tropics, all are inhabitants of the temperate zones—in the North Atlantic, western North America, Japan, New Zealand, Chile, Patagonia and South Africa. Fewer than 24 species are recognized. They are generally regarded as constituting a single family Myxinidae. Some authorities restrict Myxinidae to genera (principally the genus *Myxine*) that have a single external gill opening on each side, placing the genera (*Eptatretus*, etc.) with 6 to 14 such openings on each side in a separate family, Eptatretidae. In view of the similar basic structure of all hagfishes, and the closely approximated gill openings of the genus *Paramyxine*, the family separation has generally been abandoned. *See* also HAGFISH.

See also references under "Cyclostome" in the Index volume.

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(C. L. Hs.)

CYCLOTRON. The cyclotron is a device for accelerating nuclear particles to very high speeds. These high-speed particles are used by physicists to investigate the properties of atomic nuclei and to produce nuclear transmutation and artificial radioactive substances. *See* ACCELERATORS, PARTICLE; *see* also references under "Cyclotron" in the Index volume.

CYGNUS (the Swan), in astronomy, a constellation of the northern hemisphere fabled by the Greeks to be the swan in the form of which Zeus seduced Leda. Its brightest star is Deneb, a first magnitude star. β Cygni is a fine-coloured double star, consisting of a yellow star, third magnitude, and a blue star of magnitude 5.5. A cross formed by six stars of the constellation is called the Northern Cross.

A wide double star, 61 Cygni, because of its large proper motion of 5″ per annum, was singled out by F. W. Bessel for the first successful attempt to measure stellar parallax. The parallax is about 0.31″. The constellation includes one of the most interesting regions of the Milky Way for astronomical research.

CYLINDER. In its oldest mathematical sense a cylinder is the space swept out by a rectangle (fig. 1) rotating around one side as axis. It is from the Greek *kylindros*, "roller," from *kylindein*, "to roll." The side (called the *generatrix*, *g*) parallel to the axis (*a*) traces the curved *cylindrical surface;* the other two sides (each equal to *r*) trace the circular *bases* of such a cylinder, which is more precisely termed a *right circular cylinder.* The most common generalization supposes *g* not perpendicular to the parallel base-planes, but oblique, inclined at a fixed angle (like a pencil in writing), and tracing in the planes equal circles about the ends of the oblique axis as centres (fig. 2).

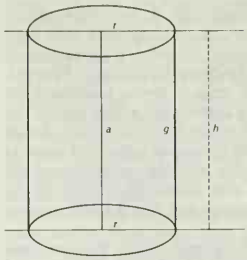


FIG. 1.—RIGHT CIRCULAR CYLINDER

Area and Volume.—The perpendicular distance between the planes is called the cylinder's *altitude* (*h*). The area of each base is clearly πr^2; the product of base and altitude is the cylinder's volume $\pi r^2 h$; the area of its curved surface is the product of its altitude and the circumference of its base; *i.e.*, $2\pi rh$. A sector of the cylinder has a volume and curved surface proportional to the sector's angle.

Archimedes' Work.—The metrical relations of a cone, hemisphere and cylinder of the same base and height were studied by Archimedes of Syracuse (*c.* 225 B.C.), who showed (in Book I of his *On the Sphere and Cylinder*) their volumes to be respectively as 1 : 2 : 3; and the surface of the hemisphere to equal the curved surface of the (right) circumscribing cylinder. These relations were deemed so important and beautiful by Archimedes that he expressed the wish that the sphere-cylinder figure be engraved on his tomb, a wish fulfilled by command of Marcellus and furnishing a mark by which the quaestor Cicero identified it in 75 B.C., after nearly a century and a half.

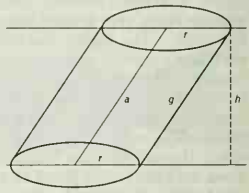


FIG. 2.—OBLIQUE CYLINDER

Generalization of Concept.—The more modern view regards the cylindrical surface as the cylinder itself (compare the cone, *q.v.*), and defines it in full generality as the surface traced by a right line (*g*) moving without turning; *i.e.*, always parallel to itself or to some fixed line or direction. To make such a surface definite, a *directrix* (D), generally a curve which the generatrix (*g*) describes upon passing through its points (fig. 3), must be prescribed. Obviously such a surface is *developable;* that is, it may be imagined as flattened or rolled out smooth, without stretching, tearing or crinkling, on a tangent plane which evidently touches the surface full length along an element in any one of its positions. In case the directrix is an ellipse, the surface has been called a "cylindroid," and may be defined as the path of an ellipse moving always parallel to itself, its centre always on a fixed line or axis. The same name is also applied to the conoidal cubic surface traced by the intersection of two moving planes $y = x \tan \theta$, $z = m \sin 2\theta$ whence, on eliminating the parameter θ, there results the equation of the surface, $z(x^2 + y^2) = 2mxy$. Clearly, any cylindrical surface may be viewed as a straight tube traced by a directrix moving always straight and keeping always parallel to itself.

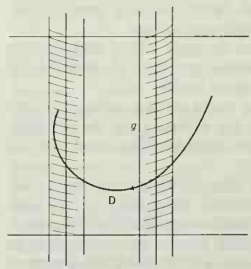


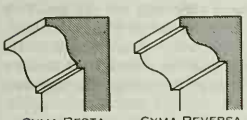
FIG. 3.—GENERATRIX AND DIRECTRIX

Sections.—If a directrix has a centre, the line through it, along which the centre moves parallel to *g*, is called the *axis.* Any plane through the axis makes a *principal section*, namely, two opposite parallels, elements of the surface, which, with two parallel sections of this plane by two parallel planes through the cylinder, form a parallelogram. This parallelogram becomes a rectangle if the two planes are perpendicular to the generatrix *g*. In a right circular cylinder such a perpendicular plane cuts the cylinder in a circle, but any plane oblique to the axis cuts the cylinder

in an ellipse, which is thus seen to be the parallel projection of a circle on an inclined plane, a fact leading directly to many properties of that curve (*see* ELLIPSE). If the circular cylinder is not right but oblique, then the plane sections across it are in general elliptic, but become circular for planes parallel to the directrix circle. The same conditions occur in oblique cones.

The cylinder may be regarded as a cone whose vertex has withdrawn to infinity (G. Desargues, 1639). Accordingly, all oblique sections of the right circular cylinder yield ellipses, but those parallel to an element (g) or the axis yield a pair of parallels, a limiting case of the parabola. Still further turned, the plane again cuts through, giving ellipses. But the same two parallels may be considered to be a limiting case of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, which for $b = \infty$ becomes $x = \pm a$, a hyperbola straightened out into a pair of right lines tangent at the vertices. The conjugate hyperbola, $\frac{x^2}{a^2} - \frac{y^2}{b^2} = -1$, on the same supposition ($b = \infty$) becomes a pair of imaginary lines, $x = \pm a\sqrt{-1}$.

See SURFACE; *see* also references under "Cylinder" in the Index volume. (W. B. SM.)



CYMA RECTA CYMA REVERSA

CYMA, in architecture, a molding of double curvature, whose profile is concave at one end, convex at the other. When the more projecting portion is concave it is known as a *cyma recta*, when convex as a *cyma reversa* (Gr. *kuma*, "wave"). *See* MOLDING.

CYMATIUM, the uppermost member of a classic cornice (*q.v.*), usually consisting of a projecting molding. In the Greek Doric the cymatium occurs only upon the pediment cornices, returning along the sides only the depth of the pediment coping which it decorates. It is in the form of an ovolo or projecting convex molding.

The cymatium also takes an ovolo form in the Tuscan order, a cavetto or concave form in the Roman Doric and a *cyma recta* form, or molding of double curvature, elsewhere. *See* MOLDING; ORDER.

CYMBALS, percussion instruments consisting of two circular metal plates struck separately or together. The use of cymbals is recorded in many ancient civilizations. They appeared in Israel about 1100 B.C. and are mentioned in the Bible. In China and elsewhere in Asia there were two kinds, the broad-rimmed cymbal, held horizontally, and the small-rimmed cymbal, held vertically. In the middle ages the term *cymbala* signified the small bells used to accompany a liturgical chant.

Modern orchestral cymbals derive from those used in Turkish military bands. In the 18th century Turkish military music enjoyed a vogue in central Europe and cymbals were introduced in works by Haydn (notably his "Military" Symphony, 1794), Mozart and Beethoven. Of indefinite pitch, modern cymbals consist of a pair of thin circular plates from 14 to 18 in. in diameter, made from an alloy of copper and tin. The plates are domed for the inclusion of the knot of the holding strap and are slightly tapered to secure contact at the edges only.

Cymbals are played (1) by clashing the plates together; (2) by striking a single plate with a soft or hard-ended drum stick; (3) by producing a sustained note in the form of a tremolo on one suspended cymbal; and (4) by rubbing the plates together. The sounds produced cover a wide range of dynamics. In romantic music, *e.g.*, Wagner's *Tannhäuser*, they are frequently used to mark a dramatic climax. Berlioz, Debussy and Ravel specified the use in their scores of small cymbals producing high notes of a definite pitch. Twentieth-century composers introduced the pianissimo tremolo on a suspended cymbal. Jazz musicians employ several different ways of playing cymbals, including a method of striking them at elbow height with the help of a pedal mechanism. (J. BL.)

BY COURTESY OF (LEFT) THE METROPOLITAN MUSEUM OF ART, ROGERS FUND, 1908; (RIGHT) THE PREMIER DRUM CO., LTD.

(LEFT) COPPER CYMBAL FROM THEBES, EGYPT; GRECO-ROMAN PERIOD. IN THE METROPOLITAN MUSEUM OF ART; (RIGHT) MODERN ORCHESTRAL CYMBALS

CYNEGILS (d. 641), king of the West Saxons from 611 to 641, succeeded Ceolwulf. With his son Cwichelm he won a victory against the Britons at an unidentifiable place called Beandun in 614. In vengeance for an attack made on him by an assassin sent by Cwichelm, Edwin of Northumbria came to Wessex with an army in 626 and defeated the West Saxons. Cynegils and Cwichelm fought in 628 against Penda of Mercia at Cirencester, afterward coming to terms. Cynegils was the first West Saxon king to be converted and was baptized at Dorchester-on-Thames in 635 by Bishop Birinus.

See *Anglo-Saxon Chronicle;* Bede, *Historia Ecclesiastica*, book ii, ch. 9, book iii, ch. 7. (D. WK.)

CYNEWULF (d. 786), king of the West Saxons from 757 to 786, succeeded after the deposition of Sigeberht and later drove him into the Weald. He fought many battles against the Britons, and he seems mainly to have been independent of Offa of Mercia until they fought at Bensington (Benson, Oxfordshire) in 779. Until this date he held parts, at least, of Berkshire and Oxfordshire. He made several donations to the church and sent a letter to the missionary Lul in Germany. In 786 he was present when King Offa received the papal legates, but later in the year he was slain by Cyneheard, the brother of his predecessor Sigeberht, at Meretun, defending himself nobly against the men who had surrounded his chamber. The refusal of his followers to accept quarter and the similar loyalty of Cyneheard's followers to their lord made the incident a famous one.

See *Anglo-Saxon Chronicle; English Historical Documents*, vol. i, ed. by D. Whitelock, pp. 23 ff., 162 ff., 165 ff., 457–459, 469, 770 (1955). (D. WK.)

CYNEWULF, the author of four Old English poems preserved in late 10th-century manuscripts, two (*Elene* and *The Fates of the Apostles*) in the *Exeter Book* (*q.v.*) and two (*The Ascension*, which forms the second part of a trilogy, *Christ*, and is also called *Christ II;* and *Juliana*) in the *Vercelli Book* (*q.v.*). An epilogue to each poem, asking for prayers for the author, contains the runic characters which represent the letters *c, y, n, (e), w, u, l, f*. The names of five of these runic characters are nouns current in Old English, and, except in *Juliana*, are to be read in these senses in the passages containing the signature. The names of the runic letters *c, y, u*, meaning "torch," "bow," "bison," are not recorded except as rune names, and it is disputed whether they can be made to give sense in these meanings, or whether these runes merely stand individually for the author's name.

In *Juliana* and *Elene* the name is spelled "Cynewulf"; in *The Ascension* and *The Fates of the Apostles* the form is "Cynwulf," a variant of no significance for dating. The spelling *Cyne-*, instead of the earlier *Cyni-*, shows that the poet could not have been writing before the late 8th century if a Mercian, and not before the 9th century if a Northumbrian. A rhymed passage in the *Elene* proves that he came from one of these areas. Nothing is known of him outside his poems, as there is no reason to identify him with any of the recorded persons bearing this common name. The 8th-century bishop of Lindisfarne, with whom he has been identified, would have spelled the name with an *i*.

The poems are all based on Latin sources, and it is probably to Latin influence that they owe their clarity and their smoothness of syntax. They display much metrical skill and a felicitous use of traditional poetic diction, especially in descriptions of voyages and battles.

As a narrator, Cynewulf does little to improve the low quality of his Latin originals, but in *The Ascension*, where the source is a homily of St. Gregory, he shows genuine religious fervour.

There have been many attempts to assign to Cynewulf other extant poems: the *Riddles* from the *Exeter Book*, the other two parts of the *Christ* trilogy, the *Phoenix* and the two poems on *Guthlac* (also in the *Exeter Book*) and the *Andreas* and *The Dream of the Rood* from the *Vercelli Book*. None carries conviction. *The Dream of the Rood* cannot be his, for some lines are inscribed on the Ruthwell cross, for which a date later than the early 8th century is highly improbable.

Detailed studies of metrical technique have led to a widely accepted belief that only the first part of *Christ* and *Guthlac B* could be added to the canon of Cynewulf's work, and even this cannot be proved.

Bibliography.—For facsimiles and editions of the *Exeter Book* and the *Vercelli Book* see the articles on them. The individual poems are edited as follows: *Christ* by I. Gollancz (1892) and by A. S. Cook (1900); *Elene* by J. Zupitza (1877), by A. S. Cook (1919), by F. Holthausen, 4th ed. (1936) and by P. O. E. Gradon (1958); *Juliana* by W. Strunk (1904) and by R. Woolf (1955); *The Fates of the Apostles* (with *Andreas*) by G. P. Krapp (1906). They are translated by C. W. Kennedy, *The Poems of Cynewulf* (1910). The best study is that of K. Sisam, "Cynewulf and His Poetry," in his *Studies in the History of Old English Literature* (1953). *See* also C. W. Kennedy, *The Earliest English Poetry*, pp. 198–266 (1943); C. Schaar, *Critical Studies in the Cynewulf Group* (1949), where full bibliographies of previous works are given; R. W. V. Elliott, "Cynewulf's Runes in *Christ II* and *Elene*" and "Cynewulf's Runes in *Juliana* and *The Fates of the Apostles*," *English Studies*, xxxiv (1953). (D. Wk.)

CYNGHANEDD, a Welsh word meaning, literally, "harmony," the name of the complicated system of consonantal correspondences and internal rhyme obligatory in the 24 strict metres of Welsh bardic verse. It had developed by the 13th century from the alliteration and internal rhymes used by the early bards, and has been practised ever since. There are four main patterns: (1) *Cynghanedd lusg*, in which the accented penultimate syllable rhymes with a preceding syllable, *e.g.*, "Am ysbryd *dewr* y *cẃri*"; (2) *Cynghanedd sain*, in which there is an internal rhyme between the first and second parts of a line, and a consonant or consonants in the second part answered in the third, *e.g.*, "Gwan y *bardd*/*sýthardd*/*sẃithu*g"; (3) *Cynghanedd groes*, in which the consonants in the first half of the line are answered in the second, but the last syllable in each part must be different, *e.g.*, "Y *gŵr márw*/e *gâr mórwyn*"; (4) *Cynghanedd draws*, which is the same in principle as *cynghanedd groes* except that consonants in the middle of the line are left unanswered, *e.g.*, "A'i *chẃrw* (a'i medd) a'i *chá*riad." The system in all its variations is much more elaborate and complicated than the four basic patterns.

See J. Morris-Jones, *Cerdd Dafod* (1925); G. J. Williams and E. J. Jones, *Gramadegau'r Penceirddiaid* (1934). (T. Js.)

CYNICS, members of a sect of ancient "philosophers," distinguished by a way of life and by a few dogmas rather than by any coherent system of thought. Their name is derived from the Greek word for "dog" (*kuon*, adjective *kunikos*), in contemptuous allusion to their shameless and aggressive manners; but they accepted the opprobrious term, saying that it was their business as watchdogs of morality to terrify malefactors. The originator of the sect was Diogenes (*q.v.*), who in the second half of the 4th century B.C. set about exposing current conventions as false coinage. It was his object to get back to the "natural" life, which he saw as identical with the simple life. Ideally this would mean the disappearance not only of luxuries but also of organized communities, whose laws and customs must be accounted "conventional" (even the family is an unnatural institution: in the state of nature men and women would be promiscuous and the children a common concern of all). He himself lived as a vagabond pauper, sleeping in public buildings and begging his food. This was not a life that all men could be desired to lead or that was led by all Cynics: Diogenes' object was to give an extreme example of how one could be happy and independent, although absolutely destitute. "Self-sufficiency," to have all that one needs within oneself, is the first of the Cynic's aims. To this he adds "shamelessness," which means disregard for the conventions which prescribe that actions harmless in themselves may not be performed in all circumstances; and "outspokenness," which is not merely an avoidance of conventional euphemism but also part of the armoury of the Cynic in his missionary task of exposing vice and conceit and stirring men to reform. Further, just as physical excellence comes from training, training (*askesis*, from which is derived "asceticism") is necessary for moral excellence; it takes the form of inuring oneself to hardship and to privation and of developing resistance to the pressures of pleasure and pain. Self-sufficiency and training for virtue had earlier been preached by Antisthenes (*q.v.*), to whom Diogenes acknowledged an indebtedness, but the extreme anticonventionalism and the reforming zeal which are characteristic of the Cynic are Diogenes' own contributions.

Zeno, the founder of Stoicism, was strongly influenced by Diogenes' pupil Crates of Thebes (*see* Crates), who was known as "gatecrasher" from his habit of intruding into families with his advice; but Zeno perceived the unsatisfactoriness of the Cynic's "virtue," which, being no more than a contempt for the usual objects of desire (wealth, honour, love, physical pleasures, etc.), was essentially a negative conception, even if presented in the guise of being master of one's will and impregnable to fortune. By his recognition of "preferred" things he opened the way to a positive system of ethics.

The most important Cynic of the 3rd century B.C. was Menippus (*q.v.*), who developed the genre of *spoudaiogeloion* (a mixture of jest and earnest), which Crates had initiated. Marcus Aurelius calls him "the mocker of mankind": indeed in any Cynic's view, most human activities involve a conceited delusion that it is his duty to expose. The nature of Menippus' works must be guessed from their titles and from the fact that Lucian found inspiration in them: they included a *Journey to the Underworld* (where the Cynic gloated over the disappearance of this world's illusions, wealth, power and beauty); *Letters from the Gods; The Sale of Diogenes* (a fiction later taken for a fact); and various mockeries of scientists and philosophers. Chance has preserved more of a less famous author, Cercidas of Megalopolis. He played an active part in the politics of the late 3rd century and, instead of merely mocking the rich and the wicked (whom he considered to be identical), proposed to usurp the neglected function of heaven and to distribute their wealth to the virtuous poor. This kind of activity may have been unusual among professed Cynics, but his attacks on other philosophers for futility, his disapproval of the charms of music and his praises of Diogenes are quite in the authentic style of the sect.

Another literary figure was Bion, from Borysthenes on the Dnieper, who developed a style of popular preaching, made palatable by similes, anecdotes, allegories, etc. A Cynic phase left its mark on his ideas, and his style in turn influenced later Cynics who wished to reach the multitude.

How many followed the Cynic way of life in the Hellenistic period is not known, but such persons were prominent in the Greco-Roman civilization of the early empire. There were many who brought the name of Cynic into disrepute. It was all too easy for a poor man to make a virtue of necessity and, calling himself a Cynic philosopher, to enjoy the licence of "shameless outspokenness" at the expense of the prosperous, to the admiration of the more simple-minded proletariat. Doubtless such elements were to be found among the Cynics who caused riots at Alexandria in Trajan's time. The other extreme is represented by the Stoic Epictetus' stirring picture (*Discourses*, iii. 22) of the ideal Cynic, who renounces all comfort, all family life, because he is God's soldier and must be free from impediments that might interfere with the bringing of God's message to the whole human family, to whom he is father and brother.

Stoicism and Cynicism were commonly associated (Juvenal speaks of them as virtually identical) in an age when many Stoics emphasized endurance, abstinence and internal independence at

the expense of those more positive aspects of Zeno's teaching that had distinguished him from his master Crates. But a survey of the more renowned Cynics of the 2nd century A.D. makes it clear that they had no common system of philosophy. Demonax, who lived at Athens about A.D. 70–170, devoted himself, like Epictetus' ideal, to the service of mankind and in particular to the restoration of good will, but, unlike him, was an atheist and a municipal politician. Religious shams were also attacked by Oenomaus, from Gadara in Palestine, who wrote against oracles and prophecies. On the other hand, Peregrinus Proteus (whom Lucian treats, too superficially, as a mere charlatan) at one time combined Christianity with his Cynicism and later adopted elements from Neopythagoreanism and from Greek and oriental religions. Finally, declaring that, having lived like Heracles (who was a Cynic hero for his labours on mankind's behalf), he would die like him too, he burned himself to death after much publicity and amid scenes of the wildest excitement at the Olympic games of A.D. 165. He certainly intended to set a memorable example of contempt for death; he may also have hoped for the cult that was established in his memory by those who supposed him to have passed through the purification of the flames to a higher form of life.

A recurring characteristic among Cynics of the early Roman empire is that they publicly attacked the emperor, but this does not imply any common political program. Some emperors' private lives and public acts provided ample material for denunciation, and even "good" emperors were objectionable because they pandered to their subjects' material desires. Thus Peregrinus obliged Antoninus Pius to expel him from Rome and, in Greece, denounced the philanthropic millionaire Herodes Atticus for providing Olympia with a water supply.

There were Cynics to the end of the ancient world. The emperor Julian, while favouring and practising a pious Cynicism as the "natural universal philosophy," upbraids contemporary Cynics with hypocrisy and greed—old charges these—and joins them with the hated "Galileans." In fact, although there were still atheists among them, other Cynics were professed Christians, and the sect was recommended to the early church by its neglect of the body, by its contempt for civil authority and by its self-dedication to the task of preaching reform to a universal human brotherhood.

See K. von Kritz, "Quellenuntersuchungen zum Leben und Philosophie des Diogenes von Sinope," *Philologus*, supplement 18 (1926); D. R. Dudley, *A History of Cynicism from Diogenes to the 6th Century A.D.* (1937). (F. H. Sh.)

CYNOCEPHALUS, the generic name for one of the flying lemurs, also commonly called cobegos or colugos. These oriental animals are a singular group of mammals usually placed within the Insectivora (*q.v.*) as a distinct suborder, but sometimes ranked as a separate order (Dermoptera). The name pertains strictly only to the Philippine species, *C. volans*, formerly called *Galaeopithecus*. According to the rules of zoological nomenclature, the latter name had to be replaced by *Cynocephalus;* this change has caused confusion because the term *Cynocephalus* had also been employed for the baboons (*q.v.*).

In appearance colugos resemble large flying squirrels and have similar habits, being arboreal climbers and gliders with extensive lateral gliding membranes and large five-toed feet, webbed and clawed. However, the form of the head and the nocturnal habits recall the lemurs. The tail is relatively short, but connected by skin folds with the hind limbs, as in bats. Most peculiar are the teeth, which number 34. The lower incisors are directed forward and present a comblike structure due to multitudinous enamel foldings; the lateral pair, like the canines, are double-rooted. Canines are lacking in the upper jaw. Cheek teeth bear sharp cusps and include premolars and molars.

Internally the large intestine is longer than the small and there is a huge caecum of complex structure correlated with the diet of leaves; but the stomach is simple, though more specialized than in insectivores. The brain resembles that of insectivores in the exposure of the *corpora quadrigemina*, but each hemisphere is marked by two longitudinal furrows—a combination not met with in any other mammal.

Besides the Philippine species, a series of other forms ranges from Burma, Thailand and the Malay peninsula to the Malay archipelago from Sumatra to Borneo. These forms are all regarded as races of a single species, *Galeopterus variegatus,* distinguished by its larger upper incisors, shorter ears and smaller skull.

(W. C. O. H.)

CYNOSCEPHALAE ("Dogs-heads"), the name of a range of hills in Thessaly, Greece (about 7 mi. W. of modern Volos), the site of the defeat by the Theban general Pelopidas (*q.v.*) in 364 B.C. of Alexander, tyrant of Pherae, and also in 197 B.C. of a more celebrated battle, the final victory of Rome over Philip V of Macedonia in the Second Macedonian War.

The Roman army under Flamininus (*q.v.*) numbered about 26,000 men, of whom about 8,000 were Greeks; it was stronger than the enemy in cavalry and had some war elephants. Philip's army numbered about the same; his phalanx comprised 16,000 men. After some skirmishing near Pherae on ground that proved unsuitable, Philip, who needed supplies and level ground for his phalanx, marched westward along the northern slopes of some hills which ended in the low range called Cynoscephalae. For three days Flamininus marched along the southern slopes, but out of touch with the enemy. When Philip turned southwest to cross Cynoscephalae toward Pharsalus, his advance force blundered in a mist into some Romans. A fluctuating skirmish developed into a pitched battle. Flamininus drew up his line along the south of the hill, while Philip advanced his centre and right wing over the rough ground, leaving his left wing under Nicanor to follow as soon as possible. Flamininus, however, had left his own right wing stationary, and led his left up the hill and drove back Philip's mercenaries. Unable to wait for Nicanor, Philip launched his main phalanx force, before whose weight the Roman left gave ground. Thereupon Flamininus galloped over to his own right wing, which routed Nicanor's wing before it could deploy. With each side victorious on one wing, the issue hung in the balance, when an unknown Roman tribune saw what ought to be done. Detaching 20 maniples from the rear of the victorious Roman right wing, he led them against the flank and rear of the Macedonian right. The day was lost. Philip fled, leaving 8,000 dead and 5,000 captured. The delay of his left wing, the roughness of the ground, a tribune's initiative, and the greater flexibility that Scipio Africanus had given to the legion had secured the victory.

Bibliography.—Polybius, xviii; Livy, xxxiii; J. Kromayer, *Antike Schlachtfelder,* vol. ii, p. 63 *et seq.;* for details of topography, etc., *see* F. W. Walbank, *Philip V of Macedon,* p. 167 *et seq.* (1940).

(H. H. Sd.)

CYPERACEAE, the sedge family of grasslike plants, often confused with the grasses and the rushes. Most sedges are perennials that have long creeping rootstocks or form dense clumps, but some are annuals. They have three-sided leafy or leafless herbaceous stems that range from a few inches to twelve feet in height and differ from grasses (Gramineae) in the three-ranked leaves with closed sheaths. From the rushes (Juncaceae) they differ in having a leathery or hard-walled fruit with a single seed. The flowers of the sedges are minute, and consist of only a pistil, two or three stamens and sometimes an appendage of bristles. The flowers are clustered in spikelets, and each flower is commonly subtended by a coloured scale.

RUTHERFORD PLATT

FIG. 1.—COTTON GRASS (ERIOPHORUM POLYSTACHION)

Practically all sedges are wind-pollinated. They are widespread throughout the world, and they play an important part in the formation of peat, especially in boreal regions.

About 70 genera and 4,000 species are known. *Cyperus,* with about 600 species, predominates in tropical marshes, and includes

papyrus (*q.v.; C. papyrus*), the bulrush of the King James Bible and the original source of paper. *C. esculentus*, known as chufa, is cultivated for the edible tubers.

Carex, with over 1,000 species, predominates in temperate regions, and grows in a great variety of habitats. More than 400 species are known from North America alone.

JOHN H. GERARD

FIG. 2.—UMBRELLA PLANT (CYPERUS ALTERNIFOLIUS)

Scirpus includes the true bulrushes, such as the tule of California, and the Bolivian *tatora*, used in making reed boats. The true bulrushes occur in lakes, ditches and marshes, and have spongy, green, three-sided or cylindric stems, up to an inch in thickness and one to eight feet high. They are usually leafless with a terminal branched inflorescence.

The flowers of cotton grasses (*Eriophorum*) have elongated silky bristles that are ornamental in bogs of the northern regions. The spike rushes (*Eleocharis*), with leafless stems topped by small flowering heads, are common in pools. They include *E. dulcis* (or *tuberosa*), the tuberous roots of which are the water chestnuts of Chinese restaurants (to be distinguished from the water chestnut *Trapa natans* eaten chiefly in the orient).

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FIG. 3.—SPIKELIKE INFLORESCENCES OF SEDGE (CAREX FRASERI)

Sedges also include the common saw grass (*Mariscus jamaicensis*) of the Florida Everglades and *Mapania*, a peculiar broad-leaved plant that forms undergrowth in tropical forests.

The strawlike stems of some tropical sedges, especially bulrushes and species of *Eleocharis*, are used for making mats and articles of clothing. In tropical savannas the whitened buttonlike heads of various kinds of sedges are conspicuous elements of the landscape. Sedges are also conspicuous in late summer in damp places in the Atlantic coastal plain of the eastern United States, where they provide much of the terra-cotta coloration.

See also BULRUSH. (H. K. SN.; X.)

CYPRESS, the common name given to several genera of evergreen, aromatic trees and shrubs belonging to the coniferous family Cupressaceae, but especially to species of *Cupressus*, the true cypress.

True Cypress.—These trees, which are indigenous to North America, southern Europe and Asia, feature scalelike overlapping leaves, usually in four ranks; few-scaled catkins; cones consisting of from six to ten peltate, woody, terminally bossed scales; and numerous small, winged seeds. All species exude a resin but no turpentine.

The Italian cypress (*Cupressus sempervirens*) has been well known throughout the Mediterranean region since classic times. It is a tapering tree resembling the Lombardy poplar; its branches are thickly covered with small, imbricate, shining, green leaves; the male catkins are minute; the cones are between 1 and 1½ in. in diameter, sessile and generally in pairs, and are made up of large angular scales, slightly convex exteriorly, and with a sharp point in the centre.

The tree grows to a height of 90 ft. in its native soil. It thrives best on a dry, deep, sandy loam, on airy sheltered sites at no great elevation. The timber is hard, close-grained, of a fine reddish hue and very durable.

The cypress, which is incapable of developing stump sprouts once the tree is cut down, was regarded as a symbol of the dead, and perhaps for that reason was sacred to Pluto. The tree grows straight, or nearly so, and has a gloomy and forbidding but wonderfully stately aspect. With advancing age its foliage becomes almost black.

The finest representative of the genus *Cupressus* in California is the Monterey cypress (*C. macrocarpa*). It is a tree of beautiful symmetry, becoming 150 ft. in height, with a trunk 8 ft. to 10 ft. in circumference. It grows rapidly, even on poor soils, and thrives best near the sea. Other Californian species are *C. goveniana* and *C. macnabiana*, which are much smaller trees than the Monterey cypress. *C. funebris* is a native of the north of China, where it is planted near pagodas.

Other Cypresses.—The Port Orford white cedar (*Chamaecyparis lawsoniana*), native to south Oregon and north California, is commonly known as Lawson cypress to horticulturists. *Chamaecyparis nootkatensis*, the Nootka sound cypress or Alaska cedar, is a hardy species reaching a height of from 80 ft. to 100 ft. *C. obtusa* of Japan is a tall tree reaching 100 ft. in height and widely planted by the Japanese for its timber—one of the best for interior construction. It is also cultivated by them in a dwarf form not exceeding a foot in height.

The bald cypress, *Taxodium distichum*, a deciduous conifer, is a member of the family Taxodiaceae, a native of the southern United States and Mexico. It is a lofty tree reaching a height of about 170 ft., with a massive trunk 15 ft. or more in diameter, growing in or near water. The lower part of the trunk bears huge buttresses, each of which ends in a long-branching, far-spreading root, from the branches of which arise the peculiar knees above the level of the water. The knees are of a soft spongy texture and have been thought to act as breathing organs, supplying the roots with air. Some authorities assert that their function is largely mechanical and that they give greater stability to the standing tree. The stout, horizontally spreading branches give a cedarlike appearance; the foliage is light and feathery; the leaves and the slender shoots which bear them fall in the autumn.

(LEFT) BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM. (RIGHT) J. HORACE MCFARLAND CO.

MONTEREY CYPRESS (CUPRESSUS MACROCARPA): (LEFT) BRANCH WITH FRUIT; (RIGHT) GROWTH FORM OF TREE

The cones, about the size of a small walnut, bear spirally arranged imbricated peltate scales which subtend the three-angled, winged seeds. The wood is light, soft, straight-grained and easily worked; it is very durable in contact with the soil, and is used for railway ties, posts and fencing and for construction.

In Mexico the bald cypress occurs in the lower Río Grande valley, furnishing valuable timber locally. Its durability and resistance to water are remarkable.

The geological history of cypress dates back to the Upper Cretaceous, the evidence being that the group was derived from the pine group during the Mesozoic. (E. S. HR.; X.)

CYPRIAN, SAINT (CAECILIUS CYPRIANUS, called THASCIUS) (*c.* 200–258), bishop of Carthage and martyr, is best known for his repudiation of heretical baptism and for his dispute with

Pope Stephen on the subject. He was born, probably at Carthage, of a wealthy pagan family of good standing, and was a worthy product of the oratorical education of the day. His conversion to Christianity (*c.* 246) transformed his life; he sold most of his property to relieve the poor and himself adopted complete chastity. His study of the Scriptures (exemplified in his *Testimonia ad Quirinum*) now displaced the profane authors, whom he never quotes, whereas he draws freely on both Testaments. In 249 he was chosen bishop of Carthage, and during the next ten years he led his flock through the persecution of Decius, defended the unity of the church against two schismatical movements, was the soul of the city's morale during a devastating plague and was beheaded as a martyr in the persecution of Valerian on Sept. 14, 258.

The corpus of Cyprian's works consists of treatises and letters. The "treatises" are mostly pastoral addresses (*e.g., The Lapsed, Virgins and Their Apparel, Generosity to the Poor*); the letters, 82 in all, include 14 addressed to him and two others of contemporary interest. The official report of his execution and the sketch of his life and martyrdom by Pontius, his deacon, were added to the corpus, as also some spurious treatises and poems. The genuine works reveal the Christian life in Carthage, the letters throwing valuable light also on Rome, Spain, Gaul and even Cappadocia.

Misled by Jerome, many writers have exaggerated Cyprian's dependence on Tertullian. In style and mentality the two are poles apart; some of Cyprian's treatises may even have been intended as antidotes to those of Tertullian. Again, his use of Stoic commonplaces and his praise of constancy under torture do not make him a follower of the Stoics, whose main tenets he explicitly denounces (*e.g.,* when he condemns Novatian's callous attitude to the lapsed).

Cyprian's own strictness is tempered by genuine human understanding; it is not the Stoic *apatheia* ("imperturbability") but union with Christ which is to be the martyrs' strength. It is always the Christian values that fill his mind: baptism, Eucharist (real presence and sacrifice), penance, charity and patience—all inspired by the Scriptures and the example of Christ.

His conception of the unity of the church has been the subject of much controversy. His view that heretics could not baptize or ordain—not having the Holy Spirit themselves, how could they impart it to others?—was unanimously endorsed by 86 bishops in his council of 256 (the first of its kind of which the minutes survive), and he vehemently attacked Pope Stephen who condemned the rebaptism of such converts. Some have held that Cyprian's outburst was but a momentary lapse from his normal recognition of papal supremacy. Others, in view of his insistence on the rights of bishops, have seen in him a champion of episcopalianism (not to mention sacerdotalism). Both these views would seem to involve anachronism, nor can the problem be solved by appealing to *De catholicae ecclesiae unitate*, ch. 4, which is extant in two recensions, one propapal in appearance, the other episcopalian; Cyprian probably was the author of both. He could see that the unity of the church depended on "the concord of the bishops," but his ecclesiology went no further. He took a practical view of things, recognizing Rome as the *de facto* centre of the church without scrutinizing the nature of its authority. He recognized that Pope Cornelius had the right to expect reports from him on important matters; he also called on Stephen to intervene in the church of Gaul. But he was quite unconscious of any inconsistency in his own refusal to obey Stephen in the matter of rebaptism. In fact Rome bore him no grudge and, though Cyprian's baptismal outlook was eventually rejected by the church, he himself is named in the earliest list of Roman feast days (Sept. 16) and in the Roman Mass, and he was quoted as an authority by the Council of Ephesus (431).

See also references under "Cyprian, Saint" in the Index volume.

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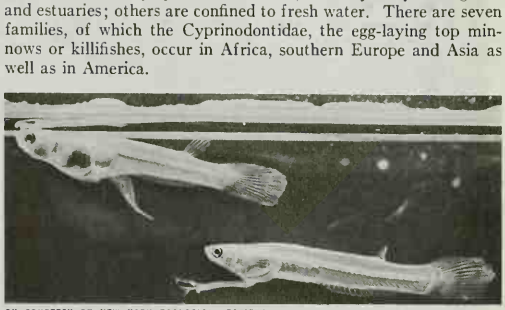
CYPRINODONT, any of the small fishes belonging to the order Cyprinodontiformes (Microcyprini). All cyprinodonts are characterized by being soft-rayed, having abdominal pelvic fins and lacking a duct to the air bladder. The small protractile mouth usually opens on the upper surface of the flat-topped head. About 400 species are known, none of which exceeds a foot in length; they are found in all warm countries but are especially abundant in America. Many species are marine, but they frequent lagoons and estuaries; others are confined to fresh water. There are seven families, of which the Cyprinodontidae, the egg-laying top minnows or killifishes, occur in Africa, southern Europe and Asia as well as in America.



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

EGG-LAYING TOP MINNOWS (TOMEURUS GRACILIS) PREPARING FOR MATING; FEMALE ABOVE, MALE BELOW WITH GONOPODIUM (ANAL FIN) EXTENDED

The cyprinodonts are favourites of tropical-fish aquarists because of their small size, pretty colours and lively habits. Courtship and pairing are general throughout the group, and in many species the sexes are very dissimilar, the males being brilliantly coloured and having large and beautifully ornamented fins.

Cynolebias, of South America, is unique among fishes, the dorsal fin of the male being not only much larger than that of the female but also having many more rays. The eggs of these fishes are able to withstand the annual drying that occurs in shallow tropical pools.

The live-bearing (viviparous) families are American, and in them the anal fin of the male is modified into an intromittent organ. The guppy (*Lebistes reticulatus*), mosquito fish (*Gambusia affinis*), and many other cyprinodonts that devour mosquito larvae have been used to control those pests in some tropical and temperate areas. The male swordtail (*Xiphophorus helleri*) has the lower half of the caudal fin produced into a long pointed process. The spotted platy (*X. maculatus*) has many colour variants. Hybrids between the two last-named fishes are useful in cancer studies. Molly (*Mollienesia*) males often have longer and more colourful dorsal fins than the females, but the fin numbers are equal in the sexes. The Amazon molly (*M. formosa*) is essentially exclusively female and "borrows" sperm from related species to initiate egg development. In one of the most curious types, the surface-swimming four-eyed fish (*Anableps*), of Central and South America, the eyes project above the head and are divided by a black horizontal band into an upper part for vision in the air and a lower for vision in the water. Spermatophores are characteristic of the viviparous members of the group. The blind cave fishes (*Amblyopsidae*) of North America are related.

See also AQUARIUM; FISH. (C. HU.)

CYPRIPEDIUM, a genus of beautiful hardy orchids, commonly called lady's-slippers or moccasin flowers, nearly always found growing in soil (unlike many of the epiphytic orchids). They are cultivated in the greenhouse and outdoors for their flowers, white, yellow, pink or rose-purple slipper-shaped blossoms. *See* LADY'S-SLIPPER; ORCHID.

CYPRUS (Greek KYPROS; Turkish KIBRIS), a republic within the Commonwealth of Nations and the third largest island in the Mediterranean sea, lies 60 mi. W. of Syria and 40 mi. S. of Turkey. With an area of 3,572 sq.mi. it is 140 mi. long in an east-west sense, about one-third made up by the narrow Karpas peninsula, and is 60 mi. at its greatest width. The coast line, 486 mi. in

length, is indented and rocky but never mountainous and includes a great number of sandy beaches which are extensive along the main bays.

This article is organized as follows:

I. Physical Geography
1. Physical Features
2. Climate
3. Vegetation and Animal Life
II. History
1. Early History and Archaeology
2. Medieval Period
3. Turkish Rule
4. British Administration
5. Republic of Cyprus
III. Population and Administration
IV. The Economy
1. Agriculture and Industry
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I. PHYSICAL GEOGRAPHY

1. Physical Features.—In spite of its small size Cyprus has a large variety of rocks ranging from perhaps Precambrian to Recent. The structure of the island comprises features deriving from both the Caledonian and the Alpine orogeny and including other features reminiscent of the East African rift valleys. The oldest rocks are in the southwest while as a rule the younger ones are away from the mountain areas. The rocks of the Troodos massif in the southwest, at the highest part of the island and at another area, are plutonic in origin and include gabbros and granophyric rocks; but the most extensive rock is the diabase. The diabase is the result of volcanic activity of probably Devonian Age. Forming a broken ring round the Troodos massif is the extensive Pillow Lava series of Devonian to Permo-Carboniferous Ages. South of the massif, and to a much lesser extent north and east of it, chalks, marls and chalky limestones of the Lapithos group (Upper Cretaceous and Eocene) and the Pakhna formation (Miocene) outcrop.

The highest parts of the Northern or Pentadaktylos mountain range are of Hilarion limestone, a massive limestone of Triassic Age. This is flanked by the Kythrea formation which is made up of marls streaked by limestone bands. Between the two ranges and in coastal plains, especially in the south, outcrop the youngest (Plio-Pleistocene and Recent) rocks of Cyprus—marls, sandstones, conglomerates, alluvium and gravels.

Cyprus can be divided into five morphological regions.

The Northern or Pentadaktylos Range rises abruptly a few miles east of Cape Kormakiti (ancient Crommyon) and attains its maximum height (Kyparissovouno, 3,357 ft.) almost at once, becoming generally lower eastward, while in the Karpas it ceases to be a mountain. It is a slender, steep-sided but elegant range with beautiful colours when the sun is low. North of it is to be found the very narrow strip of coastal plain with level-topped islands offshore, the whole landscape being a fractured and foundered former raised beach. South of the Pentadaktylos range the Miocene flysch and later rocks form a striking hummocky topography, the result of folding by pressure from the north.

The Central Lowlands, often known incorrectly as Messaoria, show considerable variations and include alluvial fans in the southwest; extensive mesas and buttes separated by very wide, alluvium-strewn valleys and basins in the central areas; and the joint flood plain of the Pedieos-Yialias rivers in the east. This flood plain is the Messaoria (or rather Messarka) proper.

The Troodos Massif, a vast, bulky and high (Khionistra peak or Mt. Olympus, 6,403 ft.) mountain range, is an old land mass extensively dissected and rejuvenated.

The Southern Uplands or White Plateaus are composed of chalks and marls and fall in steps from over 3,000 ft. close to the massif to almost sea level. Deep, trenchlike valleys cut this region into vast blocks of plateau country.

Coastal Plains of fertile alluvium represent old bays of the receding Southern uplands or raised beaches. These coastal plains are most extensive in the south and west of Cyprus and carry important towns.

The drainage of Cyprus radiates from the massif system. Most of the rivers have very steep and short courses to the sea but a few cross the Central lowlands and play an important part in the life of the island.

2. Climate.—Though an island, Cyprus comes under continental influences due to the presence of vast land masses on almost all sides. Clear skies, abundant sunshine and low erratic rainfall are the result. The duration of sunshine at its shortest exceeds 50% of the possible. Annual rainfall varies from below 12 in. in the west of the Central lowlands, and 16 in. in most lowland areas to 25–40 in. in upland and mountain areas. Rainfall is concentrated in the three winter months, December to February, which account for 65% to 80% of the annual amount. Rainfall is erratic in its distribution in time and place and serious droughts occur at least once in a decade. Annual rainfall as low as four inches has been recorded. Snow is a regular feature in the highest parts of the Troodos massif. Winters are mild, and in some years no frost at all occurs in the lowland areas. The mean temperatures for the coldest month vary from 55° F. in the coastal areas and 50° in inland lowlying areas to 40° in the upper parts of the Troodos massif. The summer months, normally rainless, are hot and dry inland and hot and humid on the coast. The most comfortable temperatures are experienced in the upper parts of the massif. The day temperatures are excessive (111° in the shade was officially recorded in Nicosia in 1934 and in 1942) and for 10 to 15 days in the year they exceed 100°. The mean temperatures for the hottest month are 85° in inland lowland areas, 80° in the coast and 72° in the upper reaches of the massif.

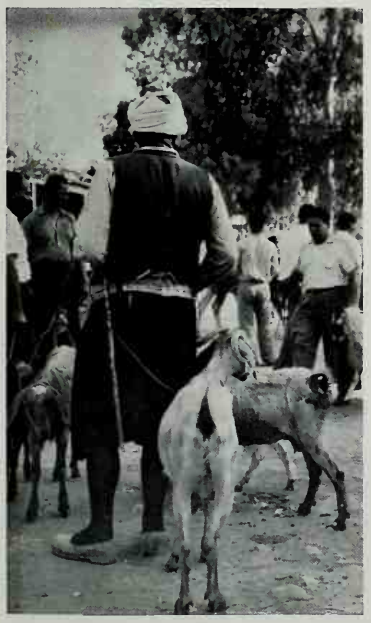
3. Vegetation and Animal Life.—It is doubtful whether any original vegetation is now left in Cyprus. Such evidence as exists indicates affinities with that of surrounding continents. The exclusive Cypriot plant is *Quercus alnifolia,* an evergreen oak widespread in forest and scrub areas. By far the most prevalent forest tree is the Aleppo pine. The cedar, after having reached near extinction, is spreading as a result of state protection. Most of the remaining forest in Cyprus now survives in the Troodos massif. The Aleppo pine and cypresses are found also in the Pentadaktylos range.

Apart from the seasonal visits of birds of passage Cyprus has very little wild fauna left other than hares, and the mouflon which is protected by the state. (D. Ch.)

II. HISTORY

1. Early History and Archaeology.—The earliest remains so far discovered in Cyprus belong to the Late Neolithic (New Stone) Age. An important settlement not far from the south coast, near the village of Khirokitia, has been dated by carbon-14 tests to the mid-6th millennium B.C. Architecture is represented by beehive dwellings and the utensils in use were of stone. Flint and obsidian implements were current while stone celts were found in great numbers. This earlier period, which may be called pre-ceramic, was followed by another period marked by well-made pottery with painted patterns. A new era is represented by the introduction of combed pottery which has been mostly found at the settlement of Sotira about 5 mi. N. of the classical town of Curium near the south coast. The Sotira culture has been dated to the second part of the 4th millennium B.C. In the early 3rd millennium the combed pottery was gradually replaced by painted pottery mostly found at the settlement of Erimi not far from the south coast. Houses were circular and the general aspect of the culture shows substantial development. Copper then made its first appearance. Toward 2500 B.C. red-and-black pottery, probably influenced by the Khirbet Kerak ware, began to take the place of the painted wares and in the 23rd century pottery shapes of western Anatolian types found their way into the island, probably introduced by people in search of copper. This period represents the Early Bronze Age which is followed by the Middle Bronze Age (early 2nd millennium B.C.), characterized by the return of painted pottery. In the Late Bronze Age (1600–1050 B.C.) Cyprus became the emporium of the east. The most important event during this period was the appearance of Mycenaean traders about 1400 B.C., followed by successive waves of Achaeans, who colonized the is-

View of the harbour and 12th-century castle at Kyrenia



Peasant with his goats at the market place in Nicosia

The mouflon (*Ovis orientalis ophion*), a wild sheep that is nearly extinct in Cyprus. Protective measures are enforced to preserve it

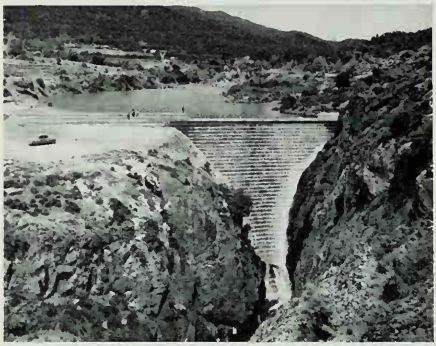
Ruins of the gymnasium at Salamis. Originally Hellenistic, it was destroyed many times and was rebuilt by Justinian as a bath, 6th century

SCENES IN CYPRUS

BY COURTESY OF (TOP, CENTRE RIGHT, BOTTOM) PUBLIC INFORMATION OFFICE, CYPRUS; PHOTOGRAPH, (LEFT) ATHENS NEWS PHOTO AGENCY FROM BLACK STAR

CYPRUS

Minaret of Selimiye mosque, formerly the Church of St. Sophia, Nicosia. The Kyrenia mountains are in the background



Irrigation dam in the Troodos massif. Irrigation is essential to the agricultural economy of Cyprus

Greek Orthodox monastery of Makhaeras in the mountains southwest of Nicosia

Farmer of Knovara using primitive method to thresh barley, one of the main food crops of Cyprus

Potato planters of Kyperounda resting for their midday meal

VIEWS OF CYPRUS

BY COURTESY OF (CENTRE LEFT) PUBLIC INFORMATION OFFICE, CYPRUS; PHOTOGRAPHS, (TOP LEFT) EMIL BRUNNER—PIX FROM PUBLIX, (TOP RIGHT, BOTTOM LEFT) © ENCYCLOPÆDIA BRITANNICA, (BOTTOM RIGHT) CROWN COPYRIGHT RESERVED: C.O.I.

land and introduced Greek culture and language.

During the Late Bronze Age Cyprus appears in Egyptian records under the name of Asi as a conquest of Thutmose III of Egypt (*c.* 1500 B.C.). But Alashiya (Alasia), mentioned in Egyptian, Hittite and Mesopotamian records, has also been identified as Cyprus although doubts have been expressed on this identification.

The cultural characteristics as reflected mostly in the ceramic production of the first part of the Iron Age (*c.* 1050–950 B.C.) show a fusion of Cypriot and Achaean but also of Syro-Anatolian elements. It appears, however, that the Achaean element gained the upper hand. The Cypriot kingship as it is known from later evidence was established by the Achaean colonists, although pre-Achaean kingdoms did exist in Cyprus; for example, at Paphos (*q.v.*). The character of the kingship, originally Mycenaean, developed later into an autocracy of oriental type with the king as the head of the state, although Idalium enjoyed a more democratic form of government. Art as reflected in pottery and other crafts of the early Iron Age is first dominated by the Achaean-Mycenaean features, but later (950–700 B.C.) Cypriot characteristics come to the fore. Commercial relations with the east (Syria, Palestine, Egypt, Asia Minor) were at first rare, but from the 9th century onward became closer. Sidon and Tyre on the Syrian coast and Tarsus in Cilicia were centres through which Cypriot wares were transmitted to the interior of the continent. The relations with Greece followed a similar course, Rhodes being the main intermediary between Cyprus and the Greek mainland and islands.

From 800 B.C. to A.D. 400.—The beginning of Phoenician penetration into Cyprus may be dated to about 800 B.C., although a funeral inscription of the 9th century B.C. shows the appearance of Phoenician elements already in that century. Citium (*q.v.*; Kition), a Tyrian colony, was the main centre of Phoenician activity and the overwhelming majority of Phoenician inscriptions were found in that city.

Assyrian Domination.—The year 709 B.C. marks the end of political independence with the submission of the Cypriot kings to the Assyrian king Sargon II. The event was commemorated in Dur Sharrukin (Khorsabad) as well as in Cyprus, where, at Citium, a stele, now in Berlin, was erected. On the stele Cyprus is referred to as Yatnana; *i.e.*, the isles of Danaoi.

The hold of Assyria over Cyprus continued during the reigns of Sargon's successors. Thus Esarhaddon's prism, written in 673–672 B.C., refers to ten kings and kingdoms of Cyprus among which is Qarthadast (Citium). Although Cyprus appears as one of the countries paying tribute to Ashurbanipal (667 B.C.), the Assyrian domination may have ended in 669. From about that date Cyprus had almost 100 years of virtual independence—one of the most brilliant periods of Cypriot culture (the first part of the Cypro-Archaic period). The power of the kings became greater, a fact reflected in the monumental tombs built of ashlar masonry. Palaces were built and shipbuilding and mining attained a high level of production. Ceramic art produced some of the island's finest and most richly ornamented vases, while metalwork, as evidenced by some remarkable silver bowls, reached great perfection under oriental (mostly Egyptian or Phoenician) influence. The output of Greek epic poetry is noteworthy; Stasinus, to whom the epic called *Cypria* is attributed, belongs to the 7th century.

Commercial and cultural relations with the east and west were intensified and Cyprus maintained close intercourse with Rhodes, which continued to be the chief steppingstone of Cypriot commercial expansion to the west. Mainland and eastern Greek pottery found its way to Cyprus and Cypriot products were widely distributed, thus transmitting oriental characteristics to Greek art.

Egyptian and Persian Influence.—Following the breakup of the Assyrian empire, Egypt became the great power. Cyprus was necessary to Egypt for minerals and material for shipbuilding, and Ahmose II (569–526) conquered the island in about 560. This meant a new orientation of Cypriot culture, and the influence of Egypt is reflected mostly in the sculpture and the increased importation of Egyptian goods, chiefly from the Greek colony of Naukratis in the Egyptian delta. The Cypriot kings and kingdoms were allowed to exist but they paid tribute to the Egyptian king.

The annexation of Egypt by Cambyses of Persia in 525 B.C. was preceded by the voluntary surrender of Cyprus, which formed part of Darius' fifth satrapy, but the Cypriot kings were left undisturbed and struck their own coinage. The Greek cities joined the Ionian revolt *c.* 498 B.C., but the Phoenician colonies, Citium and Amathus (*q.v.*), remained loyal to Persia. The rising was soon put down; in 480 Cyprus furnished 150 ships to the fleet of Xerxes and remained subject to Persia during the 5th century. But the Greek cities retained monarchical governments throughout. The principal Greek cities were then Salamis (*q.v.*), Curium, Paphos, Marion, Soli (*q.v.*), Kyrenia and Chytri. Phoenicians held Citium and Amathus on the south coast, Tamassus and Idalium in the interior. At the end of the 5th century a fresh Salaminian league was formed by Evagoras (*q.v.*), who became king in 410, aided by the Athenian Conon after the fall of Athens in 404, and revolted openly from Persia in 386. Athens again sent help. But the Phoenician states supported Persia as before, the Greeks were divided by feuds and in 380 the attempt failed; Evagoras was assassinated in 374, and his son Nicocles died soon after. After the victory of Alexander at Issus in 333 all the states of Cyprus welcomed him.

These political events are reflected in the cultural and artistic development. Architecturally, this period is exemplified by the palace of Vouni, the history of which is interwoven with events of the 5th century. Excavations at Kouklia (Palaipaphos) have shown more evidence of the political history of these times. Sculpture, after first producing remarkable works under Ionian influence encouraged by the annexation of Cyprus to the Persian empire, passed into relative stagnation. Evagoras' accession to the throne of Salamis encouraged Hellenic cultural relations but the effects were meagre. It was at this time that Greek symbols and alphabet were introduced into the local coinage.

After Alexander's death in 323 Cyprus passed, after several rapid changes, to Ptolemy I, king of Egypt. Under Ptolemaic rule Cyprus was usually governed by a viceroy of the royal line, but it gained a brief independence under Ptolemy Lathyrus (107–89 B.C.) and under a brother of Ptolemy Auletes (80–58 B.C.). The great sanctuaries of Paphos and Idalium and the public buildings of Salamis, which were wholly remodeled in this period, have produced but few works of art. It is in this period that Jewish settlements are first heard of; these later became well populated. Following the annexation of Cyprus to Ptolemaic Egypt the local coinage ceased to exist and artistic production, mostly illustrated by sculpture, was chiefly dependent on the workshops of the Hellenistic world.

Roman Period.—In 58 B.C. Rome, which had made large unsecured loans to Ptolemy Auletes, annexed the island. Under Rome, Cyprus was at first appended to the province of Cilicia; after Actium (31 B.C.) it became a separate province, which remained in the hands of Augustus and was governed by a *legatus Caesaris pro praetore* as long as danger was feared from the east. In 22 B.C., however, it was transferred to the Senate, so that Sergius Paulus, who was governor in A.D. 46, was rightly called proconsul.

The persecution of Christians on the mainland after the martyrdom of St. Stephen drove converts as far as Cyprus; and soon after converted Cypriot Jews such as Joses the Levite (better known as Barnabas) were preaching in Antioch. The latter revisited Cyprus twice, first with Paul on his first journey in A.D. 46 and later with Mark. In 115–117 the Jews of Cyprus, with those of Egypt and Cyrene, revolted, massacred 240,000 persons and destroyed a large part of Salamis. Hadrian, afterward emperor, suppressed them and expelled all Jews from Cyprus. For the culture of the Roman period there is abundant evidence from Salamis and Paphos and from tombs everywhere, and from the glass vessels which almost wholly supersede pottery in tombs. Of the sculptural works the most remarkable are the bronze statue of Lucius Septimius Severus in the Cyprus museum and two marble sculptured sarcophagi in Cyprus. The most important of the types of coin struck in the island is that with the Aphrodite temple on the reverse.

Archaeological Exploration.—This began before the British occupation (T. B. Sandwith, R. H. Lang, L. P. di Cesnola), but it was after the occupation that systematic work was started (under the Cyprus Exploration fund and by O. Richter). In the early part of

the 20th century Sir J. L. Myres and M. Markides carried out excavations for the Cyprus museum, and later the Swedish Cyprus expedition devoted several years (1927–31) to the exploration of many sites. The Cyprus museum and (from 1935) the department of antiquities investigated many prehistoric and later sites, while expeditions sponsored by the Pennsylvania university museum, the British School at Athens and the Louvre museum, Paris, explored Bronze Age cemeteries and townsites. After 1950 British expeditions excavated sites at Myrtou and at Kouklia (Palaipaphos) and Swedish and French missions undertook excavations at Kalopsida, Ayios Iakovos and Enkomi. The department of antiquities conducted large-scale excavations at Salamis.

(P. Ds.)

2. Medieval Period.—After the division of the Roman empire (A.D. 395), Cyprus remained subject to the eastern emperors, with brief intervals, for more than 700 years. During the 5th century it formed part of the diocese of the orient, under the *comes Orientis*, whose seat was at Antioch. This subordination was probably the basis of the claims advanced by the patriarch of Antioch to appoint and consecrate the metropolitan of Cyprus. These claims were successfully resisted by the Cypriot hierarchy. Both the Council of Ephesus in 431 and the Trullan council in 692 recognized the autocephaly of the Cypriot church and its right to elect and consecrate its own archbishop and bishops.

The island seems to have enjoyed a peaceful existence until the Muslims began their attacks during the 7th century. The first was launched during the years 647–649, when Mu'awiya, amir of Syria, overran Cyprus and laid it under tribute. In 653 it was attacked again, and an Arab garrison was established there. This was withdrawn after 680, and for nearly 300 years Cyprus was to be neither under the full control of Islam nor of Constantinople. Each used Cyprus as a springboard for attacks on the other. The Byzantine fleet prevented permanent Muslim occupation; but their raids were frequent and sometimes prolonged, and it was not until 965 that the emperor Nicephorus II Phocas was able to deliver the island from the constantly renewed attacks. For the next 200 years it remained an integral part of the Byzantine empire. As an outlying province, it was not infrequently used as the base for revolt against the imperial government. From about 1185 Isaac Comnenus, an ambitious Byzantine governor, held it against two successive emperors, his kinsman Andronicus I and Isaac II Angelus; but in 1191 he showed hostility to the English crusaders led by King Richard I, who promptly conquered the island. Richard first sold his conquest to the Knights Templars and then, as they could not pay, bestowed it on Guy de Lusignan, the dispossessed king of Jerusalem.

Guy founded a feudal monarchy in Cyprus which survived until the end of the middle ages. Much of its recorded history during that period concerns the life of the court and of the territorial aristocracy, which, in contrast to the peasantry, was French in speech and culture. Because of the island's trade, however, Italian merchants, especially those of Genoa and Venice, assumed an ever increasing economic and political control until, in the 15th century, Cyprus became part of the Venetian empire.

The kings of Cyprus kept alive the crusading idea. Some, such as Amalric II (1194–1205) and Hugh III (1267–84), were also kings of Jerusalem, but they were unable either to impose unity on the warring factions which weakened the Syrian kingdom, or to prevent its extinction in 1291 by the Mamelukes of Egypt. Even then, Cyprus remained a base for counterattack against the Muslims. Hugh IV (1324–59) formed an alliance with the papacy, Venice and the Knights Hospitallers of Rhodes, and in 1344 an expedition fitted out by this league retook Smyrna (Izmir) from the Turks. His son Peter I (1359–69) devoted himself to the organization of a crusade. In 1361 he took Gorigos (Korykos) and Adalia (Antalya) in Asia Minor. In 1362 he recruited an army and fleet in western Europe, and took Alexandria (Oct. 10, 1365). But he could neither retain the conquest nor persuade the rulers of western Europe to equip another crusade.

After Peter's assassination in 1369 the fortunes of the royal house declined, while those of the Italian republics rose to new heights. The economic activity in Cyprus was a result not only of its own silks, sugar and salt but also of its importance as an entrepôt for the eastern trade, especially after the Christians lost the Syrian ports. All the important commercial communities of the Mediterranean therefore established stations and bought trading privileges in Cyprus. In 1373 the Genoese took advantage of the local political situation to acquire complete control of Famagusta, the principal port, and were able to dominate trading and government in the island for 90 years. In 1426 an expedition launched from Egypt overran the island, and for a generation its kings were nominally the tributaries of Cairo.

The situation was redeemed by King James II (1460–73), a bastard of the royal house who in his father's lifetime had become archbishop of Nicosia. With the help of a Muslim force from Egypt he seized power in Cyprus and expelled the Genoese from Famagusta (1464). In 1472 he allied himself to Venice by marrying Caterina Cornaro (*q.v.*). On his death Cyprus was ruled from Venice in the queen's name till in 1489 the republic caused her abdication; the island remained a Venetian possession until its conquest by the Ottoman Turks in 1570–71. (R. C. Sma.)

Medieval Relics.—From the period between the peace of the church and the devastating Arab raids of the mid-7th century there survive numerous remains of basilican churches, a damaged apse mosaic at Lythrangomi comparable to those of the 6th century at Ravenna, Italy, a bath complex at Curium with fine mosaic pavements, and a treasure from the site of the ancient Lapithos consisting of gold ornaments and silver plate. Wall paintings of Byzantine and later styles exist in churches still in use, some domed in the Byzantine fashion, some wood roofed and tiled. Outstanding monuments of the Latin kingdom are the Gothic cathedrals of Nicosia and Famagusta, now used as mosques, and the abbey of Bellapais. Of military architecture, Byzantine, Frankish and Venetian, a good deal remains, foremost among it the walled city of Famagusta. (X.)

3. Turkish Rule.—On March 7, 1573, Venice recognized the sultan's sovereignty over Cyprus. The period of Turkish administration lasted for 300 years. At first comparatively enlightened (serfdom was abolished, the Orthodox archbishopric restored, and the Christian population granted a large measure of autonomy), it became neglectful and often oppressive. There were serious risings in 1764, 1804, and 1821. In 1838–39 and 1856 attempts were made to introduce reforms and some self-government with a local divan (council). The reform movements lagged, however, and there were few internal improvements since the imperial treasury retained most of the island's income. In the courts, Christian testimony was seldom honoured.

4. British Administration.—On June 4, 1878, Great Britain took over the administration of Cyprus and occupied it by agreement with the sultan, who was thereby assured of British help if the Russians attacked Turkey's eastern provinces. Cyprus remained under Turkish sovereignty, but from the start elements of the Greek population (80% of the total) asked the British to grant *enosis* (union with Greece). For many years this demand was of little more than academic significance.

Cyprus was annexed to the British crown in November 1914, when war with Turkey broke out. The British government offered the island to Greece 12 months later, if Greece helped Serbia, then invaded by Bulgaria. Greece refused to help Serbia, and the offer lapsed. Turkey formally recognized the British annexation under the Treaty of Lausanne, ratified in 1924; and in the following year Cyprus was made a crown colony.

In 1931 serious disturbances arose out of the demand put forward by sections of the Greek population for *enosis*. The Legislative Council was abolished and power to legislate was vested in the governor alone.

During World War II, pack transport, pioneer, motor transport, and other units were raised in Cyprus by voluntary enlistment. They served in France, the Middle East, Greece, and Italy. Apart from a limited number of air raids, Cyprus remained immune from enemy attack throughout the war.

After the war agitation for *enosis* was resumed. Archbishop Makarios III (*q.v.*), patriarch of the Orthodox Church in Cyprus, emerged as the leader of the movement, with the support of vari-

ous political groups. The campaign for *enosis* grew more violent, with persistent attempts to smuggle arms from abroad, and nationalists in metropolitan Greece raised their voices in encouragement of the malcontents. This provoked extremes of resentment in Turkey. At the London Conference in September 1955 the British, Greek, and Turkish foreign ministers failed to agree on a solution, and an atmosphere of terrorism, repression, and mistrust prevailed. In this the lead was taken by EOKA (Ethniki Organosis Kypriakou Agonos, "National Organization of Cypriot Struggle") headed by Col. Georgios Grivas ("Digenes" or "Dighenis"), formerly an officer in the Greek Army. The organization enjoyed wide support in the Greek Cypriot community and included a guerrilla body which carried out terrorist attacks on British servicemen and establishments. British reinforcements were sent to the island to suppress the guerrillas, and in the autumn of 1955 Field Marshal Sir John Harding was appointed governor. Emergency regulations were introduced. Negotiations opened with Makarios, the main issue being self-determination which the British government was not willing to concede at that time although ready to grant a large measure of self-government.

In March 1956 Makarios and the bishop of Kyrenia were deported to the Seychelles. For a year terrorism raged throughout Cyprus, but all attempts to suppress EOKA failed. In the meantime Lord Radcliffe had been asked to advise on a new liberal constitution. His proposals, published in December 1956, were accepted by the British government. On March 14, 1957, EOKA offered to suspend its activities if Makarios was released from exile. A few days later he was freed and permitted to go where he liked except to Cyprus. Terrorist activities ceased, and many of the restrictions were lifted, but in such an atmosphere progress toward a settlement was slow. Sir John Harding was succeeded in December 1957 by Sir Hugh Foot. By this time the Turkish Cypriot community (about 17.5% of the island's population), led by Fazil Kütchük, was thoroughly aroused at the prospect of *enosis*, and put forward the demand that the island should be partitioned. Renewed efforts in 1958 by the British government and by NATO to produce a settlement came to nothing in face of the Greek community's desire for union with Greece, and the Turkish for partition. Terrorism broke out again and fresh restrictions had to be imposed. But in the autumn of that year the archbishop proposed that after a fixed period of self-government Cyprus should become an independent state.

This suggestion eventually led to negotiations between the Greek and Turkish governments and to a conference held in Zürich, Switz., in February 1959, at which the British were not represented. The conference reached agreement in principle. The solution arrived at in Zürich was immediately approved by the British government. British sovereignty was to be retained over the two military bases at Dhekhelia and Akrotiri, in all an area of 99 sq.mi. (256.4 sq.km.). The new republic would not participate in a political or economic union with any other state, nor would it be subject to partition. Greece, Turkey, and the United Kingdom guaranteed the independence, integrity, and security of the republic, and Greece and Turkey undertook to respect the integrity of the areas remaining under British sovereignty. Executive power was vested in a Greek Cypriot president and a Turkish Cypriot vice-president, to which posts Makarios and Kütchük had previously been elected. They would have a council of ministers comprising seven Greeks and three Turkish Cypriots. It was later agreed that the decisions of the council would be binding on the president and vice-president, who could, however, impose a veto in matters relating to security, defense, and foreign affairs. There would also be a House of Representatives elected for five years consisting of 50 members, of whom 70% were to be elected from the Greek and 30% from the Turkish Cypriot communities, and the civil service was to consist of 70% Greek and 30% Turkish Cypriots. A Turco-Greek military headquarters was to be set up in the island to train the Cypriot Army.

5. Republic of Cyprus.—The first general election took place on July 31, 1960. Of the 35 seats allotted to the Greek Cypriots 30 were won by supporters of the archbishop, 5 by agreement being allotted to AKEL (Anorthotikon Komma Ergazomenou Laou), the Cypriot Communist Party. All 15 seats allotted to the Turkish Cypriots were won by supporters of Kütchük. The Republic of Cyprus came into being on Aug. 16, 1960, and Cyprus was admitted as a member of the United Nations shortly afterward. It remained a member of the sterling area, and the British government agreed to make £12,000,000 of financial assistance available, payable over five years. Cyprus was admitted to membership in the Commonwealth of Nations in March 1961.

Difficulties soon arose over the ratios of 70% for Greek Cypriots and 30% for Turkish Cypriots in the House of Representatives. By the autumn of 1963 the new constitution had become unworkable. Over Christmas there was widespread rioting, and a threat that the Turkish government might intervene. British troops tried to keep order at first, and in March 1964 the UN Security Council agreed to send a mixed force which eventually secured the cessation of fighting between the Greek and Turkish Cypriots. But the Turkish inhabitants were gradually forced to leave their homes and concentrate in the districts north and west of Nicosia. In the meantime the Greek government declared itself in favour of self-determination for Cyprus, the Turkish government for the original constitution, and Makarios for independence, while Colonel (now General) Grivas returned to the island in June stating that he was in favour of *enosis*. At first he said he was acting in a private capacity but he was later put in command of the Greek Cypriot security forces. No compromise between the conflicting views seemed possible. Dean Acheson, former U.S. secretary of state, proposed in July 1964 that Cyprus should be ceded to Greece and the Greek island of Kastellorizon (Castelrosso, the easternmost of the Dodecanese Islands) to Turkey, the Turks to have a military base in Cyprus, but this plan was rejected.

Almost simultaneously fighting again broke out in the northwest of the island and war between the Greek and Turkish governments was narrowly averted when on Aug. 9, 1964, Turkish aircraft bombed Greek Cypriot villages in the area. A cease-fire was negotiated on Aug. 10, but the Greek Cypriots continued to import and manufacture arms and attempts were made to secure further supplies from Egypt and the U.S.S.R. On Sept. 9, 1964, S. Tuomioja, the mediator appointed by the UN, died. Galo Plaza succeeded him. (B. S.-E.)

III. POPULATION AND ADMINISTRATION

The population at the 1960 census was 577,615, which showed an average annual increase of very nearly 2% since the previous census in 1946. A high birth rate (26 per 1,000) and a low death rate (6 per 1,000) accounted for the increase. Emigration amounts on average to 6,000 persons a year, though in 1960 and 1961 it was more than double that figure. The census of 1960 gave the following composition of the population: Greek Cypriots 77.71%; Turkish Cypriots 18.07%; the rest was made up by Maronites, Armenians, Britons, and others. The Greek Cypriots are members of the Autocephalous Church of Cyprus, an independent Greek Orthodox Church (*see* CYPRUS, CHURCH OF). The Turkish Cypriots are Muslims. About two-fifths of the population live in the six district capitals: Nicosia, Famagusta, Larnaca, Limassol (*qq.v.*), Kyrenia, and Paphos. Greater Nicosia, the capital of the island with 95,682 persons, accounts for about half of that. The rural population lives in 627 compact and nucleated villages; some of the villages are fast becoming dormitory centres for urban, mining, and other nonagricultural labourers.

About half the total population is gainfully employed and about 40% of these are engaged in agriculture, the other large categories being manufacture and construction, commerce, transport, and other related activities. Mining and quarrying engage just over 2%. The large number (about a quarter of the total employed) in manufacture and construction is the result of the amount of building that has been done since 1950. Trade unions are active and there were 179 unions with a total membership of about 64,800 in 1962.

The Zürich Agreement of 1959 (see *History* above) laid down the basic provisions for the creation and administration of the new state of Cyprus. The constitution makes elaborate provisions, among other things, for a balancing of interests of the two com-

munities and for offering safeguards for the Turkish minority.

The Cyprus system of government is a presidential one. The president must be a Greek Cypriot while the vice-president is a Turkish Cypriot. Certain important functions and prerogatives are exercised separately or jointly by the two. The cabinet of ten is appointed, the president proposing the seven Greek ministers and the vice-president the three Turkish ministers. Proportions of 7:3 (except in the army where the proportion is 6:4) were expected to be established in the public service and other state organizations. There is a Constitutional Court and a High Court, each presided over by a neutral, non-Cypriot person. Legislative functions are vested in two chambers: the House of Representatives, which is composed of both Greek and Turkish Cypriots numbering 35 and 15 respectively; and the two communal chambers, one Greek and the other Turkish Cypriot. The communal chambers deal with the religious, educational, cultural, and social matters of their respective communities. In 1964–65 certain constitutional and administrative changes were introduced pending a solution of the "Cyprus problem" (see *History*, above). Greek and Turkish are the official languages but in addition English is spoken and widely understood.

Under the London Agreement the United Kingdom has retained sovereign rights over areas totaling less than 100 sq.mi. (160 sq.km.). They are used as bases and are administered by the Air Ministry. In certain matters mixed administration (British and Cypriot) operates in the base areas.

The structure of the district and village administration remains largely as it was under British rule; *i.e.*, management by village commission, but there are provisions for separate (Greek and Turkish) elected municipalities for the five largest towns.

Since Cyprus was freed from malaria in 1949 it has become a healthy island and no quarantinable diseases occur. There are general hospitals in the six main towns but only 11 small hospitals in rural areas. In addition two military hospitals exist in the base areas. Two mining companies keep private hospitals. Private medical practice is very extensive but its services are expensive. In 1962 there was one doctor per 1,390 persons, and 70 private hospitals were functioning.

Literacy in Cyprus has improved considerably since World War II. Illiterates are found among old people, especially women (in 1960 illiterates comprised 18.1% of the population, nearly 80% in the over-40 age group), although in the absence of compulsory education some younger people may remain near illiterate. Elementary school education is free but not compulsory for children of 6 to 13. Vocational education is carried out in eight technical schools, including rural schools, where the emphasis is on agriculture, and the Forestry College at Prodhromos which caters to overseas students also. Postsecondary education is limited to two teachers' training colleges, one for each community (Greek and Turkish). Education is the responsibility of the two communal chambers and is carried out on separate and independent lines.

A social insurance scheme, introduced in 1957, provides cash benefits for marriage, maternity, sickness, unemployment, widowhood, orphanhood, old age, and death. It compulsorily covers all employees except agricultural workers on small farms.

IV. THE ECONOMY

1. Agriculture and Industry.—Agriculture is the main source of employment and the basic industry, contributing a little more than one-fifth of the gross national production. It is a saturated industry carried out by peasants working on an average holding of $15\frac{2}{3}$ ac. dispersed over 10 scattered plots. A low and erratic rainfall and the acute shortage of irrigation water reduces the productivity of the land. Thus in agriculture very low incomes and underemployment are prevalent. About 60% of the area of Cyprus is in agricultural use, but only 5% of the agricultural land is irrigable during the hot summer, so that only one crop a year is possible over most of the land; but, what is more, the extensive fallow system (covering about 33% of the cultivated land) condemns large areas to one crop every two years. Despite these setbacks a wide variety of crops are produced. The main cultivable area lies in the central and coastal lowlands but steep slopes are also cultivated. Cereals account for one-third of the agricultural land but Cyprus does not cover its needs in wheat or feeding stuffs; vines cover 8% of the cultivated area; and a large variety of crops and vegetables account for the rest of the land. The main crops other than cereals are pulses, legumes, cotton, sesame, tobacco; vegetables include potatoes, carrots, cauliflowers, tomatoes; melons and watermelons are also grown extensively. Citrus fruits are the most valuable and contribute the largest single item to agricultural exports. Carobs, olives, and almonds are plentiful. Apples and cherries are important in the massif. The low rainfall and the summer drought do not permit the growth of pastures worth the name and the island's flocks of sheep and goats subsist on rough pasturage and stubble and need hand-feeding in periods of scarcity. The dairy cattle are exclusively stall-fed. Sheep and goats are milked and provide the bulk of dairy products. Cyprus does not cover its needs in meat or dairy produce. Mules, donkeys, pigs, and poultry are widely kept.

Forested land covers 669 sq.mi. (1,733 km.), or 18.7%, of Cyprus but only one-fifth of that area is fully stocked. All forest land, except 52 sq.mi. of privately owned forest, is state owned. Timber yields cater to a very small fraction of the island's needs.

Except for a few motor trawlers, fishing is from small boats. Fish is a luxury food in Cyprus. Sponges of good quality are obtained in Cyprus waters by non-Cypriot fishers.

Mining and Industry.—Copper and the name of Cyprus are related. The Roman *aes cyprium* ("ore of Cyprus") was corrupted to *cuprum* from which was derived the Anglo-Saxon *coper*. Copper was mined from the end of the 3rd millennium B.C. to Roman times. Modern mining dates from World War I. Cupreous and iron pyrites are now the most important minerals mined in the island. Other minerals include asbestos, chromite, gypsum, and umber. Apart from flotation treatment of the copper ores, the minerals are all exported almost raw. The value of minerals exported in the early 1960s fell well below half the value of all exports (the peak export value was in 1956, the decline being due to the drop in prices).

Cyprus, having no fuel of its own and no important source of energy other than unutilized sunshine, relies on thermal electricity on the basis of imported oil. The central generating station, with an output of almost 300,000,000 units, is at Dhekhelia.

Only about 12.5% of the gross domestic production is contributed by industry. Many industrial establishments are scarcely more than minor cottage industries and only about 3% employ more than ten persons. Important industries include wines and spirits and soft drink manufacture, brewing, flour milling, cigarette making, cement manufacture, and canning. All the output is for home consumption, except for wines and spirits, of which a considerable quantity is exported. Besides the shortage of water the island lacks three things: fuel, any large output of raw material except minerals, and a ready market.

2. Trade and Communications.—The value of exports in the early 1960s averaged £20,000,000 annually while imports exceeded £47,000,000. Imports include manufactured goods (vehicles, machinery, electric goods, fabrics, fuel) and also food (wheat, vegetables, fish, oils, meat, and dairy products) and feeding stuffs. Exports include minerals, citrus fruit, carobs, potatoes, vegetables, fruit, and wines and spirits. More than one-third of the imports and more than two-fifths of the exports came from or went to the United Kingdom.

Employment in communications in the early 1960s was about 4% of the labour force. The main seaports are Famagusta, where vessels of an overall length of 425 ft. and less and with a draft of 22 ft. 6 in. can berth alongside the quay, and Limassol and Larnaca which are open roadsteads. Considerable developments and improvements had been made in all ports and a new harbour was completed at Famagusta in 1965. Shipping entered and cleared at Cyprus ports exceeded 4,500,000 registered tons net.

The only airport in Cyprus permanently open to international traffic is at Nicosia. Links are mainly with Europe, the Middle East, Africa, and the Far East.

There are 3,875 mi. (6,236 km.) of roads on Cyprus, about 1,500 (2,400) of which are asphalted. Vehicles exceeded 63,000

in the early 1960s, more than half of which were private cars.

The six main towns and about 35% of the villages are connected by telephone, while the forest service has its own network. The inland telegraph system connects the main towns and larger villages which accept both overseas and inland telegrams. The radiotelephone service is available to the United Kingdom, most European countries, North America, Cuba, Mexico, the U.S.S.R., Australia, Kenya, Turkey, Israel, U.A.R., and other Arab countries.

A broadcasting service and a television service with Greek, Turkish, and English programs are in operation.

3. Finance.—The monetary unit is the pound sterling which equals 1,000 mils. Cyprus announced in 1959 that it would stay in the sterling area for a minimum of ten years.

After World War II there were two ten-year development plans, or rather budgetary arrangements, the one lasting its full course (1946–56) and the other hardly implemented. A UN economic survey team arrived in Cyprus in 1960 to study the possibilities of economic development of the island as a guide to development expenditure and economic planning with a view also to utilizing expected foreign aid. In 1961 the government announced a five-year development plan envisaging the investment of £43,000,000, in order to finance water conservation, the improvement of agricultural production, the expansion of electrification and of existing industries, the promotion of the tourist industry, the improvement of docks and harbours, especially at Famagusta and Limassol, the expansion of public health facilities, and the establishment of a geological survey department. In 1963 the development plans were revised, the aim being to achieve an annual growth rate of 5–6%, and proposed investment from both public and private sectors was about £118,000,000.

See also references under "Cyprus" in the Index. (D. Ch.)

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Current history and statistics are summarized annually in *Britannica Book of the Year.* (X.)

CYPRUS, CHURCH OF, is one of the oldest autocephalous Orthodox churches, and, as such, a member of the Orthodox Eastern Church (*q.v.*). Its independence, first recognized by the third ecumenical Council of Ephesus (431) against the claims of the patriarch of Antioch, was ratified by the emperor Zeno (474–491) on the basis of the argument provided by the alleged body of the church's reputed founder, St. Barnabas (*q.v.;* Acts xv, 39), discovered at Salamis in 488. Under Zeno several privileges were granted to the archbishop of Cyprus. The independence of the Church of Cyprus, again reasserted by the Trullan council (692), was never lost, not even during the occupation of the island by the crusaders. Under the Lusignans and the Venetians (1193–1571), the efforts of the Latin bishops to submit the Orthodox Church of Cyprus to the pope's authority were unsuccessful. With the conquest of the island by the Turks, the Latin hierarchy and the pressure exercised by it disappeared. Under Turkish rule, the Church of Cyprus was exposed to the hazards familiar to all the other Greek churches during this period. It was granted the same rights as the patriarchate of Constantinople, and its archbishop moreover was recognized as the ethnarch of the subjugated Greek people of the island. The highest ecclesiastical authority lay with the synod, composed of the archbishop of Nicosia and the three other bishops of the island (Paphos, Citium or Kition and Kyrenia or Cyrenia), who were, and still are, elected by both clergy and laity, each of the four bishoprics being divided into several parishes. The bishops were recognized as the leaders of the nation and hence were held responsible to the conqueror. At the time of the Greek national war of independence (1821) all the bishops on the island, as well as several abbots and some eminent Greek citizens, were hanged by the Turks. During the British occupation of the island, beginning in 1878 and continuing from 1925, when Cyprus was given the status of a colony, until 1958, the position of the bishops as leaders of the nation was not changed. This is why the bishops with the archbishop at their head took an active lead in the movement of their people for *enosis* (*i.e.,* union with Greece). In 1956 the archbishop, Makarios, and the bishop of Kyrenia were exiled by the British. When in 1960, after the fierce struggle for *enosis,* the new Cypriot republic became independent, the church was assured of its position as an autocephalous and independent Greek Orthodox Church on the basis of its old titles. The archbishop became the first president of the new republic. *See* also Cyprus.

See H. T. F. Duckworth, *The Church of Cyprus* (1900); J. Hackett, *History of the Orthodox Church of Cyprus* (1901). (H. S. Al.)

CYPSELUS, tyrant of Corinth from about 657 to 627 B.C., was the son of Aeëtion and Labda, a member of the ruling family, the Bacchiadae. He is said to have derived his name from the fact that when the Bacchiadae, warned that he would prove their ruin, sent emissaries to kill him in his cradle, his mother saved him by concealing him in a chest (*cypsele*). By courting popular favour Cypselus drove out the Bacchiadae and made himself master of Corinth. Herodotus, prejudiced against tyrants, said he ruled harshly, but he is generally represented as beneficent and popular. He pursued an energetic commercial and colonial policy: he founded the colonies of Leucas, Anactorium and Ambracia.

Cypselus spent large sums on buildings and works of art. At the same time he strove by his dedications to gain the good will of the powerful priesthoods of Delphi and Olympia. He was succeeded by his son Periander (*q.v.*). *See* Corinth: *History.*

Bibliography.—Herodotus, v, 92; Aristotle, *Politics,* 1310b, 1315b; P. N. Ure, *The Origin of Tyranny* (1922); A. Andrewes, *The Greek Tyrants* (1956).

CYRANO DE BERGERAC, SAVINIEN (1619–1655), French writer, around whose name a number of unhistorical legends have accumulated, was born in Paris, March 6, 1619. Adopting the military profession, he fought at Mouzon and at Arras, but, twice wounded, had to retire from the army. He then turned to philosophy and took up residence in the Collège de Lisieux in Paris. He probably knew Pierre Gassendi and, certainly, La Mothe Le Vayer. He died in Paris, July 28, 1655.

Cyrano's writings fall into several groups. As a political writer, he was the author of a violent pamphlet against the men of the Fronde, in which he defended Mazarin in the name of political realism as exemplified in the tradition of Machiavelli. As a dramatist he wrote *Le Pédant joué* (probably 1645) and *La Mort d'Agrippine* (pub. 1654). As long as classicism was the established taste, *Le Pédant joué,* a colossal piece of fooling, was despised; but its liveliness appeals to modern readers as it did to Molière, who based two scenes of *Les Fourberies de Scapin* on it. *La Mort d'Agrippine* is intellectually impressive because of its daring ideas; and the direct and impassioned character of the tragic dialogue makes it interesting theatrically. Cyrano's *Lettres* show him as a master of baroque prose, marked by the boldness and originality of his metaphors. His contemporaries regarded them as absurdly farfetched, but they came to be esteemed in the 20th century as examples of the baroque style.

Cyrano also wrote two novels of imaginary travel, the *États et empires de la Lune* (1657) and the *Histoire comique des états du Soleil* (1662); the former had been expurgated before publication, so that the real text remained long unknown. In these tales Cyrano was inspired by the work and thought of John Wilkins and Francis Godwin; but he added the kernel of his own philosophy, a compound of Italian pantheistic naturalism, Cartesian rationalism and empiricism as preached by Gassendi.

Edmond Rostand's play, *Cyrano de Bergerac* (1897), made Cyrano's name famous, but aggravated the errors committed by the romantics in emphasizing only the more extravagant aspects of his life and work.

The best text of the novels is in the edition of Cyrano's works by F.

Lachèvre (1920–21). *See* further A. Adam, *Histoire de la littérature française*, vol. ii, pp. 113–118 and 146–148 (1948–56). (Ae. A.)

CYRENAICA (Barqah), the easternmost part and (until 1963) a province of the unitcd kingdom of Libya, covers an area of 330,258 sq.mi. Pop. (1954) 291,236; (1963 est.) 350,024.

Physical Features.—Topographically Cyrenaica comprises: (1) a coastal zone of irregular uplands—Al Jabal al Akhdar of just under 3,000 ft. and the associated cuesta formation of the ancient Marmarican hills immediately to the east, which attain 1,000–1,200 ft.; (2) a lowland zone aligned east-northeastward from the Gulf of Sirte (Khalij Surt), and occupied by a number of oases and salt basins and marshes, where there are to be found marine flora and fauna. Because of this it has been suggested that the lowland zone recently formed an arm of the sea, isolating the coastal zone, but this view is largely discounted; (3) the southern desert: an area of loose sand and stony outcrops, with several oasis groups of which Jalu and Al Kufrah, each comprising several districts, are the most important. The Sand sea of Calanscio lies south and east, presenting a formidable barrier to movement eastward. Only two routes across are known.

Because of its elevation and seaward aspect, Al Jabal al Akhdar has a heavier and slightly less erratic annual rainfall, which attains 15–20 in. on the crest. This gives rise to an area of natural scrub woodland, unique in Libya—low juniper and lentisk trees with occasional wild olives, Mediterranean pines and evergreens. Elsewhere on the uplands a terra rossa soil occurs sporadically allowing cultivation, the largest of these areas being the plain of Barca (Al Marj). Away from the higher parts of Al Jabal al Akhdar (green mountain) vegetation degenerates into thin steppe and semidesert forms, with the Marmarican hills distinctly drier and barer than the northwest. (W. B. Fr.)

History.—The northern half of the ancient district of Cyrenaica was known as the Pentapolis from its possession of five considerable cities, viz., Euhesperides-Berenice (Bengasi), Barca (Al Marj), Cyrene (*q.v.*; Shahhat), Apollonia (Marsa Susah) and Teuchira-Arsinoe (Tukrah). These cities were founded by Greek colonists, Cyrene, the earliest, being established *c.* 630 B.C. In later times two more towns rose to importance: Ptolemais (Tulmaythah) and Darnis-Zarine (Derna). These all lay on the coast with the exception of Barca and Cyrene, which were situated on the highland now called Al Jabal al Akhdar, a few miles inland.

Under the Ptolemies the inland cities declined, and Cyrenaica began to feel the commercial competition of Egypt and Carthage, from which easier roads led into the continent. When all north Africa passed to Rome, and Cyrenaica itself, bequeathed by Apion, the last Ptolemaic sovereign, had become a Roman province in combination with Crete (67 B.C.), this competition told more severely; the Greek colonists, grown weaker, found themselves less able to hold their own against the Libyan population. A great revolt of the Jewish settlers (A.D. 115–116) did much damage to Cyrene and Barca. Ptolemais became the local capital in 297 and in the 6th century Apollonia was the seat of the governor. After Arab armies under the leadership of Amr ibn al-As had conquered the country in 642, inland Cyrenaica regained importance, lying as it did on the direct route between Alexandria and Kairouan; and Barca became its chief centre. (For archaeology of the region *see* Africa: *Archaeology: Carthaginian and Classical.*) But when the Ottoman empire superseded the Arab, resulting in the virtual independence of both Egypt and Tripoli, the district between them relapsed to anarchy, which continued after Mahmud II had resumed direct control over Tripoli (1835), and by the mid-19th century Cyrenaica was still so free of the Turks that Sheikh Mohammed ben Ali ben as-Sanusi chose it as the headquarters of his nascent fraternity (*see* Senusi).

Cyrenaica, with Tripolitania, was ceded to Italy in 1912 as a result of the Italo-Turkish War (*q.v.*), but in Cyrenaica at that time and until after World War I the Italians occupied only the coastal towns of Bengasi, Derna and Tobruk. In 1920 by the agreement of Ar Rajmah (Regima) they conferred the title of amir on the Senusi leader Mohammed Idris (later King Mohammed Idris I) as head of an autonomous administration over the Bedouins and the oases. The Italian Fascist government, however, rejected this agreement and after wearing down Bedouin guerrilla resistance inaugurated a scheme to relieve the overpopulation of Italy by the mass colonization of Al Jabal al Akhdar. In 1940 about 50,000 Italian peasant colonists were busily converting northern Cyrenaica (Italian Cirenaica) into the semblance of an Italian province, cultivating cereals, vines and fruit trees. Meanwhile, on Jan. 9, 1939, Cyrenaica and Tripolitania were incorporated into the metropolitan kingdom of Italy. Cyrenaica became a major theatre of operations during World War II and the Senusi leaders with a Libyan Arab force gave useful service to the British during the desert campaigns of 1940–42. The Bedouins of Cyrenaica also co-operated freely with the British. When the British finally occupied Cyrenaica after the victory (Oct. 1942) at El Alamein (Al 'Alamayn) the Italian colonists had been evacuated and the population was once again 98% Muslim and Arabic-speaking.

After World War II the inability of the great powers to agree on the future of the former Italian colonies protracted the British military administration of Cyrenaica and although Mohammed Idris was again accorded the title of amir in 1946 it was not until 1951 that he was recognized as king of the united kingdom of Libya. As a result of a 20-year treaty of friendship signed with Libya in 1953 the British government was empowered to maintain certain defense establishments in Cyrenaica (*see* also Libya; World War II). (X.)

Economy.—Animal husbandry is the chief occupation of Cyrenaica, but this is usually combined with some degree of cultivation. A frequent pattern is to sow a number of very small plots at different altitudes and in different localities during the seasonal routine of animal movement. Barley (being a native) in particular will thrive with little or no attention, and can be harvested on return. In better watered areas cultivation is more regular, especially round Bengasi, Derna, Barca and Marsa Susah. In the southern oases millet, dates and vegetables are staples, but in the north conditions are too cool and damp for luxuriant date growth. Most animal herding involves a certain degree of nomadism, local on Al Jabal al Akhdar but more extensive toward the south, with the Jabal used as summer quarters; here the scrub provides grazing at most seasons.

Other activities are on a small scale: a very few processing industries and the sale of live animals and animal products, for which there are markets in Egypt, Malta, and Greece. The southern oases have few economic contacts with the north. Tomatoes ripen early in the Aujila (Awjilah) and Jalu oases and can sometimes be sold, even abroad; but since the decline of overland routes into central Africa (with the slave trade once a significant factor) the importance of the oases has declined.

Communications.—The chief towns, with population figures given in the 1954 census, are as follows: Bengasi (69,718), Derna (15,891), Barca (9,982), Tobruk (4,995) (*qq.v.*) and Ajdabiyah (16,336). Bengasi has a moderately good harbour and lies on an extensive plain with supplies of underground water. The other towns are mainly regional markets and route centres with some local agriculture. All lie on one main line of communication; the east-west coastal road linking Tunis-Algiers and Egypt. This is well maintained and follows the coast except in the Bengasi-Derna sector. There are two airfields: at Benina (Baninah) for Bengasi and at El Adem (Bir' al 'Uzaym) for Tobruk, and the oases are reached by tracks.

See also references under "Cyrenaica" in the Index. (W. B. Fr.)

CYRENAICS, a Greek school of philosophers, so called because Cyrene in north Africa was the centre of its activity and the birthplace of several of its members. Although the elder Aristippus (*q.v.*), a pupil of Socrates, was generally recognized as the founder, its known adherents were contemporaries or successors of his grandson and namesake, and its doctrines are very inadequately recorded in a form that suggests a later compilation, probably the end of the 4th century B.C. Yet the combination of sophistic and Socratic elements that they offer is compatible with an earlier origin and suits what is known of the elder Aristippus.

According to the Cyrenaics, a man knows that things external to

himself exist because they have an effect upon him, but he can know nothing about their nature; all that he can perceive is the way in which he is affected by them. How other men are affected is also unknown. The fact that two men give the same name to their experiences is no guarantee of identity. In this situation the only admissible object of action is to ensure that one's own affections are pleasant. The goodness of pleasure is denied only by those whose minds are perverted. The three possible conditions of the human constitution are violent change, gentle change and stability. The first is accompanied by pain, the second by pleasure, the last by neither. Man must avoid the first and seek the second; it is a mistake to suppose, as did the Epicureans, that the third is pleasant or desirable. Moreover, the pleasure to be sought is that of the moment; only present experience can give present pleasure. Happiness, the sum of pleasures, is to be valued only because it includes momentary pleasures, which are alike in kind, their relative value depending only on their intensity. Bodily pleasures (and pains) are more intense than those of the mind. Nevertheless the latter were recognized and included some that have an altruistic aspect; *e.g.*, joy in one's country's prosperity.

The Socratic contribution to Cyrenaic doctrine is the importance attached to wisdom or insight, as a necessary means to the attainment of pleasures. It has been guessed that, in pursuance of Socrates' suggestion in Plato's *Protagoras*, this insight was employed in a "hedonistic calculus" which balanced pleasures against the previous or subsequent pains that they involved. This is, however, contrary to evidence that both Aristippus and the school held that pains should not be undergone for the sake of future pleasures, since the latter must be problematical. On the other hand, it was said that acts should be avoided that would bring punishment; and it is unlikely that a practical guide to behaviour would recommend every pleasure, on the ground that resulting pains, however probable, fall short of certainty. But the insight needed is wider than this: it can turn circumstances to good account, guard against errors which bring pain (these include those of envy, superstition and falling in love) and enable a man to command pleasures without being their slave. To be stronger than pleasure is a true Socratic ideal and distinguishes the Cyrenaic from the wastrel.

Three Cyrenaics made innovations important enough to give their names to their followers. Theodorus, whose opposition to superstition made him notorious as an "atheist," being anxious to make wisdom sufficient for happiness, denied that pleasures and pains were good or bad; mental cheerfulness, the gift of wisdom, became his aim. One need not believe the tale that Hegesias' lectures drove several hearers to suicide. Doubtful, like Theodorus, about the power of wisdom to procure pleasures, he advised a chief concern with avoiding pains; much pain of mind was to be avoided by regarding such things as poverty and riches, slavery and freedom, death and life as matters of indifference. Finally Anniceris (*q.v.*) revived the original doctrines with some additions.

(F. H. Sh.)

CYRENE, the original capital of ancient Cyrenaica (*q.v.*), the site of which is partly occupied by the modern village of Shahat in the Al Jabal al Akhdar, 8 mi. S.W. of Marsa Susa, in Cyrenaica province, Libya. It was one of the greatest of Greek colonies.

History.—As told by Herodotus, the story of its foundation is a characteristic mixture of legend and historical tradition (Herodotus iv, 154 *et seq.*). On the advice of the oracle at Delphi a small group of Greek emigrants, driven by famine from the island of Thera (Santorin), set sail for Libya about 630 B.C. The first settlement on the small island of Platea in the Gulf of Bomba was a failure, and after further application to Delphi the colonists moved to Aziris on the mainland, whence shortly afterward they were led by friendly Libyans to the site of Cyrene itself. Here, on the hill to the south of the perennial spring of Cyrene (Kurana), a nature goddess who was later claimed by Greek tradition as the bride of Apollo, they established their settlement.

The leader of the expedition, Battus, became the first king, founding the dynasty of the Battiadae, whose members, named alternately Battus and Arcesilaus, ruled Cyrene for eight generations. Under Battus II, about 570 B.C., a further influx of Greek colonists disturbed the hitherto friendly course of Libyan relations; and although the Egyptian army sent by Apries to aid the Libyans was defeated, the later history of the Battiadae was one of recurrent dissension among rival domestic factions and between Greeks and Libyans, allayed temporarily under Battus III by the granting of a new constitution, but soon breaking out again and culminating in a successful, though short-lived, Persian invasion about 515 B.C. The dynasty was finally extinguished about 440 B.C.

Though politically troubled, the rule of the Battiadae was a time of expansion and economic prosperity. Apollonia (Marsa Susa), the port of Cyrene, must have been founded soon after Cyrene itself. Barca (Al Marj) followed under Arcesilaus II, and toward the end of the 6th century Euhesperides, the predecessor of Bengasi. The economy was based on grain and stock breeding, and the exploitation of silphium, a wild plant greatly valued for its medicinal properties.

The republic that followed was politically undistinguished and in 322 B.C. Cyrene passed within the orbit of Ptolemaic Egypt. The Ptolemies seem to have paid particular attention to the cities and to the problems of government. A new port to serve the city of Barca was founded at Ptolemais (Tolmeta); Euhesperides was shifted to a more favourable site, Berenice; and Teuchira (Tocra) was laid out afresh under the name of Arsinoë. The constitution given to Cyrene by Ptolemy I, a copy of which is preserved in the museum at Cyrene, is a model of its sort. During this period Cyrene was one of the great intellectual centres of the classical world. Its medical school was famous, and among its citizens it numbered the geographer Eratosthenes and the philosophers Carneades and Aristippus, founder of the Cyrenaics (*q.v.*). The poet Callimachus was a native of Cyrene.

By the will of its last king, Ptolemy Apion, Cyrenaica passed to the Romans in 96 B.C., and after years of neglect was united with Crete to form a senatorial province (67 B.C.), with Cyrene as the local capital, an arrangement which persisted until Diocletian's great administrative reorganization of A.D. 297, when the capital of the new province of Upper Libya was transferred to Ptolemais. Apart from the great Jewish revolt of A.D. 115, which caused untold havoc in Cyrene, the first two centuries of the empire were a period of relative prosperity. Thereafter the history of Cyrene is one of steady decline, due to the increasing insecurity of the desert frontiers, and aggravated by a disastrous earthquake in A.D. 365. Under Justinian it still possessed two fine churches, but much of the population had already deserted it for Apollonia; with the Arab conquest of A.D. 642 city life came to an end. The outstanding personality of this late period is Synesius, an aristocrat of Cyrene, who became bishop of Ptolemais about A.D. 410.

Archaeology.—The remains of the city lie along the brow of the highland of Al Jabal al Akhdar at a height of about 1,800 ft. To the south the plateau slopes very gradually toward the interior, a rich grain raising belt; to the north it drops steeply to a strip of level plain and then steeply again to the sea, 6 mi. distant. The site is a spectacular one, with much to remind the colonists of their native land. The original settlement was on the site of the later acropolis, a prominent rounded spur, defended on the west and southwest by a deep, curving ravine, and on the northeast by a shallower valley, from the southern slopes of which gushed the "fountain of Apollo." Later the city spread southeastward along the ridge linking the acropolis to the main plateau, and, later still, northeastward across the valley onto the adjoining hill previously occupied only by isolated temples. The two hills were enclosed within a single defensive wall, 3 mi. long; and in Ptolemaic times the plan was rationalized by the creation of an approximately rectangular grid of major streets. This grid served as a framework for all subsequent development, and with its establishment the centre of gravity shifted gradually eastward, until the formal centre of the Roman town lay at the crossroads at the head of the valley street.

The exploration of the site, undertaken on a large scale between World Wars I and II by Italian archaeologists, and after World War II by the Libyan government aided by British and Italian

experts, covers three main areas: the fountain and sanctuary of Apollo; the upper city; and the centre of the Roman town at the head of the valley street.

The actual fountain was dedicated to the Nymphs. Immediately in front of it a narrow terrace along the foot of the cliffs served the practical needs of the community; and below this, and quite distinct from it, was the broad terrace of the sanctuary proper. This was dominated by the temple of Apollo. The standing columns are those of the latest restoration, after the Jewish revolt, but the podium incorporates much of the original 6th-century building and its 4th-century successor. In front of it stood the great altar, rebuilt in marble in the 4th century B.C., and beside it, to the north, the temple and altar of Artemis, dating back to the late 7th century, rebuilt in the 4th and enlarged by the Romans. Around this central group were numerous secondary shrines, including those of Isis, Hades, Hecate and the Dioscuri; the successive Greek and Roman *propylaea;* a well-preserved Hellenistic fountain; the 4th-century *strategeion,* rebuilt under Tiberius and recently restored and reroofed; and numerous votive monuments. At the west end of the sanctuary was the Greek theatre, converted by the Romans into a miniature amphitheatre; and under Trajan (A.D. 98) the whole of the eastern part was taken over to house a grandiose bath building, destroyed by the earthquake of 365 and rebuilt soon after on a slightly different site. Reused in the floors of the later building were a number of important early inscriptions. The famous Venus of Cyrene, now in Rome, was found in the baths; and a colossal statue of Apollo, now in the British museum, was found in the main temple.

The upper city is laid out about the road that runs along the crest southwestward from the acropolis. Apart from its Roman walls and a temple of Isis, the acropolis itself has been barely examined. Outside it, around the monument that marks the traditional site of the grave of the founder, Battus, there grew up the *agora,* a rectangular open space dating in its present form from the Hellenistic period, with extensive Roman modifications. Around it were grouped public buildings, including three *stoas,* the Hellenistic public record office and *prytaneion* and two buildings identified as a gymnasium and the Roman *capitolium.* From the *agora* a broad street, closed at either end by monumental gateways, runs southwestward to join the main cross street of the city. There stands, restored in the 1930s, the Augustan *Caesareum,* a grandiose forum and basilica modeled on the famous *Kaisareion* of Alexandria; in the late 4th century it was converted into a fortress. The temple in the middle is a 2nd-century addition, whence came a fine statue of Dionysus now in the British museum. Along the south side of the street can be seen the remains of a theatre, several small temples, and the so-called "house of Jason Magnus," a large 2nd-century house with fine mosaics and intarsia floors. Across the street was a colossal *stoa,* 400 ft. long, the windows of its façade flanked by busts of Hercules and Hermes. Behind this is a theatrelike building, possibly the Hellenistic assembly hall, and a Byzantine house with 5th-century mosaics.

The valley street was entirely remodeled in Roman times, with a great covered drain and a flanking portico leading to the sanctuary of Apollo. The first building above the modern village of Shahat is a Roman market, converted into a theatre after the earthquake of 365. Beyond it lay the Roman city centre, still in process of excavation in the early 1960s. In it can be seen three temples, burned by Christian fanatics, and a small 6th-century basilica with the remains of fine mosaics. Still farther up the valley lies the cathedral, a large 5th-century basilica, remodeled and paved with mosaics in the 6th; opening off it is a baptistery. Beyond it again, unexcavated, are the city walls, a group of large vaulted cisterns and the hippodrome. A huge Doric column, recently re-erected, marks the site of the temple of Zeus, a gigantic Doric building of the late 6th century B.C., partly rebuilt under Augustus and overturned by the Jewish rebels in A.D. 115. The outer colonnades were left lying, but the *cella* was rebuilt to house a colossal statue of Zeus, 12 times life-size, probably a copy of the great statue at Olympia. Temple and statue were destroyed by the Christians.

Beyond the walls the cemeteries of Cyrene stretch for miles in every direction. They include multiple rock-cut tombs with architectural façades; upstanding masonry tombs, both circular and rectangular; and large groups of rock-cut sarcophagi. The earliest tombs, beside the Apollonia road, date back to the 6th century B.C.; the majority are of late classical and Hellenistic date, many of them reused in Roman times.

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CYRIACUS OF ANCONA (CIRIACO DI FILIPPO PIZZICOLLI) (1391–1452), an early explorer and inquirer into the remains of classical antiquity, was born in Ancona in the Marches department of eastern Italy, and died at Cremona. A merchant by profession, he traveled extensively in Greece, Egypt and the near east, interesting himself in all kinds of historical objects. His Latin and Greek were largely self-taught and his knowledge of these languages uncertain, but he collected copies of hundreds of inscriptions—along with medallions, statuettes, gems, even manuscripts —which he encountered in his travels. The collection itself was dispersed after his death. The inscriptions, presented in six volumes of *Commentaries* deposited in the Sforza library in Pesaro, were destroyed by fire in 1514. Some of his notebooks and copies of them made by friends survive, and have been published in various places.

See E. W. Bodnar, *Cyriacus of Ancona and Athens,* in the Collection Latomus xliii (1960). (J. H. Yo.)

CYRIL, SAINT, OF ALEXANDRIA (*c.* 375–444), patriarch of Alexandria, an Alexandrian Greek who was an Egyptian national leader as well as theologian, and, since 1882, officially in the Roman calendar a doctor of the church. He succeeded his uncle Theophilus in the see of Alexandria in 412. Cyril's character continues to puzzle interpreters. An able and influential theologian, he was at the same time an astute and sometimes unscrupulous politician. He left a considerable mark on the formulation of orthodox theology, yet the victories he won for the power of his see and his particular ideas were more apparent than real.

His episcopate began with conflicts at Alexandria between the bishop and the prefect Orestes. Cyril closed the churches of the Novatians (a schismatic sect that had been tolerated at Constantinople) and began, but apparently did not complete, the expulsion of the Jews. There were victims on each side in the riots that followed, of whom Orestes' friend, the learned neo-Platonist, Hypatia (*q.v.*) is the most famous. Cyril, who at least had not prevented these events, was forced to acknowledge the rights of the civil authority, but remained the leading citizen of Egypt. His most extensive literary production belongs to the following years. Commentaries on selected passages of the Pentateuch, on Isaiah and the Minor Prophets, and on the Gospels of John and Luke have been preserved in whole or in part. His central thought seems to be unity—the unity of the work of God in Old and New Testaments (maintained by a moderate use of allegory), and the unity of God and man in Christ, described at this period in terms of the indwelling of the divine Word in human flesh.

In theology Cyril was in conflict with the more literal school of Antioch, and in church politics was jealous of the rising see of Constantinople. Both causes combined when the Antiochene Nestorius (*q.v.*) became bishop of Constantinople in 428. Nestorius refused to call the Virgin Mary *Theotokos* ("mother of God" or, literally, "God-bearer"). Cyril insisted on the term as expressing the intimate union of the divine and human natures, made one in the incarnation. The letters and treatises of this controversy develop his theology further, recognizing more definitely the fullness of Christ's humanity along with the oneness of his person. To Cyril's anathemas Nestorius replied with counteranathemas, and the dispute was referred to a general council at Ephesus in 431. Armed with a commission to represent Pope Celestine I as well, Cyril convened the council and condemned Nestorius before the oriental bishops arrived, headed by John of Antioch, and condemned Cyril. Lavish gifts to courtiers secured the imperial recognition of Cyril's council, and Nestorius was banished (*see* COUN-

CIL). But the peace of the church was not restored till 433, when Cyril accepted as orthodox an Antiochene statement which emphasized the distinctness of the two natures. In this modified sense Ephesus was accepted as an ecumenical council; Cyril's own position, expressed in the phrase "one nature of the incarnate Word," incorrectly ascribed to Athanasius, was developed by his successors into the more extreme monophysitism condemned at Chalcedon in 451 (*see* MONOPHYSITES). By the time of Cyril's death in 444 the bishops of Constantinople had recovered the prominent position which inevitably belonged to the see of the imperial city.

The chief work of Cyril's more quiet later years was his reply to the emperor Julian the Apostate's *Against the Galilaeans,* the latest work of ancient Christian apologetic against paganism, and of additional interest as preserving considerable extracts from Julian's work. More in tribute to his historic achievements than to his character, Cyril is honoured as a saint (feast day Feb. 9 in the Roman calendar, June 9 in the Greek) and doctor of the church.

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CYRIL, SAINT, OF JERUSALEM (*c.* 315–386), bishop of Jerusalem, his birthplace, fostered the development of the "holy city" as a pilgrimage centre for all Christendom. Though he seems to have had few interests in the absorbing theological controversies of the time, he was none the less distrusted for not being a partisan. Three times exiled from his see by the Arians, he apparently was suspected at the Council of Constantinople (381) by the strictly orthodox for his associations with the "Homoiousians" (moderate Arians).

Cyril's primary surviving work is a collection of 24 catechetical lectures delivered to candidates for baptism. The first 19, based on the Jerusalem baptismal creed, were given during Lent, and the concluding 5 then instructed the newly baptized in the week after Easter. These lectures are characterized by clarity of exposition, abundant use of Scripture and a strong pastoral purpose. The last five throw light on contemporary liturgical practice and sacramental teaching. Cyril's eucharistic theology is an advance on that of earlier writers. He interprets the Lord's presence in terms of transubstantiation and describes the rite in pronounced sacrificial language. The last five lectures have been attributed—without, it would seem, compelling evidence—to Cyril's successor, John. Cyril's feast day is March 18. He was declared a doctor of the church in 1883.

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CYRIL AND METHODIUS, SAINTS, "the apostles of the Slavs," two Greek brothers from Thessalonica. They received their title because they not only completed the christianization of the Slavs in the Danubian region but also, at least through their disciples, influenced the religious and cultural development of all Slavic peoples (*see* SLAVS). Cyril (whose original name was Constantine) was born about 827 and Methodius about 825. Both were outstanding scholars, theologians and linguists. In 860 Constantine, who had already participated in an earlier mission to the Arabs and was professor of philosophy at the patriarchal school in Constantinople, worked along with his elder brother, the abbot of a Greek monastery, for the conversion of the Khazars northeast of the Black sea. In 862 Rostislav, the ruler of the Great Moravian state, in order to oppose German political and ecclesiastical influence and the joint pressure of the East Frankish kingdom and Bulgaria, sent to Constantinople asking for Greek support and missionaries. The Byzantine emperor Michael III and the patriarch Photius entrusted that mission to the two brothers. In the following year they started their work among the Slavs, using the native language in the liturgy. They translated the Holy Scriptures into the language later known as Old Church Slavonic (*q.v.*), and invented a Slavic alphabet based upon Greek characters which in its final form was called Cyrillic and still is used by all Slavs belonging to the Eastern Church.

In 867 the brothers accepted an invitation of Pope Nicholas I to go to Rome to explain their conflict with the German archbishop of Salzburg and bishop of Passau, who claimed control of the same Slavic territory and wanted to enforce there the exclusive use of the Latin liturgy. The two brothers arrived in 868 in Rome, where the new pope, Adrian II, took their side, formally authorizing the use of the Slavic liturgy. When Constantine (renamed Cyril on taking his monastic vows) died the following year, the pope sent Methodius back to the Slavs as his legate and archbishop of Syrmium.

From this metropolitan see at the southern border of Pannonia (the future Hungary) Methodius' ecclesiastical province extended as far as Slovakia and Moravia, where the Great Moravian state had its main centres. Rostislav's nephew and successor, Svatopluk, however, co-operating at first with King Louis the German, failed to support Methodius. In 870 the archbishop was tried by the German clergy, probably at Freising in Bavaria, brutally treated and kept in jail for about three years, until the energetic intervention of Pope John VIII resulted in his liberation. A few years later, however, he was again summoned to Rome over the question of the Slavic liturgy. On the occasion of that visit, in 880, he obtained once more, though not without difficulty and reservations, papal approval of his use of the native language. But a German named Wiching, who was made his suffragan bishop, continued through his intrigues to create troubles for Methodius, who tried to strengthen his position by visiting Constantinople in 882. After Methodius' death in 885 Wiching succeeded in taking the place of the Slavic successor whom Methodius had chosen, and forced the disciples of the two Greek brothers to leave the country. They found a haven in recently christianized and Slavicized Bulgaria. While the Moravian state collapsed under German and Hungarian attacks at the beginning of the 10th century, the posthumous influence of Cyril and Methodius reached distant Kiev and left traces even among the Slavs of Croatia, Bohemia and Poland who ultimately adopted the Latin liturgy. Soon canonized by the Eastern Church, the two apostles of the Slavs were recognized as saints also by the Roman Catholic Church in 1880. Their feast day is July 7.

BIBLIOGRAPHY.—The bibliography on Cyril and Methodius published in 1934 by G. A. Ilinski comprised more than 3,000 items. The basic studies of F. Dvornik, *Les Slaves, Byzance et Rome au IXe siècle* (1926), and *Les légendes de Constantin et de Methode vues de Byzance* (1933) are summarized in his book *The Slavs, Their Early History and Civilization* (1956). *See* also the articles by V. Jagic "Conversion of the Slavs," in *Cambridge Medieval History,* vol. iv (1927), and P. J. Alexander, "The Papacy, the Bavarian Clergy and the Slavonic Apostles," in *The Slavonic Year-Book* (1941). (O. HA.)

CYRILLIC ALPHABET: *see* ALPHABET; OLD CHURCH SLAVONIC; SLAVONIC (SLAVIC) LANGUAGES; SLAVS.

CYRUS, the Latin form of Old Persian Kurush, the name of three members of the Achaemenid house (*see* ACHAEMENIDAE.)

CYRUS I, son of Teispes and grandfather of Cyrus the Great, ruled over Anshan during the latter half of the 7th century B.C. He accepted Assyrian overlordship about 639 B.C., after the conquest of Elam by Ashurbanipal, and sent his eldest son, Arukku, with tribute to Nineveh.

CYRUS II the Great, who reigned from 559 until his death in 530 B.C., was the founder of the Persian empire. His father was Cambyses I of Anshan.

Legends about the birth of Cyrus were soon current. Herodotus mentions a tradition that he was the son of Cambyses and Mandane, daughter of Astyages of Media, was exposed in the mountains, suckled by a bitch and brought up by a shepherd. The version Herodotus follows changes the dog into a shepherd's wife. Other traditions are preserved in Nicolaus Damascenus.

The principal sources for the history of Cyrus are cuneiform documents, the Old Testament and the Greek historians. The most important cuneiform texts are the *Cyrus Cylinder* and the fragmentary verse account of Nabonidus, both composed in the reign of Cyrus, and the Nabonidus Chronicle, written between the 5th and 3rd century B.C. In the Old Testament there are references to Cyrus in II Chronicles, Ezra and Isaiah. Herodotus, Xenophon, Ctesias and the excerpts from Berossus contain historical material, although there is much that is legendary and dubious.

Cyrus, who had become king of Anshan in 559, rebelled against Astyages, his Median overlord, in 553 B.C., having previously united the leading Persian tribes under his rule and secured an alliance with Nabonidus of Babylonia. In 550 B.C. he defeated and captured Astyages and seized Ecbatana. Although he had received assistance from disaffected elements among the Medes, his victory did not lead to immediate acceptance of his rule by all the members of the Median confederation, and he may have spent the next two years in securing the submission of tribes east of the Tigris. The Nabonidus Chronicle states that in the spring of 547 B.C. Cyrus marched into north Mesopotamia and then proceeded against a land, the name of which is broken, and killed its king. It is possible that the enemy was Croesus of Lydia, who, according to Herodotus, was seeking to expand his power into the former Median territory east of the Halys river. After an indecisive battle with Cyrus, the king retired to Sardis and disbanded his mercenaries, his intention being to renew the war in the following spring when he had received reinforcements from Babylonia, Egypt and Sparta. Cyrus, however, forestalled him by a swift advance on Sardis, which fell after a short siege. If Lydia is the land referred to in the chronicle, the most probable date for this event is the autumn of 547 and, contrary to classical traditions, Croesus was killed by Cyrus.

Herodotus and Berossus agree that between the fall of Sardis and the final campaign against Babylon in 540 B.C. Cyrus made himself master of the rest of western Asia. The reduction of western Asia Minor was completed by his generals, who, by force or persuasion, secured the submission of the Ionians, Carians and Lycians and suppressed a revolt in Lydia. The king of Cilicia voluntarily acknowledged Persian supremacy, as did Gutium, a Babylonian dependency east of the Tigris. According to Xenophon, Cyrus also subdued Greater Phrygia and Cappadocia and reduced the Arabs to submission. The term "Arabs" may here refer to the peoples of the Damascus area and Palestine who had previously formed part of the Babylonian empire.

By 540 B.C., when Cyrus began his attack on Babylonia, he had gained control of most of its provinces. In Oct. 539 his general Gobryas entered Babylon without a battle. The story, given by Josephus and Eusebius, that Cyrus spared Nabonidus is contradicted by Xenophon.

Cyrus was welcomed by many of the Babylonians who had been alienated by the religious policy of Nabonidus. In his *Cylinder*, a masterpiece of propaganda, Cyrus represents himself as their liberator from the evil rule of Nabonidus and as the king chosen by Marduk, their national god, to reign over them. He assumed the Babylonian royal titulary, and although he himself did not perform the ritual duties of a Babylonian king at the New Year festival of 538 B.C., his eldest son, Cambyses, did so as his representative. A Persian governor was appointed, but many native officials were retained in their posts. Cyrus scrupulously respected the Babylonian religion; he repaired temples and restored to their cities the cult statues that had been brought into Babylon by Nabonidus. He also sent back the gods of Ashur and Susa and in 538 B.C. authorized the return to Palestine of the Jews deported by Nebuchadrezzar and made arrangements for the rebuilding of the Temple in Jerusalem.

The subjugation of northern and eastern Iran must also be attributed to Cyrus, although his campaigns in these areas are not well documented. Immediately after the defeat of Astyages, according to Nicolaus Damascenus, Cyrus was acknowledged as overlord by the Hyrcanians and subsequently by the Parthians, Bactrians and Sacae. Herodotus implies that he subdued the Bactrians and Sacae after the fall of Lydia. The historians of Alexander the Great mention that Cyrus received aid from the Ariaspae tribe on the Etymandrus and founded a fortress, Cyropolis, on the Jaxartes river, and that in a march through Gedrosia (southeast Iran and Baluchistan) he lost the greater part of his army. In 530 B.C., having appointed Cambyses as regent in Babylonia, Cyrus set out on a new expedition against the east in the course of which he was killed. He was buried at Pasargadae, the city he had founded.

Cyrus was an outstanding soldier and statesman. He founded an empire that stretched from the Indus and Jaxartes to the Aegean and the borders of Egypt and left behind him a reputation for justice and clemency, which, while in the main justified, undoubtedly owed much to his skilful use of propaganda. (*See* also PERSIAN HISTORY.)

CYRUS the Younger (d. 401 B.C.), the son of the Persian king Darius II, was born after the accession of his father in 423 B.C. He was the favourite of his mother, Parysatis, who hoped to secure the succession for him instead of her eldest son Arsaces. When, after the victories of Alcibiades, Darius II decided to continue the war against Athens and give support to the Spartans, she persuaded him to appoint the young Cyrus as satrap of Lydia, Phrygia and Cappadocia and commander in chief of the Persian forces in Asia Minor (407 B.C.). The Spartan general Lysander won the favour of Cyrus and after the Athenian victory at Arginusae (406) Cyrus used his influence in Sparta to secure the appointment of Lysander as commander of the Spartan fleet, although under a nominal chief. In 405 B.C. Cyrus was called to his father's deathbed but before leaving handed over the revenues of his province to Lysander, who the same year won the battle of Aegospotami. In 404 B.C. when Arsaces became king as Artaxerxes II, Cyrus was accused by Tissaphernes, satrap of Caria, of plotting his brother's murder, but on the intercession of Parysatis he was pardoned and sent back to his satrapy.

Immediately on his return, Cyrus began preparations to seize the throne. He used a quarrel with Tissaphernes over the Ionian cities as a pretext for gathering a large army and also pretended to prepare an expedition against the Pisidians, a tribe in the Taurus mountains. The Spartans, while not breaking openly with Artaxerxes, gave Cyrus every facility for recruiting Greek mercenaries; a Spartan exile, Clearchus, raised troops for him in Thrace and Menon of Larissa collected another army in Thessaly. In the spring of 401 B.C. Cyrus started from Sardis; he was subsequently joined by Menon and Clearchus and, on reaching Cilicia, by his fleet and a Spartan squadron. When he reached the Euphrates at Thapsacus Cyrus announced that he was marching against Artaxerxes and by dexterous management and large promises overcame the misgivings of the Greek troops at the prospect of a long and dangerous war. He advanced into Babylonia without meeting any opposition, but Artaxerxes, warned at the last moment by Tissaphernes, was hastily gathering an army. The two forces met at Cunaxa and in the ensuing battle Cyrus was slain. The Greek troops of Cyrus, after their commanders had been treacherously seized by Tissaphernes, forced their way to the Black sea.

The courage and ability of Cyrus are highly praised by the Greeks, especially by Xenophon, who in his *Anabasis* wrote the history of the Greek retreat, but from the standpoint of Persia Cyrus was a traitor who, to gain his own ends, used hostile Greeks to attack the empire.

See, for Cyrus the Great, S. Smith, *Babylonian Historical Texts Relating to the Capture and Downfall of Babylon* (1924) and *Isaiah Chapters XL–LV* (the Schweich Lectures of the British Academy, 1940) (1944). (J. M. M.-R.)

CYSTIC FIBROSIS: *see* CHILDREN, DISEASES OF.

CYSTOID, any of the fossil echinoderms (relatives of present-day starfishes, sea urchins, etc.) constituting the class Cystoidea. They were characterized by a globular or cystoid shell. *See* ECHINODERMATA.

CYSTOLITH, a botanical term for the inorganic concretions, usually of calcium carbonate, formed in a cellulose matrix in special cells, generally in the leaf of plants of certain families; *e.g.*, *Ficus elastica*, the india-rubber plant.

CYTOLOGY is that branch of biology concerned with cells, the basic structural and functional units of living matter, or protoplasm, forming the bulk of the tissue of animals and plants. The ultramicroscopic basis of the cell, and the physical, chemical, and physiological nature of living matter are also included, though these aspects of cell biology are more and more becoming the special concern of the biochemically and biophysically oriented discipline called molecular biology.

While most cells can be observed only by means of a microscope (the smallest cells visible under the ordinary light microscope are bacteria), a few reach considerable size, the largest being the egg yolk of the ostrich. Organisms entirely microscopic and consisting of a single cell, such as bacteria, are sometimes referred to as being unicellular but more often they are described as being acellular, or noncellular. Most macroscopic organisms, ranging from the smallest—barely visible to the unaided eye—to the largest plants and animals, are multicellular, being composed of millions of microscopic cells.

Applications of cytology are found throughout biology: in plant and animal breeding for food production, in the diagnosis of disease, and in genetic counseling. Further information about cells may be obtained from the articles BIOLOGY; HISTOLOGY; PATHOLOGY; DEATH (BIOLOGICAL). This article, while describing the fundamental aspects of all cells, emphasizes the cells of animals (for plant cells *see* PLANTS AND PLANT SCIENCE); it consists of the following divisions:

I. Introduction
  1. History
  2. Methods
II. Structure and Function
  A. Nucleus
    1. Nuclear Membrane
    2. Chromatin
    3. Nucleoli
    4. Nucleoplasm
  B. Cytoplasm
    1. Cell Boundary
    2. Endoplasmic Reticulum
    3. Mitochondria
    4. Pigment Bodies
    5. Golgi Complex
    6. Centrioles
    7. Vacuoles and Cell Sap
    8. Other Inclusions
III. Cell Types
  A. In the Organism
    1. Variation
    2. Differentiation
    3. Metabolic Types
  B. In Cell Cultures
  C. Evolution of Cells
IV. Cell Growth
  1. Basic Pathways
  2. Duration
V. Cell Division
  A. General
    1. Background
    2. Capacity for Division
    3. Mechanisms
  B. Mitosis
    1. Stages
    2. DNA Changes
    3. Cytoplasmic Division
    4. Significance of Mitosis
  C. Meiosis
    1. Types
    2. First Division
    3. Second Division
    4. Significance of Meiosis
  D. Notable Exceptions
VI. Cell Union
VII. Chromosomes
  1. Number
  2. Form
  3. Ultrastructure
  4. Cytochemistry
  5. Chromosomal Aberrations
  6. Chromosome Maps
VIII. Nature of Protoplasm
  1. Properties
  2. Ultrastructure
  3. Chemistry
  4. Protoplasmic Reactions

I. INTRODUCTION

1. History.—The discovery of cells became possible only after optics extended the limits of human vision. In 1665 Robert Hooke made a simple microscope, consisting of one globular lens; using this device, he examined different objects, among them a slice of cork, in which he saw a honeycomb of hollow compartments that he called "cells." Later, in 1673, Anton van Leeuwenhoek (*q.v.*) also made many observations by means of a simple homemade microscope. In 1683 he communicated his findings to the Royal Society in England, describing living cells for the first time, including bacteria, red blood cells, spermatozoa, and various protozoa. With the development of the compound microscope professional scientists began to make detailed studies on the cellular structure of plants and animals.

Intensive microscopical investigations eventually led the German biologists M. J. Schleiden and T. Schwann in 1839 to propose definitively the cell theory, which for some time had been a doctrine of common assent among many prominent scientists. Schwann expressed the theory as follows: "The cells are organisms, and animals as well as plants are aggregates of these organisms, arranged in accordance with definite laws." Cells were found to consist of two parts: a central body, the nucleus, in a jellylike matrix, the cytoplasm. (The nucleus had been discovered earlier by Robert Brown, in 1831, in the "cellular juice" of the orchid.)

The underlying principle of the cell theory gradually gave way to another, and more unifying, concept: that all living things are composed of protoplasm, a characteristic viscous living fluid. Then, in time, the idea of protoplasm as embodying the attributes of life was superseded by a more sophisticated view: that life at its basis can be comprehended in terms of the complex organization of the cell at the molecular level.

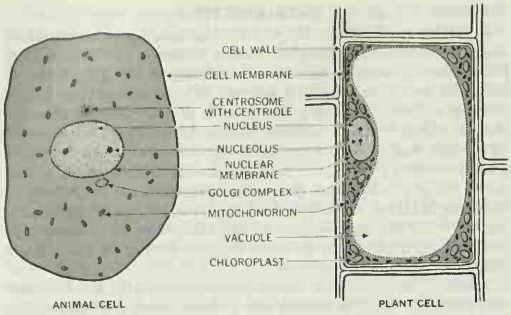
2. Methods.—Knowledge of cell structure and function is obtained chiefly by means of a microscope (*q.v.*). In order to avoid errors in observation due to the limitations of human vision, photography is used as an objective means of recording microscopic details. Alternatively, a photoelectric cell may be used to measure the amount of light absorbed by cell structures, to obtain quantitative cytochemical information, as in microspectrophotometry.

Cells may be observed either alive or after fixation by means of various preserving solutions. Living cells appear almost structureless under the compound light microscope; their structure can be revealed by mounting them in a solution of a vital stain, a dye that may disrupt some aspects of cell activity. Other types of microscopy (phase-contrast, interference, polarized light, ultraviolet, and immersion refractometry) reveal the structure of living cells without the risk of cell damage by stains. Ultraviolet microscopy has the limitation that living cells are sensitive to the radiation and can be examined only for a short time if radiation-induced changes are to be avoided.

The chemical process of fixation is the basis of common laboratory techniques used to preserve cells in as lifelike a state as possible. However, it accomplishes a selective preservation of cell parts and destroys some aspects of cell structure. Fixation renders the cells more resistant to further manipulative and chemical procedures involved in probing cell architecture. Methods of fixation are chosen according to the purpose of the investigation (whether morphological or cytochemical) and the level of observation (cellular, in terms of the light microscope, or subcellular, with the X-ray and electron microscopes).

Valuable information on the distribution of chemicals can be obtained with the X-ray microscope, but only fixed cells may be studied because the specimen must be placed in a vacuum. Electron microscopy reveals the finest resolution of detailed structure. Latest models can resolve 5 Å, enabling structures no larger in diameter than five hydrogen atoms (end to end) to be studied. The electron microscope is also limited to the extent that no living cells can be observed with it because the specimen must be examined in a vacuum. It may be that not all of the minute structures observed under these microscopes occur as such in living cells. Indeed the higher the magnification, the more likely are induced changes, or artifacts.

The cytochemical structure and physiology of cells may also



FROM BIOLOGICAL SCIENCES CURRICULUM STUDY, "BIOLOGICAL SCIENCE: AN INQUIRY INTO LIFE," 1963, HARCOURT, BRACE & WORLD, INC.

FIG. 1.—COMPARISON OF ANIMAL AND PLANT CELLS AS SEEN UNDER THE CONVENTIONAL LIGHT MICROSCOPE

be studied by labeling with radioactive isotopes of elements normally found in cells. Their pathway through the cell and areas of localization can be traced by autoradiography.

II. STRUCTURE AND FUNCTION

Detailed studies on living and fixed cells have revealed a basic architecture characteristic of all cells except bacteria and certain blue-green algae. The last two cell types have fewer components, which may be regarded as the essential minimum for a functioning cell. Superimposed on the fundamental structure and physiological plan to which all living things conform is a range of superstructures, developed at various stages in evolution, that result in biological diversity.

This section deals with the range of cell components. Some of these components are found in almost all types of cells; others are found mainly or exclusively in animal cells or in plant cells (fig. 1), or are restricted to certain groups of animal or plant cells. The two types of nondividing cells are: (1) those in the interphase (between cell divisions), which are actively growing toward full size, in preparation for division; and (2) cells that have ceased dividing, often having lost the ability to do so as a result of specialization of functions. The following discussion applies to cells at late interphase.

Although cells vary in size, shape, and internal contents, two parts are always readily distinguishable: a central nucleus and an outer cytoplasm, in which the nucleus is embedded (enclosed by a cell membrane or plasma membrane). Both nucleus and cytoplasm, essential for the life of the cell, play different but closely cooperative roles in the cell.

A. Nucleus

The nucleus is the governor of cell structure and activity. It contains the chromatin material, depot of genetic information, distributed throughout the nuclear sap, or nucleoplasm, and the nucleoli (sing. nucleolus), dense spheroids thought to be involved primarily in protein synthesis (fig. 2).

1. Nuclear Membrane.—Except in bacteria, all nuclei are bounded by a membrane, which, under the electron microscope, consists of two closely applied layers composed of proteins and lipids. Some cytologists think that this membrane is simply a continuation of the endoplasmic reticulum (*see* below), a complexly folded double membrane that extends throughout the cytoplasm.

The inner layer is continuous, while the outer contains pores large enough to allow passage of relatively large molecules such as proteins and ribonucleic acid. The membrane is a delicate selective barrier that can suffer only very minor damage; even the most gentle microdissection often irreparably destroys it and therefore disrupts nuclear integrity.

2. Chromatin.—This term, from the Greek, suggests an affinity for colour. The nuclear substance to which the name is applied stains readily with chemicals such as hematoxylin and carmine, basic dyes used to reveal structure in chemically fixed cells. Actually, it is the nucleic acid content of chromatin that accepts the basic dye.

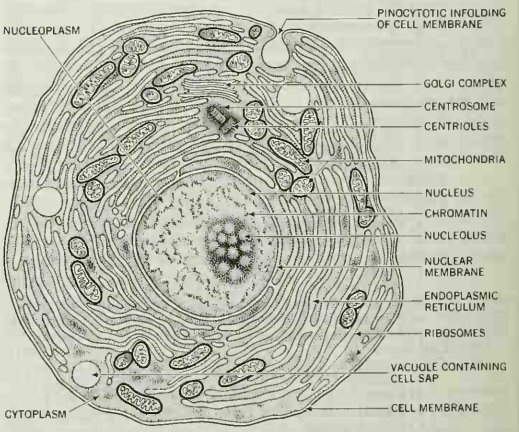
Chromatin is composed of four major molecules: histone (a low molecular weight protein), a complex protein distinguishable from histone, deoxyribonucleic acid (DNA), and ribonucleic acid (RNA). DNA is the key molecule conferring hereditary individuality to cells and organisms.

The first experimental demonstration of the role of DNA in cell heredity was accomplished by O. T. Avery and colleagues in 1944. They found that when DNA extracted from a culture of pneumococcus bacteria with fully developed "smooth," capsulated cells (Type 1) is added to a culture of pneumococcus with "rough," unencapsulated cells (Type 2), some of the Type 2 cells transform into Type 1 cells. Bacterial transformations such as this are due to incorporation of DNA (and its special genetic message) from one strain of cells into the DNA of the other strain. The same mechanism has been demonstrated in tissue cultures of human cells. In some plant viruses in which no DNA occurs, RNA is the repository of hereditary information.

The appearance of chromatin varies with the state of the cell and the process of fixation. But darkly staining chromatin bodies, called chromocentres, are always detectable both in living cells and fixed cells. In human female cells there is a chromocentre with a characteristic shape and size which is believed to represent a condensed X (sex) chromosome. This chromocentre is called the sex chromatin or Barr body after the discoverer M. L. Barr. There appears to be no sex chromatin in human male cells. Other chromocentres are believed to be condensed parts of different chromosomes and are called prochromosomes.

Two types of chromatin have been distinguished according to their staining reactions: euchromatin and heterochromatin. E. Heitz, in 1928, coined the word heterochromatin to describe chromatin that, during interphase and division, stained more or less than the euchromatin. The two types of chromatin have a quantitative difference. Euchromatin has a standard amount of nucleic acid, whereas heterochromatin has more nucleic acid at interphase (as in the chromocentres) and less during cell division (as in secondary constructions of chromosomes). It has been suggested that euchromatin carries the major (Mendelian) genes, while the heterochromatin carries genes that control quantitative response of major genes. (*See* Heredity.)

On the basis of ultraviolet microspectrophotometry, T. O. Cas-



FROM BIOLOGICAL SCIENCES CURRICULUM STUDY, "BIOLOGICAL SCIENCE: AN INQUIRY INTO LIFE," 1963, HARCOURT, BRACE & WORLD, INC.

FIG. 2.—MODERN INTERPRETATION OF A GENERALIZED ANIMAL CELL BASED ON ELECTRON MICROGRAPHS

Most of the structures are greatly enlarged in relation to the size of the cell; for example, the centrioles and mitochondria, if drawn to size, would be shown as dots, and the ribosomes and endoplasmic reticulum would be too small to see

persson and J. Schultz in Sweden suggested that heterochromatin chiefly influences the chemical composition of the nucleolus, thus acting as a centre for the synthesis of nucleic acids and hence concerned with the construction and activity of genes.

Usually, chromatin does not become visibly organized into chromosomes until the nucleus goes through a division. Exceptions to this rule are found in the nuclei of specialized nondividing cells of salivary glands of many insect species, where the chromatin is in the form of giant chromosomes, with distinct banding patterns of eu- and heterochromatin, within a nuclear membrane. This type of chromosome has been valuable for investigations of chromosome structure. (See *Chromosomes*, below.)

3. Nucleoli.—Nucleoli are spherical bodies in the nucleus and can be seen clearly in living cells under an ordinary light microscope. Most nucleoli stain with the same acidic stains that stain cytoplasm. The nucleolus is variable in structure and chemical constitution according to the physiological condition of the cell. Cytochemical staining reactions in fixed nucleoli have indicated that they are composed of RNA and protein. The general opinion is that the nucleolus does not contain DNA but is surrounded by a shell of so-called "nucleolus-associated chromatin" or heterochromatin, which takes a basic dye. Filamentous strands extending inside the nucleolus appear to be derived from "nucleolar" chromosomes at their nucleolus-organizing regions. In 1934, Barbara McLintoch first demonstrated in the corn plant (maize) that a nucleolus is produced by a specific chromosome at a special nucleolus-forming region on the chromosome. In normal cells the maximum number of nucleoli is an indication of the number of nucleolus-organizing chromosomes and the number of chromosome sets. The actual range of nucleolar number varies because adjacent nucleoli tend to fuse together into larger ones.

Nucleolar RNA plays a primary role in cell protein synthesis. RNA has been shown to be synthesized by chromatin outside the nucleoli, but the relationship of this RNA to nucleolar RNA is uncertain. The nucleolus may act as a storage depot for RNA synthesized on the chromosomes outside the nucleolus as well as RNA synthesized at the nucleolar-organizing region inside the nucleolus. Much evidence supports the hypothesis that the general pattern of cell protein synthesis involves formation of RNA copies of the DNA code in the chromatin, transferring the recorded information to the ribosomes in the cytoplasm, where the copy RNA directs the formation of characteristic proteins of the cell.

Nucleoli have not been observed in bacteria, where the RNA is found both in close association with DNA and in the cytoplasm. (*See* Nucleic Acids.)

4. Nucleoplasm.—Nucleoplasm, or nuclear sap, appears to be clear, homogeneous, and structureless. A. Claude (1943) found that chromatin and nucleoli can be sedimented away from the nuclear sap by very fast centrifuging. Nuclear sap can be precipitated by fixatives and stained with acid dyes. Cytochemical tests using certain enzymes have indicated the presence of RNA and proteins.

B. Cytoplasm

Under the light microscope (with phase contrast optics, or dark field optics) the cytoplasm appears to be composed of many bodies or organelles (except in bacteria) in a homogeneous matrix or ground substance (the hyaloplasm) found in all kinds of cells. Although the ground substance looks like a simple jelly under the light microscope, it is a chemically and physically complex system that includes membrane systems and intricate proteins. Although having general properties in common throughout all organisms, the exact chemical nature of the ground substance in any one species seems (at least in mammals) to be distinct. Sometimes the difference apparently extends down to strains or even individual animals (*see* Individuality, Biological).

While the nucleus directs cell activity, it can do so only within the limitations of the basic architecture of the cytoplasm in which it lies. This has been demonstrated by transplantation of nuclei in amphibian egg cells. Unlike nuclei, the cytoplasm can recover readily if part of it is removed or injured.

There is considerable evidence to show that the cytoplasm has autonomy and plays an essential part in cell heredity (*see* Heredity: *Cytoplasmic Heredity*).

1. Cell Boundary.—All cells have a cell, or plasma, membrane enclosing the cytoplasm. Some cells have an additional nonliving cell wall, or pellicle, secreted outside the plasma membrane. The form of the cell wall is one of the primary distinctions between plant and animal cells (fig. 1). In plants the chief structural component is cellulose, a characteristic plant substance. Cellulose walls are capable of extension with cell growth. Additional layers of lignin are laid down on the cellulose wall when some plant cells cease growth and become specialized. Animal cells may also be surrounded by cementlike substances constituting visible cell walls. Cell walls do not affect the permeability of cells.

The plasma membrane, a living part of the cell, is visible under the polarizing microscope. It usually appears as a double-layered membrane under the electron microscope (fig. 2). It probably consists of parallel sheets of protein separated by a double layer of lipid (fat). This is supported by the fact that substances soluble in lipids usually penetrate the membrane easily. The membrane is also permeable to substances such as water, which are insoluble in fats, suggesting that the lipoid layer may be porous.

The membrane is called semipermeable because it allows some molecules to pass but not others. Protein components such as amino acids pass more easily through the membrane than do many smaller molecules, so molecular size is not the crucial factor. A selective pumping action, according to the requirements of the cell, has been suggested. Irregularities occur in the plasma membrane, in the form of extensions and cavities that increase its surface area and absorptive capacity. The projections contain apparently structureless cytoplasm. Small cavities, or blebs, can form in the membrane. The blebs pinch off, passing some liquid across the membrane in the form of a vacuole. This phenomenon, called pinocytosis ("surface drinking"), has been observed in many metazoan cells as well as in protozoa.

2. Endoplasmic Reticulum.—The ground substance (hyaloplasm) of the cytoplasm has an ultrastructure that consists of an orderly arrangement of membranes. This system is called the endoplasmic reticulum, or ergastoplasm. It occurs in all cell types throughout protozoa and metazoa. Membrane systems found in bacteria may not correspond directly with the endoplasmic reticulum. In dividing cells the membrane network may rapidly appear and disappear. Numerous small RNA-rich particles (called microsomes or ribosomes) have been found lining the membranes or floating free in the cytoplasm when the reticulum is less evident. Sufficient quantities of ergastoplasmic fragments (containing pieces of membranes and particles) have been isolated from disrupted living cells to enable physiological assays to be made in test tubes. Microsomes have been found to be active in protein synthesis, while the membranes seem to be more concerned with the synthesis of steroids (including hormones).

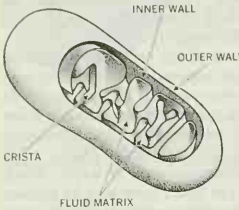
3. Mitochondria.—The cytoplasm of all cells contains numerous granules, rods, globules or filaments, among them mitochondria (or chondriosomes), plastids of plant cells, and Golgi bodies in animal cells. The identification of such structures, their origin, organization, chemical constitution, and function is often difficult.

Mitochondria (sing. mitochondrion) have a characteristic distinguishing structure and vary in size from 0.2 to 3.0 micron (μ) long (1 micron $= \frac{1}{1,000}$ millimetre). They are lipoidal, resembling phospholipids and albumins in chemical tests. They dissolve readily in organic acids such as acetic. In living cells, mitochondria can be stained readily with Janus green B. Although these procedures are insufficient to determine which of the smallest granules are mitochondria, the electron microscope can distinguish them by their characteristic structure.

In some cells, mitochondria, or bodies composed of mitochondrial material, divide; whether the individual elements regularly reproduce or arise anew each time is not clear. Regenerating liver cells contain "micro-bodies" that may be the precursors of the mitochondria. Mitochondria, which readily undergo wide changes in size and form in many cells, are present in greatest numbers in specialized organs such as liver and kidney. They have been found

in all cells except human red blood cells and bacteria.

Mitochondria are constructed in two parts, an enclosing double lipoprotein membrane (similar to the plasma and nuclear membranes) and an inner membrane convoluted into plates and folds to form a large internal surface (fig. 3). The internal arrangements vary from organ to organ and from species to species. Numerous enzymes synthesized at the ribosomes (fig. 2) accumulate in the folds of the mitochondria and cell sap. Some of the enzymes of the oxidative enzyme system form the protein component of the lipoprotein membranes of the mitochondrion.



FROM M. BESSIS, "THE ULTRASTRUCTURE OF CELLS," 1960, SANDOZ LTD.

FIG. 3.—SCHEMATIC DRAWING OF A MITOCHONDRION

The mitochondria constitute the main energy-transfer system of the cell. They act like power houses by oxidizing (burning) carbohydrates, fats, and proteins (the fuel) to release energy, carbon dioxide, and water. The energy does not escape as heat but is used to synthesize energy-storing molecules called adenosine triphosphate (ATP), a process called phosphorylation. The ATP diffuses out of mitochondria into the cytoplasm. Chemical energy is liberated from the ATP by breakdown at the site where energy is required. Oxidation and phosphorylation involve many chemical stages, each under the control of an enzyme found mostly in the mitochondria which tend to move toward parts of the cells that are doing mechanical work, *e.g.*, at the base of cilia and flagella. In specialized cells requiring a lot of energy, such as muscle cells and spermatozoa, mitochondria are found in rows between the muscle fibres and form the middlepiece at the base of the "muscular" tail of spermatozoa.

Mitochondria have been identified as the seat of respiration within all cells except bacteria, where oxidative and phosphorylating enzymes are diffused throughout the cell sap.

4. Pigment Bodies.—These include the plastids of plants and the pigment granules of animals. Evidence indicates that plastids regularly multiply by division. Some workers have found a primary granule of chromonucleoprotein in plastids, which would account for their genetic continuity. The size, shape, and colour of plastids vary with the tissue and the species. The chloroplasts, green plastids containing chlorophyll, are the bodies in which photosynthesis (*q.v.*) takes place. They reproduce by division of less differentiated structures called proplastids, which are distributed randomly to daughter cells in cell division. However, in some species such as the alga *Spirogyra*, there is only one chloroplast per cell, which divides synchronously with the cell and grows to maturity at the same rate as the cell.

Chloroplasts, like mitochondria, are membrane-enclosed enzyme sacs. They are composed of parallel membranes in an amorphous ground substance containing chlorophyll. The enzymes concerned with photosynthesis are mainly distributed on and between the membranes. Chloroplasts, which synthesize sugars, fatty acids, and proteins, can also manufacture ATP in the light to provide energy for the cell. (In the dark, mitochondria are responsible for providing the cell with energy via ATP.)

Other plastids, called chromoplasts (coloured plastids), contain different pigments, such as the yellows and browns in leaves and some reds in flowers. Several kinds of colourless plastids, called leucoplasts (some of which are chloroplasts devoid of chlorophyll), store starch grains in nonphotosynthesizing tissues such as potato tubers.

Melanin granules are the basis of pigmentation of animal cells. Their mode of origin is uncertain and no evidence has been obtained suggesting that they reproduce by division. Melanin granule formation begins with a pregranule, which has two membranes with the inner one arranged concentrically or a single membrane folded into an irregular spiral, in transverse sections. Longitudinal sections show parallel strands running down the length of the granules. The earliest recognizable pregranules have external membranes of the same electron density as other cell membranes. Later, the spaces between the membranes of the pregranule become packed with a dense combination of protein and melanin pigment that eventually obscures the inner membrane structure.

Melanin pigments in skin cells protect cells in underlying tissues from adverse effects of prolonged exposure to sunlight, especially the ultraviolet part of the spectrum (*see* PIGMENT, ANIMAL).

5. Golgi Complex.—Golgi materials, found in all cells except bacteria, are particularly prominent in secretory cells. They were discovered by Camillo Golgi in 1883 in nerve cells that had been fixed in formaldehyde followed by impregnation with silver nitrate. Golgi bodies reduce the silver nitrate to silver and readily blacken, indicating a lipoidal content.

The complex is not completely lipoidal, however, since positive reactions were obtained for ascorbic acid, the enzyme alkaline phosphatase, and glycoproteins. It is not known to be regularly self-reproducing. At mitosis it normally fragments into fine granules that are randomly distributed in the daughter cells. The morphology of the Golgi complex varies from one cell to another and within a cell type according to its functional stage. In nerve cells it often forms a reticular apparatus of fibres or canals, whereas in insect spermatocytes it has the form of small separate bodies. In animal sperms the Golgi complex forms the acrosome at the tip of the sperm head.

It consists of flattened sacs, smaller than those of the ergastoplasm, the walls of which are composed of two-layered lipoprotein membranes similar to other membrane systems in the cell. In most cases the Golgi materials surround the centrosome, but in some cells they are dispersed in the cytoplasm. Their biological activity remains unknown, but their particular prominence in secretory cells suggests a role in some aspect of synthesis.

6. Centrioles.—Centrioles are particles up to 0.5 μ long that are found in the cytoplasm at the periphery of a nucleus. They stain with nonspecific acid dyes in fixed cells. Very little is known about their chemical structure; cytochemical tests have indicated the presence of RNA and glycoproteins. Centrioles are self-reproducing and play an important role in the separation of chromosomes during cell division. They have not been observed in higher plants, but are probably present as submicroscopic multiple particles.

Electron microscope studies show that the centriole is a small cylinder 1,500 Å in diameter by 5,000 Å long. The sides of the cylinder are composed of nine parallel (often double) rods (fig. 4) apparently held together by two bands of nine rounded macromolecules. The latter seem to be attached to the rods by diffuse threads. The centriole is found in a small zone of clear cytoplasm, the centrosome.

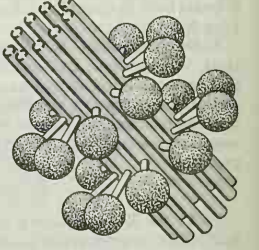


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FIG. 4.—STRUCTURE OF THE CENTRIOLE AS SEEN IN ELECTRON MICROGRAPHS

Note the nine paired rodlets and encircling belts of macromolecules

The centriole seems to be concerned in the formation, from the centrosome, of radiating fibrils of the aster and spindle of the mitotic apparatus (see *Cell Division*, below). The significance of the centriole's nine paired filaments is not known either, but it is noteworthy that the same pattern of nine elements (or multiples of nine) is found in other structures capable of movement, such as cilia and flagella.

7. Vacuoles and Cell Sap.—Vacuoles are membrane-enclosed cytoplasmic spaces containing water-soluble substances. Vacuolation is much more extensive in plant than animal cells. Their principal function is to maintain an optimum internal pressure in cells. In protozoa contractile vacuoles eject waste products out of the cell (*see* PROTOZOA). Food-vacuoles where digestion takes place are not lined by a membrane; these occur in protozoa and in phagocytic white blood cells.

In plants, vacuoles may become so large in a mature cell that they often occupy most of the cell volume (fig. 1). The vacuolar content, the cell sap, is often deceptively clear but chemically complex. It may contain dissolved pigments that give colour to the plant parts, or special materials that give rise to gums, resins, and latex. Since cell sap is derived mainly from the surrounding cytoplasm, its composition gives some indication of the makeup of the latter.

In 1938 E. C. Miller showed that the composition of the cell sap varied widely in different plants and under different conditions. The following materials have been found in vacuoles: water up to 98%; inorganic salts of various kinds, especially of sodium, potassium, magnesium, and calcium; carbohydrates, including sucrose, maltose, glucose, fructose, dextrins, and insulin; nitrogenous compounds, including proteins, amino acids, amides, proteoses, and peptones; various soluble alkaloids and glucosides, which are probably waste products of the cell; gases, especially oxygen and carbon dioxide; enzymes, principally diastase, invertase, lipase, inulase, and proteolytic enzymes; organic acids, including mainly oxalic, malic, citric, tartaric, tannic, acetic, and formic —the last two probably being present in every living cell.

8. Other Inclusions.—The cytoplasm may contain various other bodies, such as oil droplets and yolk spheres, crystals, and tiny granules. The granules, collectively described as microsomes, include the ribosomes of the ergastoplasm. In ciliated animal cells, a granule called a kinetosome is found at the base of the cilium; it is responsible for the formation of cilia in young cells. Kinetosomes are self-reproducing and are essentially identical with centriole structure in being composed of two central filaments encircled by nine filaments.

III. CELL TYPES

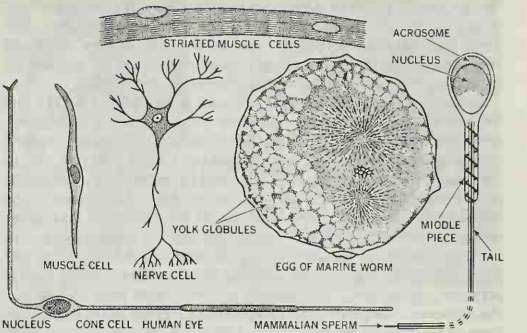
Different variations in the hereditary pattern of cell structure and physiology confer on various cells their biological individuality. The range of variation found in the organism (*i.e.*, in vivo) will be described, followed by further information on cell types obtained by growing cells under experimentally controlled environmental conditions of cell (tissue) culture, *i.e.*, in vitro.

A. In the Organism

1. Variation.—Among the smallest organisms are the bacteria, which are minute cells in the range of 0.2 to 5 μ in length. The pneumococcus bacterium is the smallest: 0.1×0.2 μ. At the other end of the cell size scale are the eggs of certain fishes, reptiles, and birds, enormous because they store food in a large yolk to nourish an embryo developing outside its parent. Excluding the size of the egg shell wall, the ostrich egg at 75 mm. in diameter is the largest known cell, 750,000 times the diameter of the smallest cell. Within this scale—0.1–75,000 μ—the human egg is 100 μ in diameter, no bigger than an amoeba, a microscopic protozoan.

An account of mature cell types would not be complete without mentioning examples of those organisms that form exceptions to the cell theory (that the cell is the smallest basic unit of protoplasm composed of a nucleus and cytoplasm). Excluding viruses, which are incapable of living autonomously outside a living cell, the exceptions to the cell theory mainly consist of multinucleated cytoplasm within a common plasma membrane. If the concept of a cell was not in terms of the smallest individual unit of protoplasm, but in terms of any autonomous unit of protoplasm within a plasma membrane (and or wall), then organisms composed of multinucleated cytoplasm would be regarded as giant cells. However, such organisms are generally regarded as noncellular or acellular in terms of the cell theory.

Microscopic examples of the acellular type are found in protozoa, *e.g.*, paramecium. Most nonprotozoan acellular organisms grow into giant "cells" that are easily seen with the naked eye: the alga *Vaucheria*, composed of multinucleated branching threads, seen as a green mat on damp soil; slime mold plasmodium, consisting of a jellylike mass, found crawling on woodland litter; and the common bread mold, consisting of many threadlike branches lacking cross walls. (Acellular algae, slime molds, and fungi reproduce by producing spores that are true cells.) The size range



(TOP AND CENTRE RIGHT) BY COURTESY OF C. W. METZ; (LEFT) FROM AREY, IN COWDRY, "SPECIAL CYTOLOGY," HOEBER. (CENTRE LEFT AND CENTRE) FROM SHARP, "INTRODUCTION TO CYTOLOGY," REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.; (RIGHT) FROM R. H. BOWEN, IN "JOURNAL OF MORPHOLOGY," VOL. 39, 1924, THE WISTAR INSTITUTE OF ANATOMY AND BIOLOGY

FIG. 5.—EXAMPLES OF DIFFERENT KINDS OF CELLS

of these acellular organisms is greater than that of cells.

In multicellular organisms, factors that contribute to the formation of a range of cell sizes and cell types according to function include: ratio of nuclear volume to cytoplasmic volume; ratio of cell surface area to cell volume; and the rate of cellular metabolism. Surface area is important for the diffusion of substances into and out of the cell. Variations of the basic spherical cell shape include flattening, elongating, and folding into convolutions, to increase the cell surface without increasing the volume, in effect bringing all cell parts nearer to the surface (fig. 5). Most plant cells overcome the surface-volume limitation in another way, by developing large vacuoles filled with cell sap, in the centre of the cell, thus allowing the protoplasm a rapid exchange of materials over a wide surface area of its inner vacuolar membrane and its outer plasma membrane.

Cell metabolism affects cell size and structure to such an extent that species differences can clearly be distinguished. Rapid metabolism cannot proceed without an adequate supply of oxygen and nutrients into the innermost parts of a cell. The smaller the cell, the greater is the surface area relative to volume. Thus the cells of the most rapidly metabolizing organisms, *e.g.*, bacteria, fungi, and flies, are distinctly smaller than those of the more slowly metabolizing organisms such as frogs, man, and elephants. Furthermore, cytoplasmic circulation (cyclosis), found in protozoa and some large plant cells, enhances molecular diffusion across the plasma membrane. In unicellular or acellular forms, the cell is the organism. The development of some acellular forms is indeterminate: one reproductive cell gives rise to an organism that grows without the formation of cross walls between daughter nuclei. Other acellular forms divide into two when growth has reached the limit of metabolic efficiency, as in true cells. In multicellular organisms, a fixed number of cells is found only in a small number of species; *e.g.*, an alga, *Pandorina*, has a constant small number of cells characteristic of each species. Most multicellular organisms have an indefinite number of cells.

2. Differentiation.—Differentiation may be defined as the modification in structure and function of parts of an organism, owing to division of labour. Cell structure is closely associated with function. Apart from the essential mechanism of the nuclear-cytoplasmic relationship in cells there is no division of labour for special physiological processes within the cell. Thus there are no special structures, within a cell, concerned with taking in food or eliminating waste products of metabolism (with the exception of certain acellular organisms, as already described). Entry of food and oxygen and exit of waste products normally occurs by diffusion across the cell membranes. In multicellular organisms working efficiency has been achieved by division into specialized parts composed of differentiated cells with specific functions.

In lower forms, all the cells of a multicellular organism may reproduce the organism either asexually or sexually (or both).

Higher forms, however, have a primary division of labour between reproductive (or germ) cells and body (or somatic) cells. The germ cells that actually take part in fertilization are produced from undifferentiated, germ-line tissue called germinal epithelium by means of a special type of cell division called meiosis.

In many animals and plants, the male germ cell is a highly differentiated cell, the sperm. The mature sperm has a head, middle piece, and a tail (fig. 5). The head consists of a nucleus capped by the acrosome (derived from the Golgi complex of the sperm-forming cell, or spermatid). The middle piece is composed of mitochondria that provide energy for the tail's movement. The tail is formed by an elongation of one of the centrioles (the other centriole remaining between the nucleus and the middle piece until it enters the egg at fertilization). The egg is a differentiated cell produced after a meiotic cell division from undifferentiated female germinal epithelium. It is usually provided with yolk or food for the embryo. Morphologically, the basic cell types of animal tissues have characteristic shapes in vivo (although they may show some variation between organs). They also have cytochemical distinguishing features.

In terms of protein synthesis (a fundamental process of all living cells), the electron microscopist E. H. Mercer (1961) distinguished two types of cell in which structure is associated with function: protein-secreting cells, which manufacture protein for use outside the cell; and protein-retaining cells, which make proteins that are retained in the cell's own cytoplasm. Examples of protein secretors are: body surface cells that produce keratin; gland cells that secrete mucin (protein in combination with polysaccharide, which lubricates internal surfaces); and fibrocytes of connective tissue, which secrete fibre-making protein called collagen to support soft tissues, and directly contribute to the formation of bones. The cytoplasm of secreting cells contains particle-covered membranes (ribosomes on endoplasmic reticulum) forming sacs in which a soluble protein precursor accumulates until it escapes where the sacs open to the cell surface. Muscle cells are examples of protein-retaining cells. The protein fibres formed are found to consist of two proteins, actin and myosin. In 1940 Albert Szent-Györgyi found that chemically pure actin and myosin, isolated from muscle cells, could be reconstituted as actomyosin in a test tube. Furthermore he discovered that reconstituted actomyosin contracted when adenosine triphosphate was added to it. Later it was proved conclusively that the proteins actin and myosin form the basis of muscular contraction, and that energy was provided by phosphorylation in mitochondria.

Cells of the nervous tissue, blood, and lymph exemplify change of cell shape and size associated with differentiation. The nucleocytoplasmic ratio of immobile nerve cells is maintained by convolution and branching of the cytoplasm (fig. 5). Highly mobile blood and lymph cells, in liquid tissue, have a near spherical shape; their nuclei tend to change shape to maintain the ratio. Experiments on the replacement of the nucleus of a fertilized frog's egg by a transplanted somatic nucleus have shown that some genetic change has occurred in differentiated nuclei since they fail to allow normal embryological development. An unusual feature associated with differentiation of cells is found in the salivary gland nuclei of certain species of flies: the nucleus has become gigantic during differentiation, with the result that the chromosomes are clearly observable within the nuclear membrane.

3. Metabolic Types.—Other cell types are based on the mode of nutrition. There are two major metabolic types of cell organizations: (1) autotrophic organisms, which have cells that can manufacture their own organic substances from inorganic matter (*e.g.*, phototrophic cells of green plants and chemotrophic cells such as bacteria that utilize the energy released by inorganic oxidations); (2) heterotrophic organisms, which are composed of cells that require a supply of organic material from their external environment. (*See* NUTRITION.)

A tremendous variety of atypical cells are formed in response to abnormal environmental conditions that result in disease. In addition to infection by other organisms such as viruses, bacteria, and fungi, chemical and physical factors lead to the production of abnormal cells (*see* PATHOLOGY; PLANT DISEASES).

B. In Cell Cultures

When cultivated in glass vessels (in vitro), acellular organisms such as protozoa and bacteria retain their natural form, while plant cells tend to grow as solid tissue (which may or may not be differentiated) or as organs (*e.g.*, roots) similar to those in the whole organism (in vivo). Metazoan tissues, on the other hand, tend to form monolayers of cells and show signs of differentiation only when allowed to grow into thick layers. When animal cells emerge from pieces of tissue in primary cultures, they can be classified on the basis of distinct morphological, physiological, cytochemical, and biochemical characteristics. A study of these basic animal cell types in culture has aided an analysis of the nature and evolutionary origin of cell types found in differentiated tissues.

E. N. Willmer (1960) grouped the basic invertebrate and vertebrate animal cell types into epitheliocytes, mechanocytes, and amoebocytes; they are distinguished by their basic patterns of structure and behaviour as living cells in culture. The variation in properties of their plasma membranes may account for their distinct cell morphology and behaviour.

Epitheliocytes grow in sheets. They are able to synthesize keratin, which is deposited on the outer walls of older nondividing epitheliocytes. Epitheliocytes arise, in culture, from those tissues which are more or less connected with the epithelium of the body: on the external surface and on internal surfaces lining body cavities. Colonies of mechanocytes (or fibroblasts) also fuse together, but into a loose network. They secrete fibres of collagen outside the cells. Amoebocytes, unlike epitheliocytes or mechanocytes, grow as isolated cells. They do not secrete proteins or mucoid substances, in contrast to the other types.

Nerve cells deviate from the basic cell types, have a distinct morphology and behaviour of their own, and are regarded as derivatives of epitheliocytes.

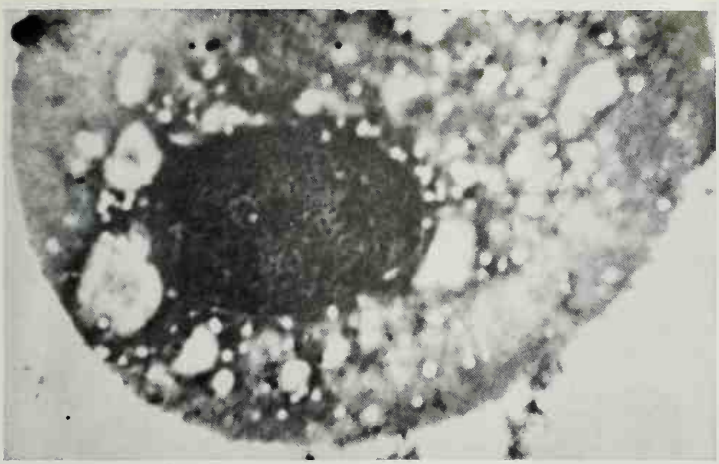
Studies on invertebrates, including sponges and more primitive metazoa, in relation to their embryological development, have shown that the same three basic cell types are formed. Evidently they are extremely primitive and fundamental animal cell types since their differentiation precedes the formation of primary germ layers (*see* EMBRYOLOGY).

C. Evolution of Cells

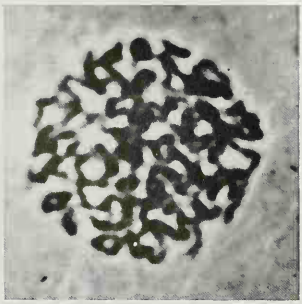
Clues to the probable evolutionary history of cell types have been obtained from studies on their morphological and cytochemical structure, and peculiarities of physiology including relationships with other cells. It is generally agreed that the probable sequence of cell types is according to the complexity of their patterns of organization inside the cell and between cells in the organism. Bacteria have the simplest cellular organization being composed of nucleoprotein lying free in relatively simple cytoplasm. Some bacteria are autotrophic (one essential feature for growth when ready-made organic foods from other organisms were not available). The next step may have involved formation of primitive chloroplasts in the cytoplasm around nucleoprotein granules (like present chloroplasts), allowing self-reproduction of units capable of photosynthesis. The nucleoprotein not directly concerned with the control of photosynthesis probably became enclosed by a membrane, separating nucleus from cytoplasm, resulting in further specialization of cell parts, as in present protozoa.

Some protozoa move by means of cilia and photosynthesize like plants, but also feed by the usual protozoan method. Some believe that such a cell gave rise to plants by cell aggregation and reduction of motility; and to multicellular animals by loss of photosynthetic activity. Acellular organisms such as slime molds, fungi, and algae could have been similarly derived with the loss of cell formation by cross walls.

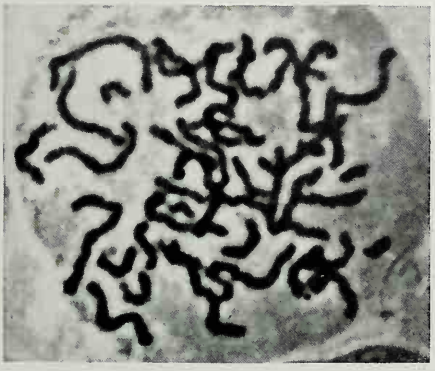
In metazoa, the in vivo appearance and behaviour of cells is a function not only of their individual genetical constitution but of their reaction to neighbouring cells and substances produced by other cells. In vitro conditions free differentiated cell types of the effect of their environment, revealing the three basic cell types already described that are common to all metazoa. It is likely that one of the first steps in the evolution of metazoa was the capacity for differentiation into the three basic cell types during



Late interphase; the nucleus, enclosed in a nuclear membrane, is surrounded by cytoplasm



Prophase; membrane has disappeared, and the chromosomes, which have begun to contract and thicken, are clearly apparent

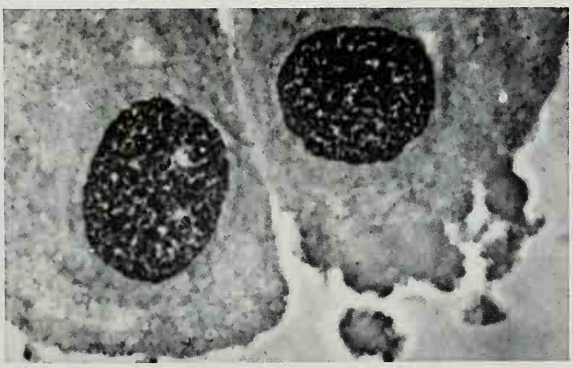


Late prophase; chromosomes spread apart

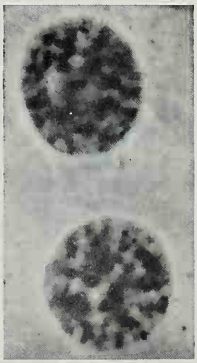
Metaphase; chromosomes arrange themselves on the equatorial plate

Anaphase; chromosomes separate into two equal groups

Late anaphase; chromosomes begin to form two daughter nuclei



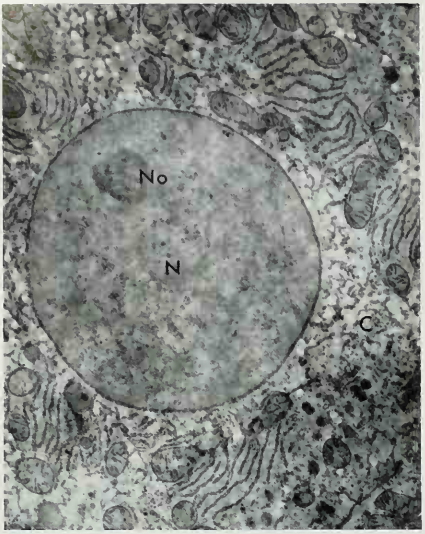
Telophase; cytoplasm divides to form two daughter cells, which are duplicates of each other



Early interphase; nuclei with chromosome structure no longer apparent. Cell then enters the "resting" stage, which will extend to the next mitotic division

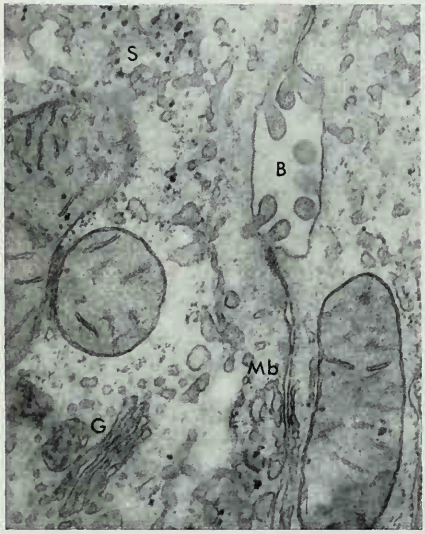
PHOTOMICROGRAPHS OF MITOSIS OF A HUMAN SKIN CELL

CYTOLOGY

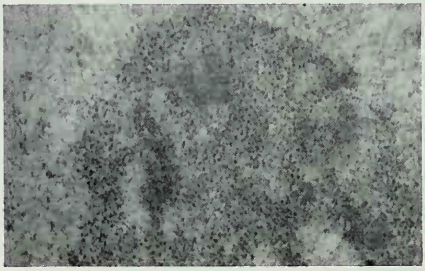


Low-power micrograph of a parenchymal cell from rat liver showing nucleus (N), nucleolus (No) and cytoplasm (C). Pale areas in the cytoplasm contain glycogen; various organelles are shown in succeeding micrographs. Magnification X 7,000

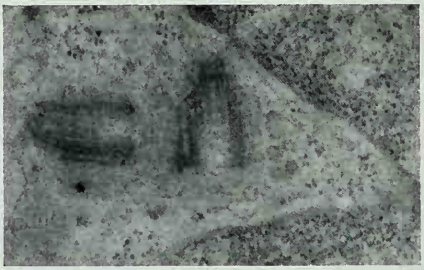
Portion of the cytoplasm much enlarged showing two mitochondria (M) containing their characteristic shelflike structures, the cristae. Membranes of the cristae contain tiny enzyme-rich particles that control cell metabolism (the electron transport system). The endoplasmic reticulum (Er) is a system of lipoprotein membranes also associated with small particles, the ribosomes. Ribosomes contain ribonucleic acid. New protein molecules are synthesized on the ribosomes and transferred to the spaces between the lipoprotein membranes for storage or transport. Magnification X 40,000



Another portion of the cytoplasm near the cell membrane (Mb) showing the complexity typical of the membrane systems of the cytoplasm. Parts of three mitochondria are shown. The bile canaliculus (B) carries off bile secretion from the cell. It is bordered by fingerlike projections of the cytoplasm, the microvilli. A small cluster of membranes of the Golgi apparatus is shown at (G); this component probably aids in the "collection and packaging" of secretory products. A portion of the smooth reticulum is shown at (S); this structure probably contains the enzymes needed for glycogen storage and re-utilization. Small glycogen granules (here stained with lead salts) are visible as black dots against membranes of the smooth reticulum. Magnification X 40,000



A portion of the nucleolus, much enlarged. This is a heterogenous structure containing clusters of fine particles resembling the ribosomes of the cytoplasm. Like the ribosomes, nucleolar particles contain ribonucleic acid. Magnification X 96,000



A micrograph of a cell of a hamster skin tumour showing two centrioles located in their characteristic position in the cytoplasm near the nuclear membrane. Centrioles, bundles of short rods arranged in cylinders, appear to be involved in some way in cell division. Here cut lengthwise, they show a typical orientation, one centriole arranged at right angles to the other. X 96,000

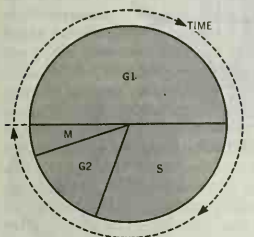
CELL STRUCTURE AS REVEALED BY THE ELECTRON MICROSCOPE

DR. HEWSON SWIFT, UNIVERSITY OF CHICAGO

development. Then the range of cell types found in tissues of various species could have arisen as variations from the basic types by interaction with other cells during embryological development. Unlike differentiated somatic metazoan cells (which have genetically changed nuclei), many differentiated plant cells are still capable of regenerating the whole organism. *See* also LIFE, ORIGIN OF.

IV. CELL GROWTH

The mechanical process of division, in which the cell constituents are actually partitioned into two parts, is a relatively small part of the cell cycle. The larger part is concerned with cell growth.



BY COURTESY OF O. T. HUGHES, THE CHESTER BEATTY RESEARCH INSTITUTE, LONDON

FIG. 6.—RELATIVE PERIODS IN THE LIFE CYCLE OF A CELL

M, time of mitosis; G1, interval between end of mitosis and onset of DNA synthesis; S, DNA synthetic phase; G2, phase between DNA doubling and onset of next mitosis

The growth period (between cell divisions) is known as the interphase. It was called the "resting stage" by early cytologists because the cell appeared to be inactive. On the contrary, the interphase cell undergoes great physiological changes, with doubling of the cell mass between the beginning and end of interphase.

1. Basic Pathways.—DNA, RNA, and protein-synthesizing systems form the basic physiological pathways in cell growth. Although RNA may carry genetic information in certain viruses, in animal cells the DNA appears to be in primary control, via the intermediary action of RNA, in putting the DNA's information into action in the synthesis of characteristic proteins. Thus DNA is in ultimate control, while the RNA is in immediate control of protein synthesis. Several stages of the cell cycle have been recognized in relation to the DNA cycle, which forms an ultimate reference point (of control) for all other cellular activities. A. Howard and S. R. Pelc (1953) first recognized and named these stages of the cell cycle as a result of their studies on the time of DNA synthesis by means of autoradiography of cells in the broad bean, *Vicia faba*. G1, S, and G2 are stages of interphase, the phase of cell growth; M stands for mitosis (fig. 6). An essentially similar sequence has since been found in the somatic cells of most other species, including mammals.

2. Duration.—The time taken for completion of the cell cycle and the duration of its phases has been found to be characteristic of actively replicating cells of a species. Many bacteria divide every 15–30 min. at 37° C (98.6° F). Certain grasshopper embryonic cells divide every 3½ hr. at 30° C (86° F), higher plant root tip cells divide every 25–30 hr. at 20° C (68° F), and human tumour cells every 18 hr. at 37° C (98.6° F) in tissue culture. An essentially similar pattern has been found for the time sequence of nucleic acid synthesis in a wide range of cell types (which vary in the actual times of the stages). Thus autoradiographic studies on cells of bean roots and human bone marrow cells gave the following times:

Tissue	Cell Cycle Stages (Hours)				
	Mitosis	G1	S	G2	Total
Bean root	4	12	6	8	30
Bone marrow	½–1	25–30	12–15	3–4	40–48

In metazoa the time of the whole cycle may vary with the tissue according to whether the cells are vegetative or differentiating intermitotics, and the stage of development of the organism or its age. Usually the various cells take the same time to pass through the phases of interphase, except for varying times spent in G2 waiting to divide. But cells from different tissues grown in culture (where they proliferate most actively, free from influence of cells of other tissues) normally have the same cell cycle time and pattern for a species.

Both DNA and histone protein (in the nucleus) undergo simultaneous doubling prior to cell division. Most of the cell protein synthesis occurs independently of the time of DNA synthesis, the time generally regarded as that for chromosome replication.

Apart from the duration of synthesis, little is known about the cytochemical processes that occur during interphase. The mechanisms involved at the molecular level are the subject of much speculation and experimental investigation. Although the interphase nucleus of living cells usually appears structureless (except for nucleoli and chromocentres), diffuse, threadlike chromonemata (believed to be uncoiled chromosomes) can be rendered visible by phase contrast and interference microscopy. In 1949 Honor Fell and A. Hughes first revealed the identity of chromocentres and chromonemata of living nuclei by fixing and staining (for DNA) the same nucleus that had been observed in the living cell by phase-contrast microscopy. In fixed interphase nuclei chromosomes are usually not visible because the chromatin forms a network artifact as a result of dehydration and precipitation of nucleoprotein.

V. CELL DIVISION

A. General

1. Background.—Rudolf Virchow (1858) was the first to realize that cells arise only from pre-existing cells by division (fig. 7). During division, the nucleus was found to consist of separate small bodies named chromosomes (stained bodies) by W. von Waldeyer in 1888. But it was not until the rediscovery of Mendel's laws of heredity in 1900 and Walter S. Sutton's cytological studies in 1903 that the close parallel behaviour of the chromosomes in meiosis and the Mendelian laws was found. Theodor Boveri (1887) first demonstrated the individuality and continuity of characteristic chromosomes from cell to cell. Then Thomas Hunt Morgan found that the number of linkage groups of hereditary characters corresponded with the number of chromosomes. Furthermore, in *Drosophila*, inheritance of certain traits was found to be associated with the inheritance of an observable chromosome aberration in the cells, clearly proving that the chromosomes carry the genetic material.

The mechanism of chromosomal division, the process whereby genetic continuity is maintained and variations produced, is basic to the processes of differentiation in embryology and of evolutionary change in populations.

2. Capacity for Division.—Unlike the situation in acellular organisms, not all the cells of multicellular organisms retain the capacity for cell division, as a result of specialization of function. In multicellular organisms, two types of cell may be distinguished according to their ability to divide and reproduce: intermitotics and postmitotics.

Intermitotics are cells with a life span that depends on the time between divisions (mitoses). Vegetative intermitotics are undifferentiated cells (*e.g.*, germ-line cells) that reproduce their own

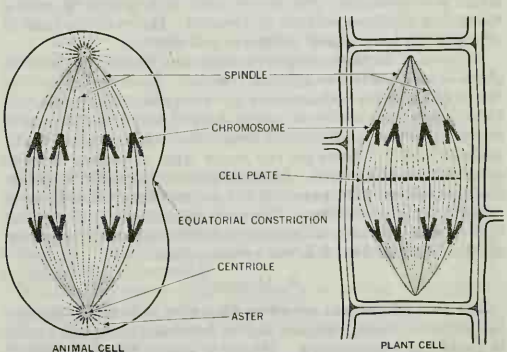


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FIG. 7.—CELL DIVISION IN A GENERALIZED ANIMAL CELL AND A GENERALIZED PLANT CELL

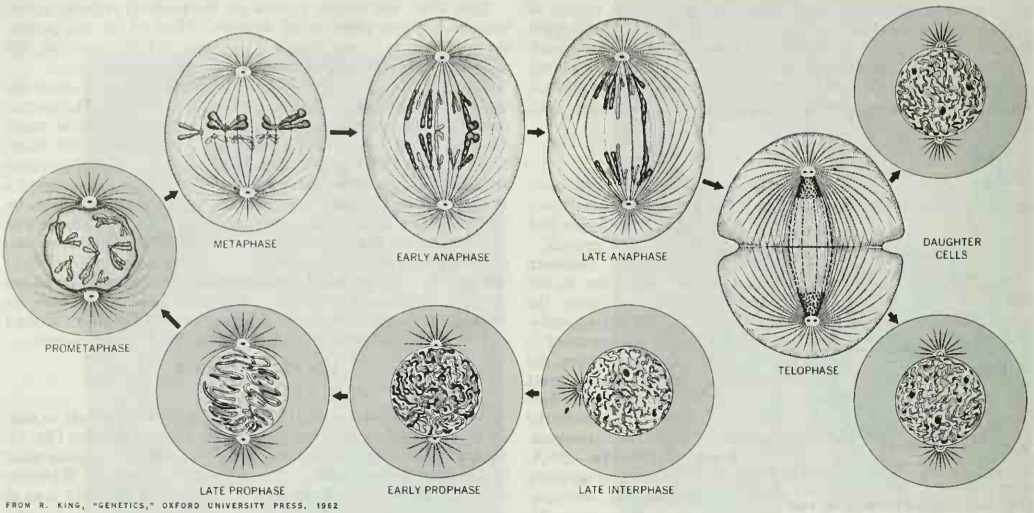

FIG. 8.—MITOSIS

type or give rise to differentiating intermitotics. Although nuclei of the latter type of cell still undergo divisions, the cells have developed specialized properties that distinguish them from undifferentiated cells. Compared with somatic cells, intermitotics of germ-line tissue have the additional capacity of meiosis in the production of germ cells for sexual reproduction.

Postmitotics are cells that no longer undergo mitotic activity in the differentiated organism; they include such specialized types as blood cells and nerve cells. Normally they are fixed in the postmitotic state, but some can revert to mitotic activity in tissue culture.

3. Mechanisms.—The earliest illustrations of fixed dividing cells, in a correct sequence of stages, were published in London by E. Klein in an *Atlas of Histology* (1880, before cytology had become a separate field of intensive study). The correctness of the sequence of stages, deduced from observation of fixed cells, had been previously confirmed by E. Strasburger (1879) and W. Flemming (1879) who first studied the mechanism of cell division in living cells.

Cell division is a remarkable process that separates mature cell constituents (replicated during interphase) into two daughter cells. There are a large number of genetically controlled variations in the actual mechanism that are characteristic of a species or even a tissue type within individuals of a species. However, the cells of all organisms have a basic pattern of cell division.

Division of the nucleus (karyokinesis) and division of the cytoplasm (cytokinesis) usually occur together. Some tissues and entire organisms are characterized by independent occurrence of karyokinesis and cytokinesis, as in delayed wall formation, until many daughter nuclei have been formed in a true coenocyte (multinucleate "cell"). There are two major types of nuclear division, called mitosis and meiosis. These terms refer primarily to nuclear changes, because both processes can occur without directly associated cytoplasmic division. The usual mechanisms, basic to most cells in which division of nucleus and cytoplasm occur together, will be described first, followed by exceptions.

B. Mitosis

The term mitosis was coined by Flemming in 1882 to represent the process of nuclear division via the formation of threads (*mitos* in Greek) or chromosomes. Mitosis is mainly found in somatic cells of multicellular organisms and in unicellular organisms (including coenocytes) not undergoing sexual reproduction. The cells of bacteria and blue-green algae, however, do not divide by the standard mitotic process represented by fig. 8.

1. Stages.—The usual mechanism of mitosis has been subdivided into four main stages, for convenience in description. Although they have several distinguishing features, the stages merge gradually from one to the next.

Prophase begins with the chromosomes becoming "fixable" as a ball of long threads instead of forming a spongy chromatin network; they appear similar to those seen in living interphase cells by phase contrast and interference microscopy. This is brought about by increase in chromosome density through loss of water. Gradually, the chromosomes become shorter and thicker by coiling up. In favourable preparations they can be seen to consist of two coiled chromonemata except in the region of the centromeres, to which spindle fibres attach at division. The nucleolus decreases in size until it usually disappears by the end of prophase.

In addition to DNA and certain proteins, RNA and other nucleolar constituents such as alkaline phosphatase, phospholipids, and zinc are found in chromosomes as soon as the nucleolus disappears. These extra components are carried by the chromosomes until the last stage of mitosis (telophase), when they are released. In animal cells (and some fungi) the centriole can be observed to divide into two parts and they migrate, one to each side of the nucleus, to form the poles of the mitotic spindle. (A similar mechanism probably operates in plants although centrioles cannot be observed.)

Prophase usually ends with the breakdown of the nuclear membrane and commencement of organization of a spindle, composed of protein fibres radiating out from the centrioles. Other similar rays radiate from the centrioles in all directions forming the star-like asters. The chromosomes become attached to the spindle fibres by their centromeres and gradually move to the equator of the spindle. The reality of the spindle was demonstrated in living cells by D. Mazia (1955), who first isolated the mitotic apparatus (spindle-bearing chromosomes plus centrioles and asters) free of cytoplasm. The transitional stage during which the chromosomes move toward the equator of the cell is often termed prometaphase.

Metaphase is reached when the chromosomes have become orientated around the equatorial plate. At this stage the chromosomes clearly can be seen to consist of two well-separated strands, called chromatids, with each chromatid orientated so as to be opposite a spindle pole.

Anaphase begins by completing the division of doubled chromosomes into two daughter chromosomes, by simultaneous division

of cell centromeres into two to give each chromatid a separate centromere. The chromatids, now called daughter chromosomes, gradually move apart as if they were being pulled toward opposite poles by the spindle fibres tugging at their centromeres. Anaphase ends with the arrival of daughter chromosomes at opposite poles of the spindle. The groups of chromosomes at opposite poles are exact duplicates of the original chromosome set.

Telophase is the final stage, in which the chromosome groups at opposite poles undergo changes that may be described as prophase in reverse. Nucleoli become reformed at the nucleolus-organizing regions of certain chromosomes. The chromosomes uncoil until they form fine threads that become progressively less distinguishable. Finally they become enclosed in nuclear membrane to complete telophase, and cytoplasmic division separates the nuclei into two daughter cells.

2. DNA Changes.—Quantitative changes in DNA during mitosis have been related to stages of chromosome division. Prophase and metaphase chromosome groups have the same amount of DNA as late interphase nuclei. Chromosome groups formed by separation of daughter chromosomes at anaphase have half the amount of DNA as is true also for early interphase nuclei of the daughter cells. The amount of nucleic acid must be doubled again before another division can proceed. The whole cell is physiologically active during mitosis, and usually no growth occurs during this time. Additional changes observed in the cytoplasm include a decrease in the endoplasmic reticulum, and morphological changes in mitochondria.

3. Cytoplasmic Division.—Cytoplasmic division usually occurs directly after division of the nucleus. In animal cells, cytoplasmic cleavage is brought about by formation of an equatorial constriction (fig. 7) that pinches the cell into two. In amoeboid acellular organisms, cytoplasmic division may occur by the two halves of the organism moving apart. Due to the rigidity of their walls, plant cells have a different method of cytoplasmic cleavage: cell plate formation across the equator of the spindle (beginning at telophase), partitioning a cell into two. Although cytoplasmic division is not so precise as nuclear division, there is a more or less equal distribution of cytoplasmic materials, giving rise to daughter cells that are equivalent to each other.

4. Significance of Mitosis.—As long ago as 1892, August Weisman concluded that only substances concerned with the transmission of heredity needed so meticulously accurate a division and distribution. Subsequent studies have proved Weisman's conclusion correct: mitosis is the mechanism whereby replicas of physicochemical components of cell heredity (chromosomes) are equally distributed into daughter cells, thereby endowing them with the same basic hereditary information as the parent cell.

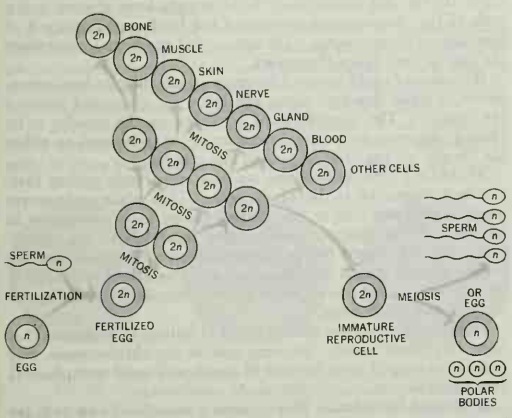

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FIG. 9.—THE RELATIONSHIP BETWEEN MITOSIS AND MEIOSIS IN THE LIFE OF AN INDIVIDUAL

The biological importance of mitosis is demonstrated by its widespread occurrence as a fundamental mechanism of nuclear reproduction in nonsexual cells of most microorganisms, plants, and animals. Multicellular organisms develop by mitosis from a single cell stage in their life cycle. An adult human being, for example, grows from a single cell to an average of 100,000,000,000 cells by means of 50,000,000,000 mitotic divisions.

The study of cell growth and mitosis is important in the study of cancer. Abnormal cells, as in neoplasms or tumours, are produced when the mitotic mechanism is damaged by environmental factors. Minor variations in the normal mitotic mechanism that are characteristic of cells of different species indicate that the mitotic mechanism is itself under genetical control. The variations in mitotic mechanism are the product of evolution and are also the means of maintaining the genetical continuity of those variations.

C. Meiosis

Unlike mitosis, meiosis or "reduction division" gives rise to daughter cells that are not identical with the parent cell. Meiosis, from the Greek for "smaller," consists of two successive divisions (termed I and II) of a nucleus accompanied by one division of its chromosomes. Each of the four daughter cells produced by one meiotic division contain only half (the haploid, or *n*) the number of chromosomes of the parent cell (the diploid, or *2n* generation). In this way meiosis is a compensatory reduction mechanism for the chromosome doubling that occurs through cell fusion (syngamy) at fertilization in sexually reproducing organisms (fig. 9). Without meiosis, the chromosome number would double at each fertilization, yielding bigger cells with greater chromosome numbers in each succeeding generation indefinitely.

1. Types.—Meiosis gives rise to a unicellular stage in the life cycle of all sexual organisms. The time at which this occurs is constant for each species. E. B. Wilson classified meiosis into three types, in relation to its occurrence in the life cycle:

1. *Zygotic,* or initial, meiosis, which occurs immediately after fertilization to yield haploid adult organisms. In this case the zygote (fertilized egg) is the only diploid cell in the life cycle. This occurs in certain fungi, algae, and Sporozoa.

2. *Sporic,* or intermediary, meiosis, which takes place during spore formation, between the times of zygote and gamete formation. This type is associated with an alternation of diploid and haploid generations in the life cycle. In higher plants, the sporophyte generation is predominant and the adult is diploid, whereas mosses and liverworts have a predominant gametophyte generation and the adult is haploid (*see* Plants and Plant Science).

3. *Gametic,* or terminal, meiosis, which occurs during egg or sperm formation (in gametogenesis). This is characteristic of most animals (all metazoa, some protozoa) and certain lower plants (thallophytes). The human life cycle is typical of this group. Meiosis reduces the somatic chromosome number from 46 to 23 in the egg or sperm, which thus have a haploid chromosome number. The zygote produced by fertilization reestablishes the diploid chromosome number. The 46 chromosomes are composed of 23 pairs, one member of each pair having been derived from the egg, the other from the sperm. Each pair is said to be homologous because they are similar in shape, size, and genetic content (except for the sex chromosomes; see *Chromosomes,* below).

Not all cells are capable of meiosis. During the development of multicellular organisms with gametic or sporic types of meiosis, certain groups of cells are set aside for meiosis. These cells increase in number by ordinary mitosis until a specific time in development. Factors responsible for the transition from mitosis to meiosis may be hormonal.

2. First Division.—The mechanism of meiosis is essentially the same wherever it occurs in plants and animals (fig. 10). The following is a brief outline of salient features of meiosis in diploid organisms like man.

Premeiotic interphase cannot be distinguished from mitotic interphase.

Prophase I has a greater duration than the prophase of mitosis.

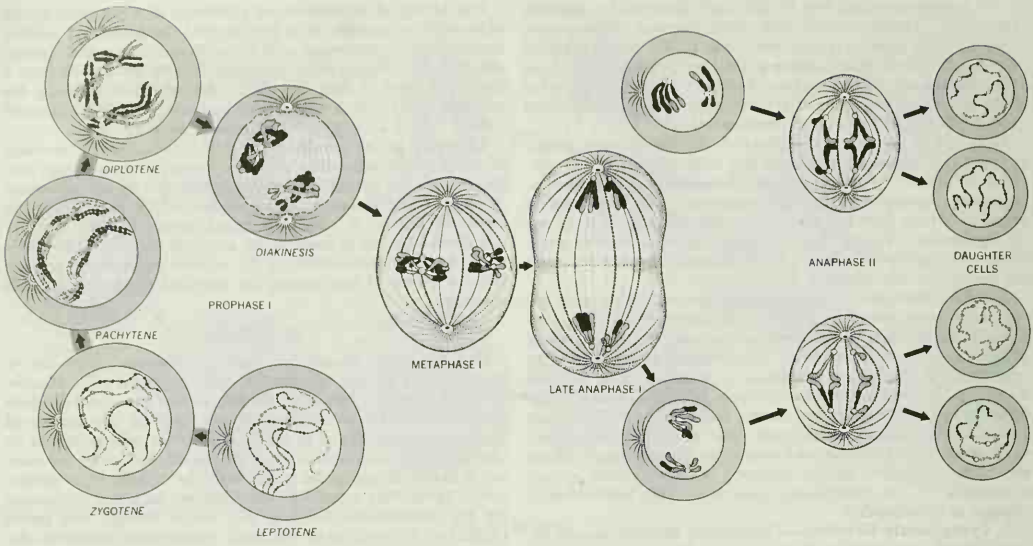
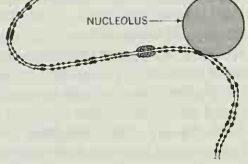


FIG. 10.—MEIOSIS

Five separate prophase stages are recognized: leptotene, zygotene, pachytene, diplotene, and diakinesis. Nuclear volume during prophase I is also three to four times larger than in mitotic prophase nuclei. In addition meiocytes continue DNA synthesis beyond interphase into prophase, and the RNA continues to be synthesized after completion of DNA duplication (*cf.* mitosis, in which RNA synthesis does not continue after DNA duplication).

Leptotene is the first definitely recognizable stage of meiosis. Leptotene chromosomes, of the same number as in somatic tissues, differ from mitotic prophase chromosomes in that they appear longitudinally single rather than double. DNA and histone synthesis is completed during leptotene, suggesting that leptotene chromosomes, though apparently single, are in fact double in structure. The chromosomes are more granular, appearing to consist of a series of chromomeres connected by nonstaining intervals. The chromomere pattern is characteristic in number, size, and position in individual chromosomes.

Zygotene is characterized by active pairing of homologous chromosomes. Pairing begins at one or more points along the chromosomes and proceeds in zipper-like fashion, uniting them lengthwise. Pairing only takes place between strictly homologous regions, as indicated by the correspondence of chromomeres.



FROM JOHN MCLEISH AND BRIAN SNOAD, "LOOKING AT CHROMOSOMES," 1958

FIG. 11.—PART OF A BIVALENT AT PACHYTENE, SHOWING COMPLETE PAIRING BETWEEN THE HOMOLOGOUS CHROMOSOMES

Pachytene occurs when pairing is complete, and the apparent number of chromosomes is haploid, or *n*. The *n* association of two chromosomes that appear as one is called a bivalent. It looks more or less like a single mitotic chromosome except that there are two distinct centromeres. Halfway through the pachytene stage, the bivalents appear to split longitudinally into strands called chromatids, thus yielding four-stranded bivalents (or tetrads). Shortening and thickening of the bivalents renders the chromomere pattern more distinct, and the nucleolar-organizing regions may be clearly seen to be attached to the nucleolus (fig. 11).

Diplotene begins when the paternal and maternal chromosomes in a four-stranded bivalent start to separate and their centromeres move apart. The chromosomes do not separate completely but remain held together at certain points where two of the four chromatids appear to form an X, crossing over one another. These points are called chiasmata. Evidently the two chromatids, at these points, broke at the end of pachytene and rejoined diagonally with the broken ends of chromatids from homologous chromosomes. The chiasma mechanism results from the exchange of parts between the paternal and maternal chromosomes in a homologous pair. The average number of chiasmata per bivalent varies from one to eight, and may vary even in the same bivalent when seen in different cells. Chiasma frequency has been found to be affected by environmental influences such as temperature.

Diakinesis corresponds to the late prophase of an ordinary mitotic division. There is no distinct difference between the end of diplotene and the beginning of diakinesis. The bivalents appear much thicker and shorter and the chiasmata have slipped to the ends of the chromosomes because of the further pulling apart of homologous chromosomes. Diakinesis, and prophase I, ends when the nuclear membrane disappears.

Metaphase I: each bivalent becomes attached by its two centromeres, at equal distances above and below the equatorial plane of the spindle. The orientation of bivalents on the spindle is by chance; maternal or paternal centromeres may be next to either the "north" or the "south" pole of the spindle.

Anaphase I: the centromeres separate, apparently pulling their attached chromatids to the spindle poles. Thus whole centromeres perform the same task as that carried out by half centromeres at mitosis. Whole chromosomes become separated to the spindle poles (instead of split halves, chromatids, as at mitosis) resulting in two haploid groups of chromosomes. The actual reduction in chromosome number per nucleus is thus completed by the end of the first meiotic division.

Telophase I resembles the telophase of mitosis in organisms that form interphase nuclei. In some species the chromosomes may remain unchanged from the end of anaphase I until metaphase II (*see* below).

3. Second Division.—This division is superficially an ordinary mitosis in which the centromere again becomes functionally double at metaphase II and then the chromatids become separated into haploid groups at anaphase II. The four haploid nuclei produced

by meiosis become separated into daughter cells, all of which may differentiate into gametes (as in sperm formation) or only one may form a gamete (as in egg formation).

4. Significance of Meiosis.—First of all, meiosis is a necessity for sexually reproducing organisms in order to counteract the chromosome doubling effect of fertilization. Meiosis is a mechanism that promotes genetic variability. This is achieved in two ways: (1) by random segregation of chromosomes at anaphase, so that haploid cells contain a mixture of maternal and paternal chromosomes; (2) chiasma formation breaks up linkage groups of genes (per chromosome) by causing exchange of chromosome parts between homologous chromosomes, thus altering the set of genes that a chromosome possessed at the onset of meiosis (fig. 12). The chances of distributing only paternal or only maternal genes to a gamete are very remote indeed.

The behaviour of chromosomes at meiosis parallels the transmission of genes in heredity. Not only is meiosis the mechanism of genetic recombination and segregation but it is itself governed by genes on the chromosomes, as is clear from observation of characteristic variations in chromosome pairing, chiasmata, and spindle formation in various species.

D. Notable Exceptions

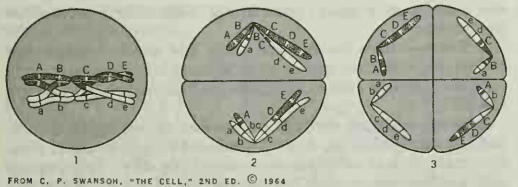
Amitosis is a form of nuclear division by simple constriction, without spindle formation, resulting in daughter nuclei that are usually unequal in size. Examples of amitosis have been described in degenerating cells in tissue cultures and pathological conditions.

Nonequational divisions may also occur as environmentally induced aberrations of mitosis or meiosis with the result that unequal numbers of chromosomes enter daughter cells (a process called chromosome nondisjunction).

Endomitosis is the multiplication of chromosome strands (chromonemata) or whole chromosomes inside the nuclear membrane, *i.e.*, without division of the nucleus. This mechanism may result in polyploidy (multiples of the haploid chromosome set, in excess of $2n$) with the chromosomes having a normal number of strands. Alternatively, the chromosome number may remain diploid with an increase in the number of strands per chromosome—a phenomenon called polyteny. Polyteny and polyploidy may coexist in the same cell. Endomitosis normally occurs during tissue differentiation in many species, particularly in the differentiation of cells having a secretory function. Polytene chromosomes are remarkably well developed in the salivary gland of the fruit fly *Drosophila* and other tissues of dipteran insects; they are also found in other animals and in some plants. Growth of a polytene chromosome seems to occur by lateral duplication of chromosome fibres from 8 fibres per homologous chromosome pair at the beginning to about 1,000 fibres when fully formed.

Meiosis in haploid and polyploid organisms: in haploid insects like the male honeybee, or drone, the first division is modified or almost entirely suppressed to enable gametes to be formed with the same number of chromosomes as somatic tissues of the adult male. Normal meiosis occurs in the queen bee, which is diploid.

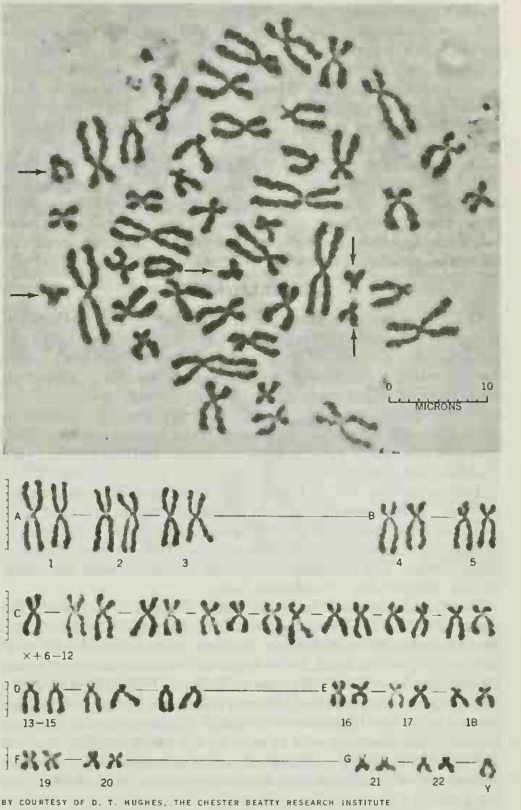
In polyploids, meiosis becomes complicated by the presence of more than two homologous chromosomes, so that associations of eight or more chromosomes may be formed. Triploids are usually



FROM C. P. SWANSON, "THE CELL," 2ND ED. © 1964

FIG. 12.—THE GENETICAL CONSEQUENCES OF CROSSING-OVER

(1) A bivalent, consisting of a paternal (dark) and a maternal (white) homologue, has formed and crossing-over has taken place between genes A and B, and C and D. (2) At anaphase the two chromatids in each segregating chromosome are no longer alike genetically. (3) The chromatids are now separated and two of them have a different genetic composition, while the other two remain as before



BY COURTESY OF D. T. HUGHES, THE CHESTER BEATTY RESEARCH INSTITUTE

FIG. 13.—MITOTIC METAPHASE CHROMOSOMES OF A NORMAL HUMAN MALE

(Top) Chromosomes as they appear in cultured white blood cell. Arrows indicate five small accrocentric chromosomes. There are only four such chromosomes in female cells because they lack a Y chromosome and have an extra X instead. (Bottom) an analysis of the above cell in which the like chromosomes have been paired. There are 23 pairs (one of each pair from each parent). Male sets of chromosomes can be distinguished from those of females by the sex chromosomes: an unequal XY pair in males and an equal XX pair in females

sterile, since abnormal numbers of chromosomes are passed on to the gametes. Polyploids that are an exact multiple of $2n$ tend to be more stable since they can produce gametes with an even number of chromosomes.

Meiosis in organisms with nonlocalized centromeres: most organisms have one centromere per chromosome and are said to have localized centromeres. In certain insects (Homoptera), some algae, and the wood rush *Luzula*, the chromosomes do not have a localized centromere. Instead, whole chromosomes behave as if they have the properties of a centromere along their entire length. It appears that there is a diffuse centromere which forms a sheet of spindle fibres on the poleward surfaces of chromatids so that the chromosomes are capable of auto-orientation at metaphase I. They have chromatid autonomy in spindle formation.

Somatic Meiosis. Meiosis is not exclusively confined to sex cells. It has been observed in body tissue of the *Culex* mosquito. The multistranded polytene chromosomes of mosquito gut cells have been observed to separate into their constituents prior to segregation of normal chromosomes into daughter cells, without chromosome duplication. Reduction divisions have also been induced in plants in response to treatment of somatic cells with sodium ribonucleate. Genetical experiments with the mold *Aspergillus* support cytological observations suggesting that crossing-over

(a meiotic occurrence) can occur in somatic cells.

Unequal cytoplasmic division: unequal divisions of the cytoplasm follow certain meiotic divisions, *e.g.*, at egg formation in mammals, where one of the two daughter cells at both meiotic divisions is much smaller than the other and degenerates as a polar body (fig. 9). In the modified meiosis of the male haploid honey bee the first meiotic division cuts off a small cytoplasmic segment containing no chromosomes.

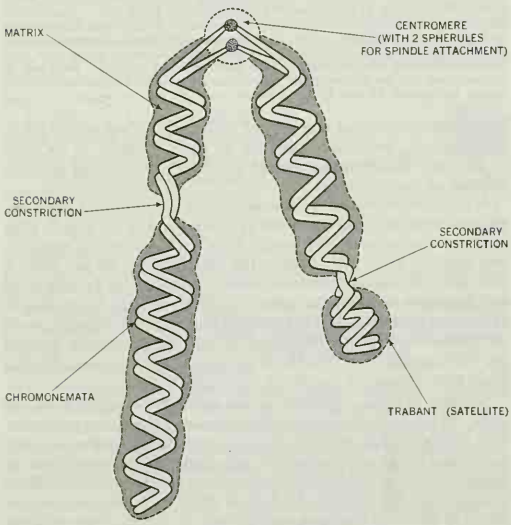
Organisms that consist of a multinucleate mass of cytoplasm without differentiation into cells may bud off uninucleate spores at certain stages of their life cycle, by cytokinesis, as in the common pinhead bread mold. There may even be a fine balance between the number of nuclei per "cell" and cytokinesis, as in the tissues of certain mushrooms.

VI. CELL UNION

Cell union is the primary act in the process of fertilization (syngamy) in sexual reproduction. Fertilization (*q.v.*) is completed with the union of male and female nuclei (fig. 9). The sperm contributes to the egg: a stimulus to development, a paternal set of haploid chromosomes, and (only in animals) a centriole for spindle formation in cell division. A proteinaceous chemical in the egg coat tends to prevent penetration of foreign sperm so that, in most cases, sperm from one species cannot fertilize another (*see* EMBRYOLOGY, CHEMICAL).

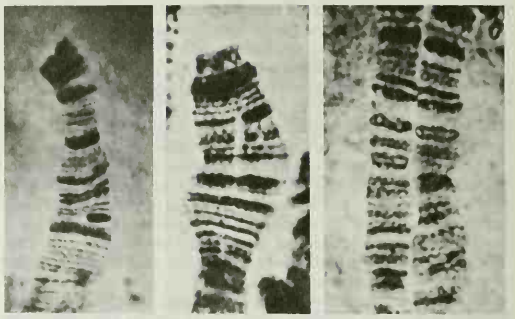
The occurrence of cell fusion is not restricted to sexual reproduction. It has been observed in multinucleate formation of plasmodia in slime molds. Since 1960 cell fusions have been observed in tissue cultures composed of mixtures of two types of mouse cancer cells. The spontaneous hybrids produced were the result of both nuclear and cytoplasmic fusion.

The capacity for cell fusion probably depends on surface properties of the cells. Virus infection can alter the cell surface and lead to successive cell fusions between virus-infected and noninfected cells. In 1965, in a series of remarkable experiments, Henry Harris and J. F. Watkins at Oxford University, succeeded in inducing the formation of hybrid cells from mouse and human tumour cells, by the action of a virus. Characteristic mouse and human chromosomes could be seen in the same dividing nucleus of hybrid cells. Virus-induced cell union has opened up a valuable new source of information on nucleus-cytoplasm relationships and the genetics of mammalian cells.



BY COURTESY OF O. T. HUGHES, THE CHESTER BEATTY RESEARCH INSTITUTE, LONDON

FIG. 14.—DIAGRAM OF A CHROMOSOME



BY COURTESY OF C. W. METZ

FIG. 15.—CHROMOMERE BANDING PATTERNS OF POLYTENE CHROMOSOMES IN GIANT SALIVARY GLAND CELLS OF FRUIT FLIES

Left and centre show differences between homologues; right shows a segment of a pair of chromosomes in a species hybrid

VII. CHROMOSOMES

1. Number.—Each living organism has a characteristic number of chromosomes per nucleus, ranging from 2 in the threadworm, *Ascaris megalocephala univalens*, to 500 in the fern *Ophioglossum vulgatum*. Some families of plants and animals include species that differ in the number of chromosome sets they have per nucleus. They are called polyploid when the number of sets exceeds the diploid. A genus may include a polyploid series of species, such as n, $2n$, $4n$, $6n$; such a series is found in wheat, where the n number is 7 chromosomes. (The wheat used to make flour is $6n$, or hexaploid, having 42 chromosomes.) Owing to the multiple pairing of homologous chromosomes, anomalies arise in most sexual polyploids at meiosis, leading to sterility. For this reason the polyploid condition is infrequent in animals, and is most common in asexually reproducing plants. Individuals that have chromosome numbers in irregular multiples of the basic complement are called aneuploids. These arise by unequal nuclear divisions in which both chromosomes of a homologous pair may pass to one daughter nucleus instead of one chromosome to each daughter nucleus. Such misdivisions can occur at either mitosis or meiosis.

Polyploid and aneuploid cells are frequently found in tumours, in which the most frequent chromosome number characterizes the "stem-line" of cells.

The normal diploid chromosome number of man is 46 as was discovered by J. H. Tjio and A. Levan working with a new technique in Sweden in 1956 (fig. 13). An example of aneuploidy in man is found in the condition termed mongolism, in which the person's cells contain 47 chromosomes ($2n + 1$), the odd one being produced by a misdivision during meiosis (*see* GENETICS, HUMAN).

In some multicellular organisms changes in chromosome number occur during differentiation of tissues. Thus supernumerary ("B-chromosomes") become restricted to the germ cells of certain plant genera such as *Sorghum* and *Poa*.

Misdivision at mitosis during body development can give rise to individuals composed of mosaics of normal and aneuploid cells, as has been found in certain abnormal children. Aneuploidy has also been found in aging tissues in which the mitotic process has lost efficiency.

2. Form.—Since chromosome shape and size is constant and characteristic for each species, these features have been extensively used for assessing evolutionary relationships within and between species.

At metaphase each chromosome consists of two apparently cylindrical chromatids (fig. 8) each composed of spirally coiled chromonemata as in an anaphase chromosome (fig. 14). In organisms with localized centromeres, in the position of a centromere may be terminal, subterminal, or median, and divides the chromosome into two arms, to give a characteristic arm ratio. Organisms with nonlocalized centromeres have rod-shaped chromosomes, without separation into arms. Secondary constrictions, often associated with nucleolus organization, appear as unstained gaps at meta-

phase. When secondary constrictions are subterminal they may separate off terminal bodies called trabants or satellites, which can be a means of chromosome identification. The number of chiasmata at diplotene of meiosis affects the shape of bivalents: one gives a cross, two give a ring, while three or more yield a looped appearance.

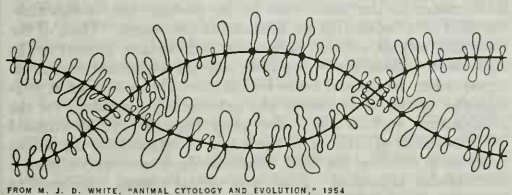
Chromomeres, darkly staining granules along the length of both mitotic and meiotic chromosomes, form characteristic patterns for each chromosome. Although chromomeres cannot be seen in metaphase chromosomes, when chromonemata are maximally condensed and spiralized, there is considerable evidence to indicate that they are a universal constituent of all chromosomes. Chromomeres can be seen particularly clearly in the giant polytene chromosomes in salivary glands of dipteran insects (fig. 15) in various stages of meiotic prophase and in the diplotene lampbrush chromosomes of many amphibian oocyte nuclei (fig. 16). Evidently chromomeres are coiled knots in the chromonema; they give a banding pattern because the connecting strand is so thin that it appears not to stain. Especially in polytene chromosomes, the chromomeres form a distinct pattern of transverse banding, which forms alternating stained and unstained bands of differing thicknesses. Homologous polytene chromosomes show close band to band pairing of chromomeres. Special chromomeres have been observed to "puff" out, by uncoiling, in certain tissues and may indicate which chromosome band is physiologically active in those differentiated cells.

The length of an individual chromosome, at metaphase, varies widely, from 0.2 μ in fungi to 10 μ in maize and man. The largest known chromosomes are the amphibian lampbrush chromosomes and dipteran polytene chromosomes, which have been observed to reach a length of 2,000 μ. Polytene chromosomes are more than 100 times the size of the same chromosomes at mitosis. Chromosome size, though primarily genetically controlled, may be modified by special environmental conditions.

The karyotype, the typical chromosome pattern per nucleus, is characteristic of a cell type, an individual organism, or a species. Chromosome number, shape, and size contribute to the patterns. Analysis of karyotypes in primates show that the chromosomes of the chimpanzee (48), gorilla (48), orangutan (48), and man (46) are morphologically similar in many respects—supporting the theory that man and the apes have evolved from a common ancestor.

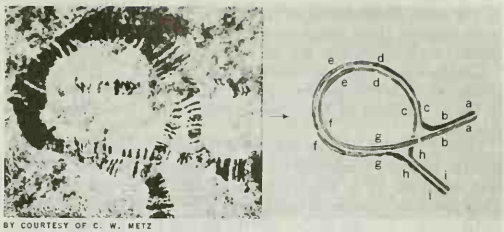
Karyotype analysis has revealed a cytogenetic basis for several congenital abnormalities including mongolism and sex abnormalities such as Turner's syndrome (45 chromosomes, with one sex chromosome missing) and Kleinefelter's syndrome (47 chromosomes, a sterile male with an extra X chromosome). With advancement in techniques, other factors such as DNA content are being added to the morphological criteria for karyotype analysis.

3. Ultrastructure.—Electron microscope studies have supported the contention of some light microscopists that chromosomes have a basically multistranded structure. In 1957, Hans Ris showed that the chromonema is composed of submicroscopic fibrils 100 Å thick. Each of these fibrils was later shown to be made of two subfibrils, 40 Å thick, twisted together. The latter have the dimensions of a nucleohistone macromolecule. Each 100 Å elementary fibril is probably composed of two DNA double helices, with associated histone material. Different species have different numbers of elementary fibrils, *e.g.*, 32 in leptotene chromosomes of the plant *Tradescantia* and 64 fibrils in single chromonema of sperms of scale insects.



FROM M. J. D. WHITE, "ANIMAL CYTOLOGY AND EVOLUTION," 1954

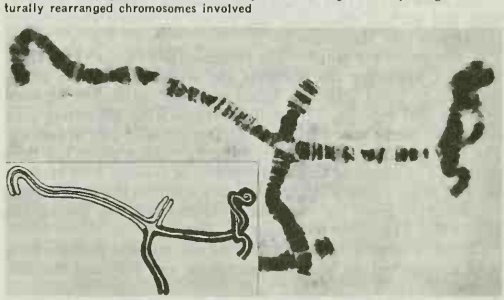
FIG. 16.—DIAGRAM OF A LAMPBRUSH CHROMOSOME (BIVALENT), SHOWING LATERAL LOOPS. THERE ARE TWO CHIASMATA (POINTS WHERE THE CHROMOSOMES CROSS OVER)



BY COURTESY OF C. W. METZ

FIG. 17.—TWO EXAMPLES OF CHROMOSOME REARRANGEMENT

(Above) Inversion and (below) translocation, as seen in polytene chromosomes in a giant salivary gland cell of a fruit fly. Insets diagram the pairing of structurally rearranged chromosomes involved



Bacteria and blue-green algae, which do not have true chromosomes, display uniformly distributed filaments, about 25 Å thick; these are DNA helices uncombined with histones but not organized into the multistranded structure of a true chromosome.

4. Cytochemistry.—Chromosomes are composed of DNA, RNA, base proteins (of the histone and protamine types), and residual proteins (containing the amino acids tryptophane and tyrosine). Exactly how these components are organized into chromosomes is the subject of much speculation. The macromolecular structure of chromosomes may involve double DNA helices joined together by histone protein links.

Autoradiographic studies with radioisotope-labeled metabolic precursors revealed that the rate of synthesis of DNA, RNA, and proteins in chromosome formation is not synchronized among chromosomes in the same cell. The patterns of DNA synthesis have been found to be characteristic of certain human chromosomes (*e.g.*, the X). However, since the labeling pattern depends on the physiological stage of the chromosomes at the time of observation, this method has not led to the identification of many more chromosomes than could be identified morphologically.

L. Carlson, T. O. Caspersson, and colleagues in Sweden (1963) studied the normal range of variation in DNA content per chromosome. They found that different cells of a species contain the same proportions of DNA per chromosome. G. T. Rudkin and colleagues (1964) found that in cases of human chronic myeloid leukemia 40% of the DNA has been lost from one of the smallest pairs of chromosomes (usually designated chromosome no. 21).

5. Chromosomal Aberrations.—These include changes in numbers of chromosomes as well as in structure of individual chromosomes. An increase or decrease in chromosome number, by misdivision at mitosis or meiosis, was discussed above, under *Number*.

Structural alterations involve chromosome breakage and reunion in various ways that give new combinations of genes, outside the scope of recombination following crossing-over at meiosis. Pachytene and polytene chromosomes most clearly show the details of changes in patterns of chromosome structure. The types of alteration are: deletion, or loss, of a part; duplication of a segment; inversion, or linear reversal; and translocation (fig. 17). Inversions are the most common chromosomal aberration found in nature. Translocation of a piece of chromosome to another part

of the same chromosome or to another nonhomologous chromosome requires three simultaneous chromosome breakages and reunions; such aberrations are not so common as inversions.

Chromosomal rearrangements may accumulate to give new varieties, with karyotypes that appear characteristically different, as in the 15 varieties of *Drosophila virilis* (with chromosome polymorphism).

Lateral multiplicity, or polynemy, involves a mutation in the number of fibrils composing the chromosomes. The condition was first described by S. Hughes-Schrader and F. Schrader in 1956. They found two species of hemipteran insects with the same diploid DNA value. Yet one species had the diploid and the other a tetraploid number of chromosomes. The tetraploid species had smaller chromosomes that probably contained half the number of fibrils.

The same factors that induce gene mutation (radiation, temperature, and various chemicals) are known to induce chromosome aberrations (*see* MUTATION).

6. Chromosome Maps.—The construction of maps of the chromosomes, indicating the positions and sequences of parts corresponding to genic action, is based on close correlation between cytology and genetics. In sexually reproducing organisms gene maps have been constructed from data on crossing-over at meiosis. The linear arrangement of genes within a linkage group has been calculated by assuming that the frequency of crossing-over between any two genes varies with their distance apart on the chromosome —the farther genes are apart on a chromosome, the greater the chance that a crossover will occur.

On the cytological level, maps of the chromomere patterns have been constructed by studying pachytene and polytene chromosomes.

Correlation of genetic and cytological maps largely depends on the occurrence of localized chromosome aberrations, coinciding with the presence or absence of particular genes. Extensive cytogenetical maps have been obtained in this way of the giant polytene chromosomes in *Drosophila*. Breeding experiments showed that the deeply staining polytene discs, or bands, form the structural basis of genes responsible for heredity.

In organisms lacking polytene chromosomes or easily accessible pachytene chromosomes, as in man, the construction of cytogenetical maps is dependent on location of genes in aberrant parts of somatic chromosomes, a much more difficult task, requiring complete identification of individual chromosomes. The human X chromosome can be identified by labeling with radioactive tritiated thymidine. Such a technique enabled J. Lindsten and colleagues (1963) to locate certain blood group genes on the short arm of the X chromosome. (D. T. H.)

VIII. NATURE OF PROTOPLASM

Protoplasm is a highly organized colloidal system endowed with characteristic properties, the sum of which is life. It is well known that if the structure of the protoplasm is degraded into its component parts, the property of "life" is destroyed even though many of the parts may continue to carry out their specific functions. In the case of multicellular organisms the individual cells may be separated, causing the death of the organism without destroying the life of the individual cells. Studies on protoplasm at the cellular and subcellular levels have contributed much information to knowledge of the nature of life and its origin (*see* LIFE, ORIGIN OF; BIOCHEMISTRY).

The term protoplasm was introduced long after the discovery of the microscope and not until investigators began to be aware of a visible substance enclosed within what had been known as cells of plants and animals. It was probably first coined in 1839 by Johannes Evangelista Purkinje of Prague, who adopted it from Protoplastus, a liturgical term having reference to Adam. Shortly thereafter, Hugo von Mohl, a German botanist, applied the same term, as meaning "first plasma," to the slimelike, granule-filled material which he observed undergoing circulatory movements within plant cells. In 1835 Félix Dujardin, a French protozoologist, had introduced the term sarcode for the material he saw in protozoa which had been called a living jelly. He described it as "a substance, viscid, translucent, homogeneous, elastic and contractile." In 1861 Max Schultze called attention to the similarity of the protoplasm of plants and animals and of the sarcode of protozoa and proposed the term protoplasm for the physical basis of all life. Thus, the unification of biological science was begun by the recognition of the cell and of its protoplasm as the physical basis of all living beings.

1. Properties.—According to the present concept, protoplasm possesses an ultramicroscopic, labile system of structural proteins offering large internal surfaces for the promotion of heterogeneous catalyses, the interstices of the system being filled with a liquid. This interstitial liquid is generally regarded as aqueous, and the protein fabric as capable of imbibing water.

The characteristic properties of protoplasm are irritability, motility, metabolism, growth, and reproduction. Adaptability must also be included to account for the evolutionary changes. The ovum, from which an organism springs, possesses potentialities for changes, but these changes ordinarily lie within the limits of the organization of a particular species. Occasionally mutations occur spontaneously and have even been induced experimentally. The surprising feature is that, with the complexity of the protoplasmic constitution and the variety of environmental conditions, there should be such an extraordinary stability of protoplasm as we find it in nature.

Motility is expressed in two types of motion, amoeboid locomotion of entire cells and cyclosis, or currents of flow within the protoplasm of a cell. Both vary greatly in rate. It is of interest to note that the apparent inertia of most plants and the constant activity of animals are in striking contrast to what is observed within their cells. The protoplasm of most plant cells generally exhibits a marked streaming which is barely perceptible in most animal cells. The property of irritability may be easily observed by the cessation or, conversely, the acceleration of protoplasmic flow when mechanical or electrical stimuli are applied. The phenomena of reproduction and growth can be observed readily in young root hairs, in yeast, and in cells of tissue culture by the cleavage of parent into daughter cells and the increase in size of the latter.

To appreciate the implications involved in a study of protoplasm it is advisable to begin with results obtained on its physical state and that of its structural components. Protoplasm is to be regarded as a microheterogeneous system in which particles and molecules of varying solubility are dispersed in an aqueous phase. The state of the protoplasm of many cells is such that the cells round up into spheres when freed of their extraneous envelopes. This is also true for the protoplasts of plant cells removed from their rigid cell walls.

The protoplasmic surface film is a tenuous structure usually interposed between an external envelope of varying rigidity and an internal layer of gellike, cortical material of the protoplasm. The external material which serves as a supporting envelope is an excretion product of the protoplasmic body. It is extraneous to the protoplasm, since it can be removed without interfering with the viable properties of the latter. This envelope depends for its rigidity upon the presence of calcium in the surrounding medium. In multicellular tissues the envelope of contiguous cells serves as intercellular cement for binding the cells together. When calcium is deficient or absent from the medium the cement loses its cohesiveness and the cells become separated. The protoplasmic surface film beneath the extraneous envelope also depends for its maintenance on the electrolytes of the medium but, in this case, the chief ions responsible are sodium and potassium. Thus, of the three electrolytes, sodium, potassium, and calcium, present in the aqueous environment of living cells, calcium is essential for the external cell envelopes and hence for the intercellular cement of multicellular forms, while sodium and potassium are required for the protoplasmic surface film. The older literature which stressed the importance of calcium, to the extent of introducing the phrase "calcium is essential for life," arises chiefly from observations on multicellular organisms. Plant and animal tissues, immersed in nutrient media lacking calcium, break down into isolated cells but, as long as sodium and potassium are present, maintain their individual vitality.

Theoretical considerations, supported by certain experimental observations, lead to the concept that the surface layer of protoplasm consists of a palisadelike arrangement of lipoproteins, the more water-soluble groups of which are directed outward. It is suggested that the extraneous envelopes of animal cells are produced by the continual casting off of denatured, proteinaceous material. Experimental tearing of the protoplasmic surface results in the outflow of the fluid parts of the interior, provided that calcium has been removed from the environment. Otherwise, irreversible clotting of the exuding material occurs and spreads into the interior. The protoplasmic surface layer disappears in a wave spreading from the torn region, as if the palisade arrangement forming the boundary were disrupting or breaking down. Repairs from such injuries, if not too extensive, have been observed. Minute vacuoles appear in the cytoplasm of the torn region. These break open and the linings of the vacuoles spread out and join until a sufficient area of film separates the disintegrating from the intact cytoplasm underneath.

The formed elements of protoplasm are of two general types: well-defined inclusion bodies and regions of gelation, the latter being transitory and serving special purposes. Of the inclusion bodies, some, in highly differentiated cells, are specific organellae such as the elastic, contractile trichocysts of paramecia. Other inclusion bodies are fat and yolk globules, pigment-containing and colourless vacuoles (some of which may be very large, especially in plant cells), rod-shaped or spherical mitochondria, and microsomes, the last being barely within the limits of vision. These bodies mostly float freely in the cytoplasm, and their constant movements reveal the existence of currents flowing in various directions in the cell. The function of many of these bodies is unknown. Some are doubtless reservoirs of foodstuffs, while for others there is suggestive evidence that they carry enzymes and are concerned with oxidation-reduction activities and various anabolic and catabolic processes.

The so-called ground substance of protoplasm exhibits at one time the properties of a fluid (sol) and at another, those of a deformable solid (gel). It is known that many colloidal substances, *e.g.*, certain proteins, bentonite, or vanadium pentoxide, in solution readily pass from the sol to the gel state and vice versa. This phenomenon, called thixotropy, is exhibited by these systems upon shaking, application of pressure, temperature changes, or the action of chemical agents. Protoplasm thus may be regarded as a thixotropic colloid.

2. Ultrastructure.—According to A. Frey-Wyssling, the cytoplasm forms a network of fibrils having the dimensions of a single polypeptide chain of a protein molecule. These chains are considered to be angular in shape and periodically branched. The side chains interact through points of attachment which may be of various types. This creates a finely meshed, three-dimensional net or molecular sponge the interstices of which are occupied by aqueous solutions of salts and also by lipids. The entire assembly is well ordered through the hydrophilic and lipophilic groups present in the protein network. Such a spongy fine structure would explain many properties of protoplasm, such as reversible swelling by imbibition of fluid or dehydration by constriction of the interstitial spaces.

The salient feature of this concept is the presence of an organization of the materials constituting a scaffold, so as to ensure an orderly progression of the reactions over the surfaces of the structure, presumably through the alternate adsorption and desorption of substrate molecules on the stationary centres of enzymatic, active proteins. Obviously, any detailed picture of protoplasmic fine structure must be based largely on our knowledge of the structure of proteins (*see* BIOCHEMISTRY).

A striking phenomenon is the streaming of the cytoplasm. This is accompanied by a greater or smaller degree of flow birefringence to be explained by the alignment, through shearing stresses, of asymmetric, rod- or platelike particles. When observed in the Tyndall beam of the slit ultramicroscope or with dark-field illumination, the cytoplasm reveals the presence of immense numbers of particles, as small as 50 Å, which are in active Brownian motion. These may represent the basic building blocks of protoplasm of which the larger particles, ranging up to 5,000 Å, are aggregates.

There appears to be a close correlation between the submicroscopic and the visible structure of cellular components. A fibril, for instance, has its special form and properties, *e.g.*, elasticity, because the protein molecules which it contains are themselves fibrous and contractile. Experimental observations have also indicated that cilia, flagellums, sperm tails, and linear chromosomes consist of interlinked bundles of submicroscopic fibrous protein particles which are oriented with their long axes parallel to the fibre axis. Likewise, membranes and films seem to be built up of submicroscopic layers or lamellae of single molecules. It is of interest to note that the plasma or protoplasmic surface film appears to contain also lipid molecules, with their long axes perpendicular to the surface. On the other hand, the nuclear membrane seems to contain little or no oriented lipid material.

These complex, fine structures of protoplasmic organization constitute a reversible, dynamic system, continually being built up and broken down during the course of normal cell metabolism. This has been demonstrated through the use of isotopic tracer elements, carbon, nitrogen, etc., which, when fed to animals or cells, rapidly replace the corresponding elements forming essential parts of the molecular structure (R. Schönheimer).

3. Chemistry.—From a quantitative point of view, water represents the major component: animal tissues contain up to about 80% water while the plasmodia of slime molds may contain as much as 94%. The water may be a basic constituent additional to serving as the solvent or suspension medium of many components of protoplasm.

The chemical composition of the protoplasmic solids may be deduced from the analysis of such animal tissues as lung, muscle, brain, or liver. They contain about 20% solids. The protein content is, on the average, about 10%, that of muscle about 16.5%. The total lipid content of brain and liver is about 4%, that of lung 2.7%. The mineral content of tissues in general is approximately 1.5%. In addition to these there is a series of minor substances, such as reserve carbohydrates (glycogen), organic acids, creatine and creatinine, free amino acids, pigments, urea, etc. Some of these minor constituents vary in amount, depending on the functional state of the tissue; they may be classified as metabolites and excretion products rather than as essential constituents of protoplasm.

The compounds classed under the general terms of "protein" or "lipid" may be subdivided into conjugated and straight proteins, or neutral fats, cholesterol, cephalin, etc. The conjugated proteins comprise such different complexes as nucleoproteins, lipoproteins, mucoproteins, iron proteins, etc.

The nucleoproteins are of signal importance: those containing deoxyribonucleic acid (DNA) appear to occur almost exclusively in the nucleus, while those containing ribonucleic acid (RNA) are found predominantly in the cytoplasm and in the nucleolus. DNA is an integral component of the chromosomes and carries the inherited characters (genes) of the organism. The RNA of the cytoplasm appears to be related functionally to the mitotic cycle, which involves the chromosomal nucleoproteins, and to the synthesis of proteins and protoplasmic substance of the cell in general. (*See* NUCLEIC ACIDS.)

The lipoproteins constitute an important group of conjugated proteins contained chiefly in the cell or plasma membrane, in the mitochondria, microsomes, and other cytoplasmic inclusions. The lipoprotein "mosaic," present in the plasma membrane, plays an important role in determining its permeability.

The components just enumerated represent either building blocks or metabolites of protoplasm. There are also many catalysts; *i.e.*, substances (unchanged chemically, at the end of reaction) capable of accelerating and promoting reactions that, in their absence, would take place only at negligible rates.

The distribution of the various enzymes and other catalysts between the different formed elements of the cell and the cytoplasm has as yet not been completely elucidated. However, it would seem as if all important enzymes occur both in the nucleus and in the cytoplasm. It would appear that the mitochondria are par-

ticularly rich in enzyme content. The control of the orderly flow of the reactions in protoplasm is accomplished by various devices, such as the mechanical separation of catalysts and substrates and the regulation of the hydrogen-ion concentration which, in turn, affects the rate of enzymatic processes. The orderly progress of reactions of these various catalysts and their substrates, all within the confines of a single protoplasmic unit, postulates the existence of regulatory mechanisms. For example, the rate of enzymatic processes is markedly affected by changes in the hydrogen-ion concentration of the medium. Spatial separation may also be assumed to play a role since there is evidence that some of the enzymes concerned with the terminal oxidation of metabolites are anchored, in a definite pattern, to the surface of macromolecular particles within the living cell.

4. Protoplasmic Reactions.—*Cell Respiration and Energy Production.*—Perhaps the most valid criterion of life is metabolism, a term which covers the intricate processes concerned in the synthesis and breakdown of foodstuffs (substrates or metabolites) and the utilization of the reactions to release energy required for the proper functioning as well as for the repair and growth of protoplasm. Energy-yielding reactions are of two types: respiration and fermentation. Respiration utilizes the molecular oxygen of the air. Fermentation, on the other hand, proceeds in the absence of air and, in many instances, is adversely affected by the presence of oxygen (Pasteur effect). In the metabolism of the most primitive types of cells, represented by certain strictly anaerobic microorganisms, the primary requisite of life appears to be the ability to ferment carbohydrate, yielding end products such as lactic acid, butyric acid, carbon dioxide, or hydrogen. From an energetic point of view, fermentation is not very economical since it releases only a small fraction of the energy available in foodstuffs. In contrast to this the respiratory or oxidative process releases all the available energy from a given substrate by burning it to carbon dioxide and water. Aerobic cells possess both types of mechanism. Fermentation is an indispensable prerequisite for respiration, since the latter utilizes chiefly products made available by anaerobic splitting of foodstuffs. The Pasteur effect allows only that portion of fermentation to persist in the presence of air which is required for the production of the substrates needed by the respiratory system.

It had been assumed that the ability to respire was restricted to intact and complete cells. It is now known that neither the cell membrane nor the nucleus is indispensable for this process and that the ability to utilize oxygen for the combustion of suitable substrates resides in the smallest particles which can be obtained from the protoplasm by mechanical means. Cell-free extracts retain the ability to ferment sugar but lose the ability to respire normally. It appears that the mechanical methods which break up the architecture of the protoplasm destroy the intricate correlations which are necessary for normal cell respiration. The same is true for the Pasteur reaction. However, it has been possible to demonstrate in cell-free solutions the presence of many of the enzymatic components of the respiratory system. This shows that the steps catalyzed by single enzymes do not depend upon the coordinated, vital activities of protoplasm (*see* ENZYMES).

Chemical energy is required for all of the so-called "vital" functions of the cell, such as the maintenance of membrane potentials, selective permeability, the maintenance of optimal hydrogen-ion concentration, of oxidation-reduction potentials, as well as cell division and protoplasmic movements. While primarily this energy can be made available only by fermentation or respiration processes, it is becoming increasingly clear that the immediate source of readily available energy for these diverse functions is to be found in energy-rich phosphate bonds. The energy released from the foodstuffs by the metabolic activity may be stored up by the synthesis of compounds of the type of adenosine triphosphate and creatine phosphate. The energy can then be released for such processes as the contraction of a muscle fibre or the excitation of a nerve fibre with the aid of specific enzymes which split the energy-rich phosphate bonds.

Oxidation-Reduction Potentials in Living Cells.—*Oxidation-reduction* systems are classified as reversible or irreversible. However, there exist many intermediate types such as the fully electroactive, the sluggish, and the semireversible systems, depending on the case with which the state of oxidation of the system may be reversed or with which electrons may be exchanged with other systems. A cell cannot be regarded as a system endowed with a uniform degree of oxidation-reduction intensity. It is possible that certain materials of a suitable reduction intensity are being continuously depleted by irreversible oxidation and are as continuously being replenished by the formation of fresh amounts. The physiological function of the reversible systems would then lie in their continual oscillation between the oxidized and reduced state, thus enabling the systems to plan the role of nonenzymatic, intermediary catalysts. Systems composed of certain oxidative enzymes and their substrates in the presence of suitable, electroactive dyestuffs (mediators) have been shown to constitute truly reversible oxidation-reduction systems, the potential of which is determined by the ratio of the oxidized and the reduced form of the substrate. In the living cell, we do not encounter such a state of thermodynamic equilibrium but rather a steady state resulting from the incessant and simultaneous flow of oxidative and reductive reactions in both directions; this balance has been designated as "aerobic" and "anaerobic" potential. It is evident that any disturbance of this steady state by changing the oxygen tension of the medium or by the addition of strongly reducing or oxidizing agents will profoundly affect the physiological activity of the cell, provided they break through the defensive mechanism which may be described as the oxidation-reduction buffering capacity of protoplasm.

Hydrogen-ion Concentration.—Attempts at determining the intracellular hydrogen-ion concentration or pH (*see* HYDROGEN IONS) have been made in various ways. The earliest was to crush a mass of cellular tissue and determine the pH of the extract electrometrically and also by means of colorimetric pH indicator-solutions. Considerable variations were found to occur, not only with different tissues but with the same tissue at different times. It was later observed that the damage produced in crushing the protoplasm of cells causes the appearance of what has been termed an "acid of injury" which upsets the evaluations. The only method to prevent this kind of injury is to obtain values in single cells while the cells are known to be still alive. Such a method has been made possible by means of microinjection (*see* MICROMANIPULATION). Colorimetric indicators in aqueous solution can be injected into living cells and have produced results on which this section is based. In the determinations it is necessary to realize that the values obtained refer to the aqueous portion of the protoplasm.

The two chief constituents of protoplasm are protein and water. The water is continuous throughout the protoplasmic matrix and serves as a dispersing medium for granules of various sorts, fatty droplets, and vacuoles, also as a solvent for electrolytes and the ionizable portions of the other main constituent, namely protein. The nature and degree of the ionization depend upon the hydrogen-ion concentration, which is a conditioning factor for the metabolic activities of protoplasm. For the cytoplasm the pH value has been found to be 6.9 ± 0.2 where pH 7.0 represents neutrality. For the nucleus the value is 7.7 ± 0.2 indicating that the aqueous phase or portion of the nucleus is definitely more alkaline than that of the cytoplasm. It is significant that these values have been found to be constant in a large variety of animal and plant cells, both of unicellular and multicellular organisms. This constancy is maintained by the so-called buffers; *e.g.*, the bicarbonate-carbonic acid system and the amphoteric proteins. Otherwise, the normal functional state of the protoplasm would be seriously disturbed by the acids which are produced during the various metabolic reactions occuring in the cell. For example, such metabolic end products as lactic and carbonic acid are immediately neutralized. The resulting neutral compounds are carried to the surface of the cell where their acid components are released to the outside.

The cytoplasmic vacuoles are liquid-filled sacs. Their enveloping membranes consist of a nonaqueous material and serve as mechanical and selectively permeable barriers to keep the vacuolar

contents separated from the surrounding cytoplasm. The membranes of the vacuoles may allow certain solutes to enter but not to leave. In other words, these membranes exhibit the remarkable property of a one-way permeability, a property which has caused considerable speculation as to their physicochemical structure. The vacuolar contents are usually more acid and, in some instances, more alkaline than the cytoplasm. They are only slightly if at all buffered. Because of this the pH of the vacuoles may vary considerably with the nature of the environment. On the other hand, the pH of the cytoplasm and of the nucleus is independent of the environment as long as the cell is alive. This constancy of the protoplasmic pH is of great significance for the maintenance of the normal physiological state of the protoplasm and of its metabolic activities.

Gel-Sol Reversal.—The peculiar property of protoplasm to maintain or to change its physical state occurs generally in such a way that one part of the protoplasm is gelated while another remains in the sol state. These changes, together with protoplasmic streaming, are related to various protoplasmic activities such as amoeboid movement, cell division, and possibly the periodic torsion observed in extended strands of myxomycete plasmodia. The gelated regions are more or less transient in character and revert to the sol state either spontaneously or when subjected to certain experimental conditions.

Selective Permeability of Protoplasm.—Ever since the cell was discovered as the structural unit of protoplasm, it has been abundantly proven that protoplasm exhibits a unique selectivity in the incorporation of certain materials and not of others from the surrounding medium. Water and dissolved gases readily pass in and out; so do certain ions, but not others. Nonionized molecules, *e.g.*, of weak acids and bases, appear to penetrate readily, while water-insoluble fatty acids do not. The penetration of particles in suspension and of nonelectrolytes appear to be a matter of size.

Electric charges play an important role with ion-valency as a determining factor. Most cells appear to be readily permeable to monovalent and distinctly less so to polyvalent cations. Some types, *e.g.*, blood cells, have been found to be permeable to anions and not to cations; but this is not true for all red cells. The fact that, in general, weak acids and weak bases penetrate more readily the less they are dissociated, has been used as an argument for a predominantly lipoid nature of the protoplasmic surface.

There is no generally accepted opinion regarding the nature of the protoplasmic surface to explain its selective permeability. Some have claimed the surface layer to be a mosaic of water and lipoid soluble regions, both of which may be present simultaneously or may alternate in appearance with time. Others adhere to the theory that ions are converted into lipoid soluble compounds at the time of their passage. Still others lay stress on the role played by electric charges on the surface. The selective permeability of the protoplasmic surface layer also may be conditioned by the interstices of the molecules constituting it, and by the chemical affinity for cations or for anions, according to whether carboxyl or amino groups predominate in the surface layer.

See also METABOLISM; DEATH (BIOLOGICAL).

(R. CH.; K. G. ST.; X.)

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CYZICUS, an ancient town of Mysia, the ruins of which are situated on the shoreward side of the Kapidagi (Arctonessus) peninsula on the south coast of the Sea of Marmara in the Bali-Kesir *il* of Turkey. It is said to have been a colony of Miletus, founded in 756 B.C. Its advantageous position soon gave it commercial importance, and its electrum staters were a staple currency in the ancient world till they were superseded by Alexander the Great's world coinage. Cyzicus came under Persian rule on the collapse of Lydia (*c.* 546 or 540) but joined the Delian league (*q.v.*) after the defeat of Xerxes and remained loyal to Athens till 411 B.C.

Assigned to Persia, with the other Greek cities of Asia, by the peace of Antalcidas (387), it was freed by Alexander's invasion. The history of the town in Hellenistic times is closely connected with that of the dynasts of Pergamum, upon whose extinction it came into direct relations with Rome. Cyzicus was held for the Romans against Mithradates in 74 B.C. till the siege was raised by Lucullus; its loyalty was rewarded by an extension of territory and other privileges.

Still flourishing in imperial times, Cyzicus was partly destroyed by the Arabs in 675 and appears to have been further damaged by a series of earthquakes. The principal extant ruins are the walls, traceable for nearly their whole extent; a picturesque amphitheatre intersected by a stream; and the substructures of the temple of Hadrian, which was sometimes ranked among the seven wonders of the world (31 immense columns still stood in 1444). Excavations on the site were undertaken in 1959 under the supervision of Ekrem Akurgal of Ankara university.

See F. W. Hasluck, *Cyzicus* (1910).

CZAPLICKA, MARIA ANTONINA (1886–1921), Polish-English anthropologist best known for her works on the peoples of northern Siberia and the Turks of central Asia, was born near Warsaw, Poland, in 1886 and went to England early in her career to complete her university work. She studied at the universities of London and Oxford. From 1912 on, she lectured at both universities and later at Bristol university, where she was at the time of her death on May 27, 1921. Through her mastery of Slavic languages she was able to interpret the anthropological studies of Siberia and central Asia for the English-speaking world. In 1914–15 she led, together with Henry U. Hall of the University of Pennsylvania, an expedition to the Samoyed and Tungus peoples of Siberia. Some of the findings of the expedition are incorporated in a vividly descriptive work, *My Siberian Year* (1916). The more purely scientific results of the expedition have remained unpublished.

In two general works of excellent scholarship, *Aboriginal Siberia: a Study in Social Anthropology* (1914) and *The Turks of Central Asia in History and at the Present Day* (1918), she reviewed virtually all then-known aspects of the ethnology of the peoples of Asiatic Russia. Her surveys are unsurpassed for succinctness, clarity and good judgment. Her literary remains include a series of unpublished lectures for the London county council, 1920. These go beyond her earlier work into questions of the general history and economy of Siberia; in addition, there is an unfinished manuscript on Poland. Her untimely death at the age of 35 cut off a brilliant mind in mid-career. (L. K.)

CZARNIECKI, STEFAN (1599–1665), was the foremost Polish general of his age. As a young man he fought in the Prussian campaigns against Gustavus Adolphus (1626–29) and under Wladyslaw IV in the Muscovite campaign of 1633. In 1648 he fought the Cossacks and the Tatars at Zheltye Vody and was captured by the latter, being freed in 1649. Two years later he helped to defeat the Cossacks at Beresteczko. When Charles X of Sweden invaded Poland (1655), Czarnieckі led the national rising and carried on a partisan campaign which contributed to the defeat of the Swedes. In 1658–59 he helped the Danes in their war against Sweden. After the peace of Oliva (1660) he fought against Russia, winning victories at Polonka and the Basia river. He died at Sokolowka, near Brody, on Feb. 16, 1665, just after he had been appointed deputy commander in chief. Under him Jan Sobieski learned the art of war.

See Ludwik Jenike, *Stefan Czarniecki* (1891). (ST. HE.)

CZARTORYSKI, a Polish princely family, descended from the ruling dynasty of Lithuania. The family seat was the Czartorysk castle on the Styr river in Volhynia. In the 15th century the

sons of Prince Wasyl Konstantynowicz were Orthodox and anti-Polish, and one of them, ALEKSANDER, murdered Zygmunt Kiejstutowicz, grand duke of Lithuania (1440). Settling in Moscow, he played a part in the internal struggles there and became viceroy of Pskov (1443) and Novgorod (1447). He returned to Lithuania in 1462 and died there after 1477.

At the end of the 16th century the Czartoryskis became Roman Catholics and favoured closer union with Poland and held senatorial office. The founder of a strong family party, the so-called Familia, was KAZIMIERZ (1674–1741), treasurer and later vice-chancellor of the grand duchy of Lithuania, who was opposed to Russian influence. The Familia attained great power through the activities of his sons, ALEKSANDER AUGUST (1697–1782) and MICHAL FRYDERYK (1696–1775). The former, governor (*wojewoda*) of Ruthenia, was a highly competent landlord, who gathered together a great estate and founded workshops, forming a strong financial basis for the party.

Aleksander August's son, ADAM KAZIMIERZ (1734–1823), born in Danzig on Dec. 1, 1734, was educated in England and prepared to take over the Polish throne. The political leader of the Familia in Poland was his uncle Michal Fryderyk, chancellor of the grand duchy of Lithuania. The policy of the Familia was to strengthen the state, with the backing of Russia and England, in opposition to the Potocki party, supported by Austria and Prussia. In the period when Poland was left without an elected king, Adam Kazimierz refused the crown (1763), which was accepted by his first cousin, Stanislaw August Poniatowski. The interests of Adam Kazimierz were mainly literary and pedagogical. In 1763 he launched the publication of *Monitor*, a periodical in the style of the English *Spectator*. In 1768 he accepted command of the newly formed cadet corps, which was in fact the first Polish lay school. He wrote for it the *Codets' Catechism*, formulating in it the ideal of education in the spirit of the age of enlightenment. He also rendered great service to the educational commission and became the first minister of education in the world. In addition, he fulfilled with zeal his duties as lieutenant-general (up to 1783) in command of the Lithuanian army. By his efforts and those of his ambitious wife, Izabella Elzbieta, née Countess Flemming (1746–1835), their palace at Pulawy became an important centre of culture competing with royal patronage in the support of classical architecture and Polish literature; this provided an excellent school for their sons and those of the local gentry. The economist P. S. Du Pont de Nemours taught there. A supporter of the Polish theatre, Adam Kazimierz wrote several comedies for his Pulawy theatre. His daughter, Ludwika Maria, unhappily married to the prince Ludwig of Württemberg, wrote popular sentimental novels. As a politician Prince Adam Kazimierz allowed himself to be drawn into anti-royalist circles. However, he showed his loyalty during the vote of the 1791 constitution. After the downfall of Poland in 1795, Pulawy, ruined in 1792–94 and rebuilt, became the shrine of the country's past, mainly through Princess Izabella's efforts. In 1800 the "temple of remembrance" (now called Sybilla's temple) was built to house souvenirs of the Polish kings and leaders. The so-called "Gothic house," inaugurated in 1809, was the first Polish museum. Prince Adam Kazimierz died at Sieniawa on March 19, 1823.

The son of Adam Kazimierz and Izabella, Prince ADAM JERZY (1770–1861), born in Warsaw on Jan. 14, 1770, was the most renowned member of the family. Having received a thorough education in his native country, he later traveled widely in Germany (where he met Herder, Wieland and Goethe), France, Switzerland, Holland, and, above all, in England and Scotland. He studied in Edinburgh, was present at parliamentary sittings, visited estates and factories and made contact with great families such as the Argylls, Lansdownes and Straffords, who were of great help to him in the years 1814 to 1831. While in England he formulated his program of liberal toryism. On returning to Poland in 1791 he played a distinguished part in the 1792 campaign against Russia. On the advice of his parents he took no active part in the 1794 insurrection; nevertheless, Pulawy palace was destroyed and his estates confiscated.

Seeking the recovery of his property, Adam Jerzy went in 1795 to St. Petersburg, where he became friendly with the grand duke Alexander. When Alexander became emperor he called upon Czartoryski to work out a plan for the reform of the government, appointing him deputy minister of foreign affairs in 1802 and minister in 1804. Czartoryski advocated world peace, based on an Anglo-Russian understanding; he also supported the liberation movements in the Balkans. He worked unsuccessfully for the restoration of Poland and its union with Russia. The Russian military defeat in the 1805 campaign against Napoleon, undertaken against his advice, caused his dismissal in the spring of 1806. However, he remained in Russian service until 1824 as curator (from 1803) of the educational region of Wilno, which embraced the eastern provinces of the former Polish state. He attained great success in the extension of Polish schools and of Wilno university. In 1812 the Poles, under the nominal leadership of his father, Prince Adam Kazimierz, sided with Napoleon. After Napoleon's downfall Adam Jerzy resumed his efforts to restore Poland and obtained from Alexander a promise to unite to that country the former Polish lands of Lithuania and Ruthenia. Czartoryski also sought for English support. With Alexander's consent he was Poland's spokesman at the congress of Vienna in 1815, obtaining as much as was possible; *i.e.*, the creation of a kingdom of Poland with Alexander as king. In his capacities as senator and member of the government he helped to prepare a liberal constitution, but in 1816, disillusioned with Alexander, he withdrew from public life. In 1827 he published, under the pseudonym Filhellène, his *Essai sur la diplomatie*, in which he proposed a league of nations for the defense of world peace.

Although he opposed war against Russia, Czartoryski found himself at the head of the Polish insurrection that broke out on Nov. 29, 1830. He saw that its success would depend more on western diplomatic intervention in Poland's favour than on actual fighting by the Poles. On the collapse of the insurrection, Czartoryski, sentenced to death by the Russians and deprived of his estates, left Warsaw on Aug. 15, 1831, and went into exile. The "Hôtel Lambert," his Paris residence, became a centre of Polish political activities. Maintaining unofficial envoys in Constantinople and Rome and having many lesser agents abroad, Czartoryski was always well-informed; once again he bent all his efforts to restoring Polish independence. From 1836 he paid special attention to events in the Balkans and Turkey. Wishing to undermine Russian influence there, he encouraged the national movements of the Balkan peoples and later, with the support of Turkey, the Caucasian national movements. During the years immediately preceding the Crimean War this also served the interests of the western powers, especially of Great Britain. Maintaining contact with Poland, Czartoryski took an important part in the preparation of the 1863 insurrection, though he did not live to see it. He hoped that, under the pressure of public opinion, the British and French governments would help to restore Poland's independence. As, at the same time, he was opposed to social revolutionary movements, he was sharply criticized by Polish radicals. He died at Montfermeil, France, on July 15, 1861.

WLADYSLAW (1828–1894), the younger son of Adam Jerzy, born in Warsaw on July 3, 1828, continued his father's policy and, during the 1863 insurrection was the chief diplomatic agent abroad for the Warsaw underground national government. He was successful in organizing unified opinion against Russia and its Prussian allies and came to an understanding with the Russian revolutionary emigration. When, however, it became clear that diplomatic intervention was not to be supported by armed action, he resigned from his official functions and called upon his country to cease fighting. From that moment Wladyslaw Czartoryski's political activities flagged. He turned his main interest to cultural affairs. In accordance with his father's will he set about saving the family historic and artistic collections, starting with those from Pulawy, and in 1876 founded the Czartoryski museum in Cracow, one of the richest in eastern Europe. The family archives and collections of manuscripts are one of the main sources of research into Poland's history. He died at Boulogne-sur-Seine, France, on June 23, 1894.

AUGUST FRANCISZEK (1858–1893), Wladyslaw's son, did not continue his father's political activities. A mystic, he became a mem-

ber of the Salesian Order.

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CZECH LANGUAGE. Czech is the native language of Bohemia, Moravia, and Silesia, all within the Czechoslovak Republic; the Slovak language (*q.v.*) is the official language in Slovakia. Recent sporadic attempts to merge Czech and Slovak have failed, although they are the two least differing Slavonic languages and the territories in which they are spoken have long cultural affinities and have been politically joined since 1918. Czech has about 9,000,000 speakers.

Etymology.—The older name of the language, Bohemian, is from Boii, a Celtic tribe transient in Bohemia ("the home of the Boii") before the Christian era. In Old German it became *Boheim;* it was Latinized *Bojohemum* and *Bohemia;* and in modern German it became *Böhmen.* Czech is considered, by some, hypocoristic: derived from a proper name (Čestislav). According to tradition, Čech was the name of a Slavonic leader. Other conjectures about the etymology of Czech are equally uncertain. The Czech term for Czechoslovakia's western part is Čechy; Czech people are *Čech* (sing.) or *Češi* (pl.); and the adjectival form is *český.*

Classification.—Western Slavonic languages, namely Czech, Slovak, Lusatian (Wendish, Sorbian) and Polish, are separated from other Slavonic languages (*q.v.*) by a fixed stress. Czech differs from others in this group in the following ways:

1. Czech, like Slovak, retains the original vocalic quantitative differences, unlike Polish and Lusatian (and Russian and Bulgarian), where only the semi-short vowel remains.

2. Czech, like Slovak, preserves the clusters *ra, la,* while Polish and Lusatian have *ro, lo.* For example, the Old Church Slavonic (and modern Bulgarian and Serbian) word *glava* ("head") becomes *hlava* in Czech and Slovak, *głowa* in Polish and Lusatian and *golova* in Russian.

3. Czech stress, like Slovak and standard Lusatian, is always on the first syllable of a word or prepositional phrase, even in loan words and naturalized foreign expressions; in Polish the stress is on the penultimate. The diacritical sign ′ (*čárka*) indicates the vocalic length only, not the stress: *páni* ("gentlemen") and *paní* ("lady") both have the stress on the first syllable, although the vocalic quantities differ. The stress is not normally written.

4. Czech, like all other Slavonic languages, except Polish, replaced the original nasals by pure vowels: Old Church Slavonic *rǫka* ("hand") becomes *ruka* in Czech, Lusatian, Serbian, Slovak, Russian and Bulgarian, and *ręka* in Polish.

History.—The Czech version of Slavonic of the 6th to 10th centuries was probably not very different from Old Church Slavonic (*q.v.*). Single Czech words intermixed in Old Church Slavonic bear testimony of the oldest stage of Czech as early as in the 11th century. Czech glosses appear in Latin and German texts of the 12th century. Czech literature proper, however, began in the 13th century, although there was no uniform language at that time. Dialects and provincialisms were marked. Phonetic changes entailed spelling changes that took place in three main periods:

1. *The Old Period (11th to 14th centuries).*—Penetrating changes occurred during this period. Characteristics of Czech, differentiating it from other Slavonic languages, were: mutation *a-ě, u-i* (*duša-duše, dušu-duši*); narrowing *é-í* (*řéci-říci*); monophthongization *ie-í* (*viera-víra*); diphthongization *ó-uo* (later: *ů*), *u-ú-ou* (*bóh-buoh, luka-lúka-louka*). Nominal and especially verbal inflexional variety was reduced. The dual number was weakened and often neglected in favour of the plural. (In modern Czech, the dual is nearly extinct, except in declension of *dvě, obě, ruce, oči, uši, nohy.*) Three past tenses were reduced to one: the aorist *ved/ech* and the imperfect *vediech* were replaced by the periphrastic *vedl jsem.*

2. *Middle Czech (15th and 16th centuries).*—The great religious reformer John Huss (*c.* 1370–1415) was also an ingenious and successful innovator in Czech, both in vocabulary and orthography. A standardization set in with his far-reaching simplification of spelling, based on phonetic adaptation of the Prague dialect which he popularized in his own numerous writings. Huss introduced diacritical signs ′ and ˇ which have survived up to the present. Lexical resources grew with neologisms and adopted words, mostly from the Latin, brought in with the Latin-German Christianity, French and German courtly life and German colonization. For example, the Latin *missa* became *mša* (later *mše,* "mass") and *crux* became *kříž* (later *kříž,* "cross"). German and French military terms entered the language from the 13th century onward, such as the German *Ritter* which became *rytieř* (later *rytíř,* "knight"). The humanism of the 16th century had profound effects on syntax, word order and vocabulary. The *Bible kralická,* 1593, served as a standard of usage.

3. *Modern Czech.*—In the subsequent period of the Habsburg regime in the Czech countries (1620 to 1918), political and cultural germanization nearly suppressed Czech. Linguistic revivalists from this period of semistagnation were J. Dobrovský, J. Jungmann, P. Šafařík, J. Gebauer and L. Niederle. The prolific linguistic production in Czechoslovakia during recent decades pertains mainly to the Czech language. *See* CZECHOSLOVAK LITERATURE.

Phonology.—The Czech alphabet, of Latin type, consists of all the letters of the English alphabet of sound value (q, x and w are found in foreign words only), with these additions: *č* (as in the English word *catch*); *ď* (*did you*); *ě* (*yes*); *ň* (*canyon*); *š* (*ash*); *ť* (*hit you*); *ž* (*measure*); *ř* is *rž.* Diacritical marks indicate the quantity of vowels and the quality of consonants. (1) *čárka* (literally, virgule): *á, é, í, ó, ú, ý.* It indicates the length, never the stress. (2) *kroužek* (little circle): *ů* (from older *uo*). It is also long and is only found over *u* medially and finally. (3) *háček* (little hook): *e.g., č, ď.* It indicates soft pronunciation (palatalization). Among vowels, only *e* carries the "hook." In combinations of a consonant and *ě*, the "hook" is found on *č, ř, š, ž;* otherwise it is only found on *ě: čeština, řeka, děti, němčina, těšiti, město, oběra.*

Di, ti and *ni* are soft (*dyi, tyi, nyi*) in Slavonic words: *nyní* (now); in foreign words, even domiciled, they are always hard (as in the English d, t, and n): *finiš, difúze, Titanic. Dy, ty* and *ny* are hard. Czech has no slurred or reduced vowels or consonants. All the sounds are fully pronounced. Exceptions are less striking than in English. Voiced *b, d, g, v, z* are unvoiced *p, t, k, f, s,* respectively before a voiceless consonant: *podzim* (*-dz-,* "autumn"), but *pod paží* (*-tp-,* "under the arm"). Similarly, *p, t, k, f, s* are voiced before a voiced consonant: *kde* (*gde,* "where"). In foreign words, *s* is voiced after *n, l, r,* or between vowels: *universita, fysika* (*-z-*), but *zase* (*zasse,* "again"). The *y* is the same as *i; r* is trilled, like Italian or Dutch; *l* and *r* may be syllabic: *plný, trn.* The pronunciation *ou* is as in English *go; ch* like the German in *ach.* Simple vowels are not diphthongized regardless of length: *láká* (*laakaa,* "lures"). All diphthongs are written as such: *au, ou, aj, ej, oj; u* is rounded as in *food.* The phoneme *ř* is closest to *rž: Dvořák.* In final position *v* is unvoiced: *lev* (*lef,* "lion").

Morphology.—Modern Czech has nine parts of speech; seven cases; two numbers; three persons; three tenses (present, past and future, all modified in verbal aspects); two voices; and three moods (indicative, imperative and conditional, including subjunctive). It lacks the article and the so-called "emphatic" verbal forms. It has, however, verbal aspect, a marked feature of Slavonic languages. Basic aspects are perfective and imperfective (durative, iterative), indicated by an internal change (*nésti, nositi, nosívati*). Some verbs modify these aspects further by numerous prefixes, connoting varieties of action as well as of time (*nésti: roz-, za-, pro-, při-, pře-, u-, do-, vy-, s-, na-, v-, vz-, nad-, od-, po-, popo-*).

Dialects.—Dialectal differences are now slight, lexically and phonetically. The most popular dialects in Bohemia are: (1) in the southwest, the dialect of Domažlice (*chodské nářečí: bul* for *byl,* "was"); (2) the central dialect (of Prague), the basis of the standard written Czech; (3) the dialect of Krkonoše Mountains, in the northeast. In Moravia and Silesia the dialects are: (4) the dialect of Haná, around Olomouc (*bel* for *byl*); (5) the Valach dialect in the northeast; (6) the Silesian dialect, with Polish ele-

ments; (7) the Moravian Slovak dialect, in the southeast, similar to Slovak.

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CZECHOSLOVAKIA (Československá Socialistická Republika), a landlocked, elongated country of central Europe. Area 49,367 sq.mi. (127,861 sq.km.). The most noticeable feature of configuration is the disproportion between length from north to south and breadth from east to west. The caterpillar outline of the country, truncated in the east with the cession of Subcarpathian Ruthenia to the Soviet Union after World War II, stretches across the heart of Europe. Czechoslovakia has common frontiers with the German Federal and Democratic republics, Poland, the U.S.S.R., Hungary, and Austria. The western regions, Bohemia and Moravia-Silesia, have been for centuries the westernmost settlement area of the Slavonic peoples, thrust like a wedge between the Saxons to the north and the Bavarians to the south.

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I. PHYSICAL GEOGRAPHY

1. Geology and Physiography.—The lands of the Czechoslovak republic belong in structure to two contrasting sets of physical features in Europe. To the west, the Czech part of the country lies wholly within the Hercynian highland area of the Bohemian Massif. To the east, the greater part of Slovakia is a section of the large Tertiary arc of the Carpathian Mountains (*q.v.*). In the centre, Moravia and southern Silesia are geological and structural borderlands. Western Moravia, mainly Czech in tradition, is the easternmost part of the Bohemian Massif. Eastern Moravia, mainly Slovak, belongs to the outer foothills of the White Carpathian and Javorníky ranges. Lowland Moravia, like the plains of southern Slovakia, formed in the Miocene Period the northern inlets of the great sea which covered the whole of the Middle Danube Basin. The thick and sometimes very fertile Tertiary deposits are characteristic also of the broad lower valleys of the North Carpathian river basins. In Czechoslovak Silesia are the southernmost traces of the Pleistocene ice sheets, so conspicuous in the landscapes of Germany and Poland. In physical geography, therefore, Czechoslovakia lies at the crossroads of Europe.

The Bohemian Massif.—The high country reaches a maximum elevation of 5,256 ft. (1,602 m.). The effect in landscape is of rounded, forested, rather monotonous highland, mainly of Archean crystalline rock. Four bounding ranges frame the massif: the Erzgebirge or Krušné Hory (Ore Mountains) in the northwest, the Riesengebirge or Giant Mountains (*q.v.;* Krkonoše) in the northeast, the Moravian Heights in the southeast, and the Šumava and Český Les (Bohemian Forest; *q.v.*) in the southwest. Only the Moravian Heights are wholly within Czechoslovakia. Bohemia shows plainly not only the effects of long-continued erosion and submergence, which wore down the Hercynian highland to the rounded stumps of the original ranges, but also the effects of the violent folding and thrusting in the Alpine region to the south. The massif contains much evidence in its highlands and river systems of tilting, faulting, and breaking. The many cliffed edges to the highland masses serve to break the general monotony of contour. In the northern hills of the massif, variety is given to the landscape by the Cretaceous sandstone covering, which is elsewhere almost wholly worn away. This warm, beautifully coloured rock in the Lužiké Hory (Lusatian Mountains) and in the Elbe gorge on the Czech-Saxon border accounts for a small region of fine scenery with spectacular rock formations. Former volcanism explains the number of spas in northwest Bohemia which include Karlovy Vary, Františkovy Lázně, and Mariánské Lázně.

In the inner part of the massif four contrasting types of lowland are separated from each other by wide stretches of thinly settled rugged country, mainly of crystalline rock. In the northeast is the Upper Elbe plain with the regional name of Polabí. It is a small region of Cretaceous marls, largely covered with fertile loess. Polabí is the heartland of Bohemia, with its ancient and now dense settlement, established skilled farming, ample manufacture and trade. In the south are the two lake basins of Třeboň (Wittingau) and Budějovice (Budweis) through which flow the Lužnice and Vltava (Moldau) rivers. These are curious areas of heavy impermeable Tertiary clays on which some peat has formed. The remarkable distribution of the *rybník* (small lakes and ponds) and the exploitation of them for a local economy of freshwater fisheries make these localities both distinctive and interesting. In the west and centre are the Plzeň and Kladno basins both with coal measures of limited economic importance. In the northwest, in the Ohře (Eger) and Bílina basins, the Oligocene lignite beds form the main reason for two considerable mining and manufacturing regions.

The whole is given an apparent coherence by the pattern of the river system. The Elbe rises in the Krkonoše and flows south, west, and north to the German frontier. It is joined near the western end of Polabí by the Vltava which rises in the Šumava Mountains in the south. The right-bank tributaries of the Vltava, the Lužnice, and the Sázava are large streams, and so also are the left-bank rivers, the Otava and the Berounka. The convergence of waterways above and below the capital, Prague, which occupies both banks of the Vltava downstream from the St. John's Rapids, is remarkable. Most of the Bohemian rivers have upper courses of shallow valleys and gentle gradient in the mature higher regions of the massif but, as well, many of them have rugged, tortuous middle courses. Navigation is therefore strictly limited, and the development of road and rail communications converging on Prague is an achievement of communications in spite of natural difficulties.

Slovakia.—The broad arc of the North Carpathians (*see* Car-

PATHIAN MOUNTAINS) in Slovakia forms the greater part of the region. Their general character is of open block mountains with the groups of ranges separated from each other in the west by the great valley of the Váh, and in the north and east by upland basins of some individuality. Contrasting rock series mainly explain the variety in landscape. In the north the Tertiary fold ranges are continuous from the White Carpathians in the west, far beyond the eastern frontier of Slovakia to the Transylvanian Alps of Rumania. These flysch mountains are of no great height, but they form a broad, thickly wooded outer belt of the arc. They are a major part of the Carpathian landscape. The exposed core of crystalline rock provides the finest scenery, and is most noticeable in the High (Vysoké) and Low (Nízké) Tatra groups. The High Tatra contains a line of fine jagged peaks, and evidences of glaciation are also present in the frequent cirque formations and in the number of small tarns which fill the cirque hollows. Limestone ranges, relatively small in extent, lie mostly to the west of the Tatra Massif (*see* TATRA MOUNTAINS) and are mainly conspicuous in parts of the Lesser (Malá) Fatra and the Greater (Vel'ká) Fatra ranges. One section of the Váh Valley between Liptovský Sväty Mikuláš and Žilina is a magnificent gorge of Triassic limestone crags. Beyond the limestone and crystalline hills are the volcanic highlands, of moderate altitude and stretching away in scattered outcrops to the Slovak and Hungarian plains. The inner side of the curve of the North Carpathians contains the lines of fracture surrounding the depression of the Middle Danube Plain. These lines of weakness formed the vents for the outpouring of volcanic material and explain the rich soils, especially suited to viticulture, in parts of Slovakia and north Hungary.

There are few lakes and therefore no natural check to the marked seasonal runoff in the southward flowing streams: the Váh and the Hron, the Ipel, and the great fan of tributaries which form the upper part of the Tisza (Tisa; *q.v.*) Basin. The careful maintenance of the forest cover which could lessen the violence, especially of spring flooding, has often, unfortunately, been neglected in the traditional and rather primitive use of woodland in Slovakia.

The smaller region of lowland Slovakia to the south is a part of the great basin of Hungary. To the west the Slovak plains are the northern extremity of the Little Alföld (or lowland), and to the east they form the tip of the Great Alföld. On the western side the meandering streams of the Middle Danube form the southern frontier. The southern part of the Slovak plains is alluvial farming land reclaimed from natural marsh by diking and drainage. The northern part has fertile loess material which continues in the valleys of the Váh, Nitra, and Hron rivers both in the Little and the Great Alföld. The distinctions in relief are the more noticeable because traditionally the plain settlement is that of the Magyars, who penetrated right into the Carpathians, while the hill country settlement is that of the Slovaks.

Moravia-Silesia Borderland.—Between the two contrasting regions of west and east lies the border country of Moravia-Silesia (Moravia means a border region). The demarcation between the Hercynian and Alpine areas is buried below the thick Miocene deposits with their rich loess covering. This good farming land runs in well-marked zones below the Moravian Heights from the Austrian frontier to the upper basin of the Morava River. In sharp contrast is the spectacular Moravian Karst (Moravský Kras) landscape (*see* KARST) to the north of Brno. This is formed in Devonian limestone much fragmented, interspersed with Carboniferous schists, and partially covered with Jurassic and Miocene beds. Its curious topography of large caverns, swallow holes, and underground streams, together with the great Macocha gorge (600 ft. deep), developed during the Paleozoic era and have become apparent once more through the processes of denudation.

Carpathian Moravia is more remote, more monotonous, and poorer than the west. In the extreme south the lower Morava Valley contains big stretches of unreclaimed marsh. Farther north the relief is broken by the spurs and outcrops of the White Carpathian foothills, notably the Chřiby Plateau. The valleys of two eastbank tributaries of the Morava, the Olsava and the Drevnice, provide the connections between Moravia and Slovakia.

Moravia is separated from the southern tip of Silesia by the broad pass known as the Moravian Gate (Moravská Brána). There the divide between the Bečva Valley, which is part of the Morava system, and the upper valley of the Oder, which flows north eventually to the Baltic, is low and easy. On the west side the low range of the Hercynian Jeseníky overhangs the Gate in a steep cliff. About six miles to the east the outermost flysch ranges of the Carpathians rise more gradually. The country both to east and west of the Gate is sufficiently rugged to explain the canalizing of movement through it over centuries of history.

In northernmost Moravia and Czech Silesia the most conspicuous physical feature is that of the coal measures. East of Silesia there are no other substantial coal resources in Europe except those of the distant Donets Basin in the U.S.S.R. On the Carpathian side of the coalfield the poor country of the wooded flysch ridges has provided part of the emigrant labour force for the mines. On the northwestern side the rich loess soils of the lower Olza (Olsa) and Opava valleys provide a part of the food supply for a large established urban market.

2. Climate.—Throughout Czechoslovakia the influence of topography on climate is stronger than that of geographical location. The conditions of temperature and rainfall depend mainly on relief, and local variations are noticeable. In the Czech lands the sharpest contrasts are between the basin climates which tend to continental features (Prague, January −3° C [26° F], July 19.5° C [67° F]) and those of the surrounding hills which are more moderate. In Slovakia the same kind of contrast is noticeable between the climates of the Alpine region and those of the Danube plains. There is a tendency to a slight increase in temperature range with a more easterly position, and to a summer maximum in rainfall. Prague, with a total rainfall of only 19 in. (483 mm.) illustrates the conspicuous dryness of inner Bohemia. Other noticeable climatic features are those of frequent fog (a hazard to aviation) in Bohemia and Moravia and the occurrence at 10- to 15-year intervals of violent and destructive storms in the Carpathians.

3. Vegetation.—The position of Czechoslovakia in Europe in part explains the wide range of its plant associations. The flora of eastern and western Europe, of the great plain of the north, and of the Mediterranean are present. Moreover, the diversity of climatic conditions, arising from the broken relief, together with the varieties of soil, is faithfully reflected in the plant distributions.

A little more than one-third of the country is forest covered. In Bohemia and Moravia-Silesia the existing woodland is the result of years of competently managed forestry. The proportion of coniferous forest to the whole is high, more than two-thirds, and this is largely the result of replanting with a view to timber markets. Spruce, fir, larch, and Scots pine are the most usual species. In the bounding ranges to Bohemia there are still big beech forests, and in the sandstone area north of the Elbe are fine stands of oak. The Šumava ranges in southern Bohemia contain preserved areas of virgin forest. In Slovakia the proportion of deciduous forest is higher than in the west (just under half) and the predominant forest cover is beech (one-third). Managed forestry in Slovakia has neither so long a tradition nor so high a standard as it has in Bohemia: the actual forest cover therefore is much nearer the natural one than that in the west. The beech woods become especially impressive toward the frontier with Subcarpathian Ruthenia (the Transcarpathian Oblast of the U.S.S.R.). There they are compact and more exclusive of other species.

There is an alpine flora in Slovakia that is noticeably rich in the limestone areas. Dwarf moss campion, bird's-eye primrose, and creeping geum are found at great heights, together with edelweiss and some beautiful gentians. It is a different flora from that of the high moors of Bohemia, although both the Krkonoše Mountains and the White Carpathians have a very abundant and rather similar hill vegetation. In Bohemia, dwarf birch and knee pine are common. The high meadow flora of the Krkonoše in spring and early summer is especially brilliant with globeflower, Turks-cap lily, and anemone. In the White Carpathians the flysch ranges are marked with an abundance of broom in early summer, and later with beautiful bellflowers.

Both parts of the country at lower levels contain plants which are generally associated with steppe environments. In Bohemia

soil distinctions account for some distributions. The limey soils favour cocksfoot grass, upright brome grass, and yarrow; the soils rich in humus have a good range of orchids. In central and southern Moravia are a number of halophytic plants; *e.g.*, marsh samphire (*Solicornia herbacea*) and goosefoot. In lowland Slovakia, the *puszta* vegetation appears with the abundance of fescue and feather grass.

The north–south tectonic depression in the Carpathians, which lies roughly between the towns of Prešov and Košice, appears to be a plant frontier as well as a geological divide. The German botanist, F. Pax, at the end of the 19th century found a remarkable differentiation in the plant distribution on either side of it.

(H. G. S.)

4. Animal Life.—Czechoslovakian fauna includes among the larger mammals the bear, wolf, lynx, and wildcat in small numbers, while otter, badger, polecat, marten, and mink are more numerous. Red and roe deer and wild boar inhabit the forests; the reintroduced chamois is found in some mountain regions. Birds include golden and whitetailed eagles, osprey, griffon and Egyptian vultures, and eagle owls. Greylag geese and many marsh and water birds occur, as well as both black and white storks. The giant European catfish (or *Wels*) of the Danube, weighing 200 lb. or more, is outstanding among the many fish. Reptiles and amphibia are represented by European pond tortoise, several kinds of snakes and lizards, and many toads and frogs. (Ro. W. H.)

II. GEOGRAPHICAL REGIONS

The traditional regions of the Czechoslovak republic are Bohemia, Moravia, Silesia, and Slovakia. Bohemia and Moravia-Silesia were long known as the Historic Provinces and somewhat resemble the French *pays* in their longstanding identity. Their distinction is partly a criterion of relief—the Bohemian Massif, the Moravian Basin and corridor, and the Slovak Carpathians—and partly one of language. Bohemia is almost wholly Czech-speaking, Slovakia is Slovak-speaking, and Moravia-Silesia includes both languages. There is also a distinction of tradition—the Historic Provinces were for centuries Austrian in orientation, while Slovakia was Hungarian. The structural regions described in *Physical Geography* above do not coincide with the traditional regions.

There are, in addition to the traditional regions, contemporary economic regions which are described as follows:

West Bohemian Region.—Plzeň (*q.v.*) is the capital of this area, which includes the Plzeň and Ohře basins with conspicuous coal and lignite resources. A group of established spa towns lies in the northwest.

East Bohemian Region.—This, with the capital of Hradec Králové (*q.v.*), includes the farming area of Polabí. There are textile and glass factories bordering the Krkonoše.

North Bohemian Region.—With Ústí nad Labem (*q.v.*) as its capital, this region has lignite mines west of Ústí. There are chemical works and glass factories; the farming neighbourhood of Žatec is renowned for its hops.

South Bohemian Region.—Centred on České Budějovice (*q.v.*), this area comprises the Šumava ranges and the two lake basins of Třeboň and České Budějovice. Forestry is important.

North Moravian Region.—The capital is Ostrava (*q.v.*) and some mining and manufacture are based on the southernmost measures of the Silesian coalfield. The region also includes the rich farming area around Olomouc.

South Moravian Region.—The capital of Brno (*q.v.*) serves this productive and prosperous area, which has a wide variety of industry and good farming.

West Slovak Region.—Bratislava (*q.v.*) is the capital of this region of established farming on good soils and of expanding manufacture based on recent water power development as well as oil refineries.

Central Slovak Region.—With its capital at Banská Bystrica (*q.v.*), this area lies between the Liptov-Poprad Basin and the frontier with Hungary. Its wealth is in the mines of the Slovak Ore Mountains and in the forests. Manufacture in the 1960s was growing, mainly because of hydroelectric power development.

Tatra Region.—Rugged Alpine scenery has long attracted visitors to such established resorts as Štrbské Pleso (Strba Lake), Starý Smokovec, and Tatranská Lomnica.

East Slovak Region.—This area, with Košice (*q.v.*) as its capital, is advancing in industrial production mainly because of water power development.

In the Third Republic these regions have superseded those of tradition, although the major divisions are roughly in accordance with them. They were based on the planned use of resources in an authoritarian regime, and they cut across regions of structure, climate, vegetation, and soil. The precedent for this type of region was the pattern in the U.S.S.R. of geographic division based on the use of resources.

For the administrative regions, see *Administration and Social Conditions* below.

III. THE PEOPLE

1. Racial Characteristics.—There is no distinctive physical type among the Czechoslovak people. In a territory which has experienced so much population movement, anthropological distinction would not be expected. The anthropologist Ales Hrdlička observed: "The original type is best preserved in parts of Moravia and Slovakia. It is a type characterized by good stature; strong, well proportioned body; mostly rounded head; face, medium or rounded rather than narrow and long; hair varying from blond to brunette, and eyes ranging from blue to medium brown; absence of prognathism." (*Czechoslovakia* edited by R. J. Kerner; University of California Press, 1945.) C. S. Coon's study of the races of Europe suggests a progressive change of cranial indices from the dolichocephalic skulls of Bohemian pre-Christian grave material to the quite marked brachycephaly of modern times. There is, however, no consistent correlation between the development of a different cranial index and historical episode. In Slovakia slightly less stature and rather narrower head measurements are common. The minority groups are sometimes conspicuous; the surviving gypsies are markedly swarthy and have often narrower skulls and noses; the Magyars of the Slovak plains have on the whole broader, flatter faces than the Slovaks and concave noses are common. Frequent intermarriage between groups has made comments on physical distinctions somewhat pointless. Differences in temperament —the dourness of the Bohemian, the geniality of the Moravian, the quick emotions of the Slovak—are certainly noticeable, but are not traits measurable in figures.

Some past ethnographic distinctions remain in the gaiety and diversity of peasant costume, although this has vanished from daily use. Noticeable forms of it are in the Chod villages near the Bavarian frontier and in Slovak Moravia.

2. Languages.—Czechoslovak, a Slavonic tongue of the Aryan group, is the language of the republic. There is sufficient difference between Czech and Slovak to make the philology and literature of each something of a separate culture. (*See* CZECH LANGUAGE; SLOVAK LANGUAGE; CZECHOSLOVAK LITERATURE.) Bohemia is now almost wholly Czech-speaking although the German past of the peripheral highlands cannot be discarded completely from its cultural inheritance. Western Moravia is Czech-speaking, again with indelible traces of German settlement; eastern Moravia is Slovak-speaking. Some Hungarian is used on the southern borders of Slovakia, some Polish in the extreme northwest of Slovakia, but language and culture by the mid-20th century had become practically homogeneous throughout the republic. In south Moravia, near Mikulov, a curious group of Croat villages of obscure origin remains identifiable. In the Carpathians the spoken dialect is "Lach," mainly Czech in character but with Polish terms occurring frequently. Occasionally traces of a Vlach dialect appear in Beskydy (Beskid Mountains), suggesting a past connection with the Rumanian pastoral groups of the East Carpathians.

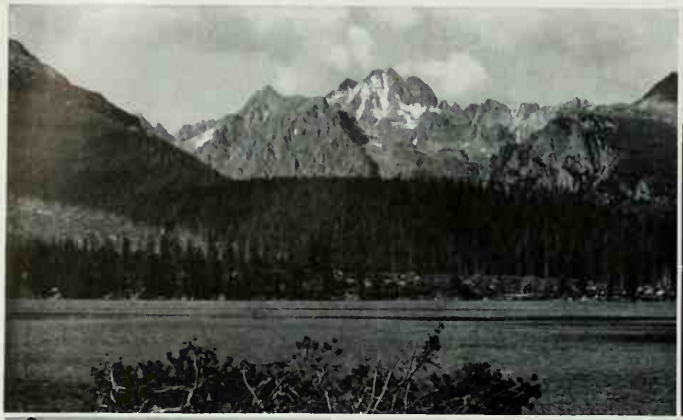
3. Religion.—The religion of a country with a Communist regime has no normal expression in statistics of church membership. In 1948 the majority of the population was ostensibly Roman Catholic. The minorities were Protestants (mainly in northeast Moravia and east-central Slovakia), the Greek Catholics of northeast Slovakia, and the adherents to the compromise institution of the National Church of Czechoslovakia founded in 1920. In parts

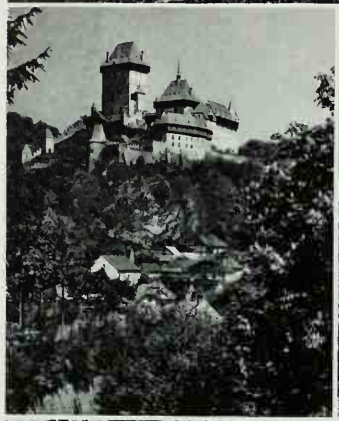
PHOTOGRAPHS, (TOP LEFT) PAUL POPPER LTD., (TOP RIGHT) PIX FROM PUBLIX, (CENTRE RIGHT) ERNEST RATHENAU—PIX FROM PUBLIX, (BOTTOM LEFT) THREE LIONS, (BOTTOM RIGHT) J. ALLAN CASH

PRAGUE

Top left: Tyn church and Huss memorial, in the "Ring" or market place of the Old Town
Top right: The Charles bridge at night
Centre right: Peasants in traditional costume ascending Hradcany hill
Bottom left: The shopping and business district of the modern town
Bottom right: Wenceslas square with the statue of St. Wenceslas (1913) in the centre

CZECHOSLOVAKIA





PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) AUTHENTICATED NEWS, (TOP RIGHT) THREE LIONS, (CENTRE) ČTK—CZECHOSLOVAK NEWS AGENCY, (CENTRE RIGHT, BOTTOM RIGHT) EASTFOTO, (BOTTOM LEFT) PETER SCHMID-PIX FROM PUBLIX

SCENES IN CZECHOSLOVAKIA

Top left: Lake Strbske Pleso in the High Tatra mountains of eastern Czechoslovakia near the Polish border

Top right: Iron- and steelworks at Kladno in Bohemia

Centre left: Karlstein castle, near Prague, founded in 1348 by King Charles IV (1316–78)

Centre: Grain harvesting in the Hana area, south Moravian region

Centre right: Atomic reactor at Rez, operated by the Czechoslovak Academy of Sciences

Bottom left: Karlovy Vary (Carlsbad), spa and resort town of western Czechoslovakia

Bottom right: Square and 16th century castle of Nove Mesto, northeastern Bohemian town along the Metuje river

of Bohemia, especially north and south of Plzeň, agnosticism has long been widespread and pronounced. Archbishop (later Cardinal) Josef Beran of Prague, primate of Czechoslovakia, was expelled from his see and interned from 1951 to 1963. Other bishops and priests were imprisoned or silenced but an edict of Oct. 2, 1963, removed restrictions on the personal liberty of the prelates. The courageous witness of many Roman Catholics in the face of atheistic Communism was possibly somewhat weakened in its effect by former associations of Roman Catholicism with Austrian repression. By the 1960s the churches in Czechoslovakia, as in all Communist countries, provided an unsolved problem. They seemed indestructible, but were divorced from public life and especially from education. Under the law of 1949 they are administered by a government bureau of ecclesiastical affairs and the state pays the salaries of ministers; religious instruction is provided in elementary schools for those wishing it. (H. G. S.)

IV. HISTORY

For the history of the Czechs before World War I *see* BOHEMIA; also MORAVIA. For the Slovaks *see* SLOVAKIA.

When World War I broke out in 1914 Czech and Slovak sympathies tended to be on the side of Russia and the Serbs and their western allies against the Central powers, while the Germans of Bohemia were zealous supporters of the Austro-Hungarian and German war effort. Both Czech and Slovak soldiers went over to the Russians in considerable numbers in the early days of the war. Many Czech civilians suspected of disloyalty to Austria were interned, and by 1916 several thousand had been shot. In May 1915 the eminent "Young Czech" leader and exponent of neo-Slavism, Karel Kramář, was arrested for high treason, and in July another Young Czech leader, Alois Rašin (*q.v.*), suffered the same fate: both were sentenced to death, but were not executed. Thus open political activity within the country came to an end.

Until the eve of the war, Kramář, like Tomaš Garrigue Masaryk (*q.v.*), had been loyal to Austria. Kramář had worked for an Austro-Russian alliance, while Masaryk was drawn toward the western democracies, but both men had hoped that the Austrian authorities would accept the fact that the majority of their subjects were Slavs and draw the—as it seemed to them—obvious conclusions. As soon, however, as Austria-Hungary was at war with Russia, Kramář began to think in terms of a Russian grand duke as king of the Czechs. Masaryk, who had little respect for tsarist Russia, happened to be in Switzerland toward the end of 1914. Learning that he would be arrested if he returned home he decided to remain abroad in order to present the Czech and Slovak case to the Allies against what he regarded as the anachronism of Austria-Hungary. In London and Paris few people had any real knowledge of Austro-Hungarian affairs, and those who had were inclined to regard Austria-Hungary as a necessary structure which should not be disturbed and which might be drawn away from its German ally by conciliatory gestures: indignation in both Great Britain and France was concentrated against Germany.

Czechoslovak Struggle for Independence.—In the autumn of 1915 Masaryk was joined in Switzerland by Josef Dürich, a member of the conservative Czech Agrarian Party, and by the young Edvard Beneš (*q.v.*). It was decided that Dürich should go to Russia, that Beneš should join the Slovak patriot Milan Štefánik in Paris, while Masaryk himself proceeded to London.

On Nov. 14, 1915, a manifesto was issued, signed by Masaryk and Dürich, by the leaders of the Czech colonies in the Triple Entente states (France, Great Britain, and Russia), and notably also by the Czechs and Slovaks in the United States. This was the first public pronouncement by the Czechs abroad against Austria-Hungary and in favour of the Entente and of the independence of a Czech and Slovak state. In January 1916 a Czechoslovak foreign committee, which had been formed earlier, was transformed into the National Czechoslovak Council, with Masaryk as its president, Dürich as its vice-president, and Beneš as its secretary-general; the Slovak representative was Štefánik. Its first big success came on Jan. 10, 1917, when, having been asked by the U.S. president, Woodrow Wilson, for a statement of their war aims, the Allies included among them the liberation of the "Czecho-Slovaks."

At first Masaryk and Beneš had been able to communicate with the Czechs at home only through their secret organization, the Maffia, but the death of the Austrian emperor, Francis Joseph I, in November 1916 and the beginning of the Russian Revolution in March 1917 transformed the situation. Charles, the new emperor of Austria, put an end to the severe military regime to which the country had been subjected and recalled the *Reichsrat* in May 1917. The Czech deputies immediately demanded "a federal state of free national states with equal rights" and declared "before the whole world the Czech people's will to freedom and independence." Just before this, 222 Czech men of letters had signed a manifesto in favour of what they thus believed to be their national rights.

Though many Czech and Slovak prisoners in Russia were impatient to fight for their cause their hopes were constantly deferred until on July 2, 1917, they were at last able to fight in the Battle of Zborów in Galicia. By this time Russia was collapsing and it was important that the Czech troops should not be lost in the general confusion. Masaryk, who had left London for Russia in May 1917, managed to obtain recognition of the independence of the Czechoslovak forces in Russia in the following October, but the Bolshevik Revolution in November reopened the whole question. On Dec. 19, 1917, the French government agreed to the establishment of an independent Czechoslovak army on French soil and it was decided that the Czech and Slovak soldiers in Russia should be transferred across Siberia to France. In May 1918, probably thanks to German pressure, L. D. Trotski, the Soviet commissar for war, issued an order for their disarmament, which, much against Masaryk's will, led to serious Czech-Russian hostilities. In these, however, the Czech legionaries were able to distinguish themselves. Meanwhile, after Italy's defeat at Caporetto in October 1917, the Italian government no longer blocked the aspirations of the Croats, Serbs, and Slovenes with whom the Czechs and Slovaks felt such strong solidarity. In April 1918 representatives of all the subject peoples of Austria-Hungary were invited to a congress in Rome and the Italian authorities agreed to the enrollment of Czech and Slovak prisoners of war in a Czechoslovak legion in Italy. By this time Masaryk estimated the Czechoslovak forces mobilized in the service of the Allies at 128,000 (92,000 in Russia, 12,000 in France, and 24,000 in Italy).

Masaryk left Russia in March 1918 in order to travel to the United States via Japan; he arrived in May. Through his American wife he had useful connections there, and, since President Wilson had begun to take the lead with the Fourteen Points (Jan. 8, 1918) in delineating the future peace settlement, it had become vital to exert all the influence that he could bring to bear in Washington. In Pittsburgh (Pa.) on May 30, 1918, Masaryk attended a meeting of American Czechs and Slovaks and there signed a statement in favour of the political union of the Czechs and Slovaks, which, however, provided that the Slovaks should have a separate parliament, administration, and courts of law. Masaryk regarded this as "a local understanding between American Czechs and Slovaks upon the policy which they were prepared to advocate." Later it was quoted as the "Pittsburgh Treaty" and led to grave dissensions between Slovaks and Czechs.

Masaryk was fortunate in his young lieutenants, Beneš, Štefánik, and an American Slovak, Stefan Osuský, who worked in Geneva from 1916 onward. These younger men kept in touch with the French, British, and Italians and with the Czechs at home. Beneš helped to instigate the Epiphany Convention on Jan. 6, 1918, in Prague, which was attended by all the Czech members of the *Reichsrat* and of the diets of Bohemia, Moravia, and Silesia and by other prominent Czechs. The proceedings concluded with a demand for a sovereign state "within the historic frontiers of the Bohemian lands and of Slovakia." On April 13 a national vow was made at a meeting of notables in Prague, in the presence of Croat and Slovene delegates, to persist to the end in the struggle for national independence. On May 16 the foundation of the National Theatre in Prague was celebrated with Kramář, reprieved and released, presiding, in the presence of representatives of the other subject races of Austria-Hungary. In the same month the Slovaks

in Hungary felt strong enough to declare their hand. At a meeting of the Slovak National Party "a share in the creation of an independent state to consist of Slovakia, Bohemia, Moravia, and Silesia" was claimed: Father Andrej Hlinka pressed for "the Czechoslovak orientation." Thus Masaryk had the support that he needed in order to urge his policy upon the U.S. government.

Czechoslovak State Recognized.—When on May 29, 1918, the U.S. government approved the anti-Austrian resolution passed by the Congress of Oppressed Nations in Rome, the Allied War Council at Versailles associated itself with this proclamation (June 3, 1918). The first country to recognize the National Council as the leading body of the Czechoslovak movement and also of the army that was fighting on the side of the Triple Entente was France (June 29, 1918). The next day Pres. Raymond Poincaré handed over the colours to the 1st Czechoslovak regiment at Darney, France, and on the following day the British government expressed its agreement with the speech made by Poincaré on that occasion. By a declaration on Aug. 9, 1918, the British government recognized the Czechoslovaks as an Allied nation, the three Czechoslovak armies as a single Allied army carrying on regular warfare against Austria-Hungary and Germany, and the National Council as the supreme body controlling national interests. On Sept. 3, 1918, similar recognition was obtained from the U.S. government.

On Oct. 14, 1918, Beneš notified the Entente states of the establishment of an interim Czechoslovak government in Paris with himself as minister for foreign affairs. This interim government was recognized by France on Oct. 15 and by Italy on Oct. 24, while on Oct. 18 the interim government itself proclaimed the independence of the Czechoslovak nation by a declaration dated from Washington, D.C.

The capitulation of Austria-Hungary took place in the night of Oct. 27–28. On Oct. 24 Kramář and other leading Czech deputies had already obtained permission from the emperor to proceed to Geneva for the purpose of conferring with Beneš and Osuský there. The National Committee at Prague, however, did not await their return but drew its own conclusions from the Austrian capitulation. On Oct. 28, by its first law, it proclaimed the independence of the Czechoslovak state, taking into its hands the administration of the Czech territories without encountering any considerable opposition from the army or from the authorities. Two days later, on Oct. 30, by a manifesto of the Slovak National Council at Turčianský Svatý Martin, Slovakia pronounced itself in favour of Czechoslovak unity.

The conferences at Geneva also gave the new state its definite form of a democratic republic. On Nov. 13 the National Committee issued an interim constitution, and a day later there was a meeting of the Czechoslovak National Assembly, constituted in accordance with the proportional numerical strength of the individual political parties, containing 256 (later 270) members, of whom 44 were Slovaks. There were no Germans among them, the German representatives having refused participation. At this first meeting of the National Assembly Masaryk was unanimously elected the first president of the Czechoslovak republic, and on the basis of the interim constitution the National Assembly elected its first government. The prime minister was Kramář, the foreign minister Beneš, and the minister for war Štefánik (later killed in an air accident in May 1919). On Dec. 21 the president returned to Prague.

A. The First Republic (1918–38)

Geography forced upon the new Czechoslovak republic the racial problems of old Austria-Hungary in reverse. In the formerly Austrian provinces of Bohemia and Moravia the Czech majority, about 6,500,000, was now in command, with 3,100,000 Bohemian and Moravian Germans who were unwilling to be reconciled to the new state. The German leaders tried at first to attach themselves to the new republic of Austria. On March 4, 1919, the day when the Austrian Parliament assembled, there were serious clashes between the Bohemian Germans and the Czech police with 52 Germans killed and 84 wounded. However, the treaties of Versailles (June 28, 1919) and St. Germain (Sept. 10, 1919) established the new frontiers, making a few slight adjustments in favour of the Czechs. In formerly Hungarian Slovakia and Ruthenia the Hungarians had to be driven out, and it was not until June 4, 1920, that they were obliged to sign the Treaty of Trianon by which they finally acknowledged their loss. On this side the frontiers were drawn so as to leave about 700,000 Magyars under Czechoslovak rule. But the Magyars were not the only problem presented by the eastern provinces of the new republic. The 2,000,000 Slovaks, although their language had remained similar to that of the Czechs during their subjection to the Magyars for nine centuries, were mostly backward peasants with but a tiny educated class. And whereas the Czechs were on the whole anticlerical, the Slovaks were mostly devout Catholics. Still more remote Ruthenia, with a highly mixed population of about 600,000, the majority Ukrainian, emerged from Hungary in a state of economic neglect and illiteracy.

For the moment the Czechoslovak provisional government had more urgent questions with which to deal. Four years of war followed by the disintegration of Austria-Hungary had spelled economic collapse throughout central Europe. At the same time the swing of opinion, as was shown in the Czech municipal elections of June 15, 1919, was strongly to the left, in favour of socialist solutions. The concentration of land in the hands of German and Hungarian aristocrats under the Habsburgs was quickly attacked, and a first and long-overdue land measure was enacted on April 16, 1919. According to this no one as a general rule might retain more than 150 ha. of arable land or 250 ha. altogether.

Immediately beforehand, at the end of February, Rašin, now Kramář's minister of finance, had called in the old Austrian paper money; the notes were stamped with their Czech value and in part reissued. Those who had possessed a notable capital sum were reimbursed after the deduction of a levy on their capital. At the same time, if they were landowners whose land had been partly expropriated, they received money compensation. On the whole the operation was successful; the amount of paper money in circulation was reduced and a sound currency established.

1. Constitution of 1920.—The constitution voted on Feb. 29, 1920, created a centralized, not a federal, state. Legislative power was vested in a bicameral parliament elected by "universal, equal, direct, and secret suffrage on the principle of proportional representation." Whereas the chamber of deputies with a maximum life of six years was to have 300 members (minimum age 30) chosen by citizens over 21, the senate with a maximum life of eight years was to contain only 150 members (minimum age 45) elected by citizens over 26. The government was to be responsible only to the chamber of deputies, which could also veto the senate's suggestions; on their part, three-quarters of the senators could veto the wishes of the chamber if the latter were supported by fewer than three-fifths of the deputies. The president was to be elected by both houses in joint session every seven years.

At St. Germain, Czechoslovakia had acceded to a minorities treaty intended to protect minorities in the new states. The obligations thus undertaken were incorporated in the constitution of 1920 and in a special language law passed at the same time. In fact the Czechs added to the general obligations assumed under the minorities treaty a promise to provide their minorities with higher as well as other education. Though emphasis was laid upon Czech as the language of the state, wherever a minority comprised 20% or more of the local population the minority language could be used in the courts, and minority schools were to be provided. The constitution allowed only threats to the security of the state to stand in the way of minority rights. On the whole the first Czechoslovak republic misused the security plea relatively little and treated its minorities well; it was unfortunate in having an unusually large and well-off minority in the Sudeten Germans (as they were beginning to be called) and one which belonged to the potentially most aggressive racial group in Europe—67,000,000 Germans being citizens of a neighbouring state of a great-power status.

The constitution of 1920 incorporated a statute providing autonomy to Subcarpathian Ruthenia; but, although a special governor was appointed to Ruthenia and a diet established there, in practice Ruthene autonomy was constantly postponed, Ruthenia

in fact being very efficiently ruled by Czech officials. For on the one hand the Ruthenes themselves entirely lacked a competent personnel and on the other the Czechs doubted their loyalty.

2. The "Pětka" Governments.—A general election was held in April 1920 in accordance with the new constitution. The five chief parties that went to the polls had for some time formed a standing committee called the *pětka* (group of five). They were all prewar parties: the Czech National Socialists, the People's (Catholic) Party led by Msgr. Jan Šrámek, the Agrarians, the Social Democrats led by Vlastimil Tusar, and the National Democrats (Kramář's Young Czechs). The Agrarian Party, for which the Czech peasants mostly voted, and the Socialists emerged as the two big political forces. A few months later the left-wing Socialists split off to form the Czechoslovak Communist Party. This put the Agrarians in the strongest position of all, the more so thanks to their able leader, Antonin Švehla, whose political experience went back many years and who showed dexterity in dealing with the other parties of the *pětka*. Švehla became prime minister in October 1922 and established a system of coalition government which was firmly rooted by the time of his retirement in 1929; he was prime minister with scarcely a break throughout these seven years.

His opposite number, Masaryk, who with Beneš was then associated with the urban and socially progressive Czech National Socialist Party, was formally elected president of the republic on May 27, 1920. He was reelected in 1927 and remained at the head of the state until in December 1935, at the age of 85, he retired.

The prosperity of the later 1920s contributed to a political *détente* in various sectors of Czechoslovak life. In October 1926, after Socialist losses in the general election of 1925 had caused the Social Democrats to withdraw from the government, two Sudeten Germans at last agreed to enter Švehla's new cabinet. In January 1927 a Slovak autonomist, Father Josef Tiso, did the same. The relations between Czechs and Slovaks had been made difficult by a split in the Slovak ranks.

3. Slovak Autonomists.—Most members of the educated class in Slovakia, men like Vavro Šrobar and Milan Hodža who had taken command in 1918, favoured unification with the Czechs so that the full meaning of the name Czechoslovakia should be realized. But the biggest single party (it never polled more than 40%) in Slovakia, the People's (Catholic) Party led by Hlinka and supported by the peasantry, claimed administrative autonomy for Slovakia. The quarrel was embittered by the fanatical eagerness of the Hungarians to win back all the lands which they had formerly ruled, so that Magyar intrigues played up all possible friction between Slovak and Czech. Hlinka himself went dangerously far in associating himself with two Slovak agents of Hungary, Father Ferenc Jehlička and Béla Tuka, the latter of whom was finally brought to trial in 1929 and, having been proved to have been in Hungary's service, was sentenced to 15 years' imprisonment.

While Hlinka and his party seemed to the Czechs to be traitors to the republic, the new state appeared to be an overcentralized and godless institution to the Slovak Catholics. When the quarrel was so far patched up as to allow Tiso to join the cabinet the Czechs had, however, begun to take steps to answer Hlinka's indictments. In the first place, the local government of the whole country was reorganized by a law passed in July 1927; in accordance with this law each of the four regions (Bohemia, Moravia, Slovakia, and Subcarpathian Ruthenia) was given restricted powers of self-administration through a president, vice-president, elected assembly, and executive committee of which two-thirds were elected, the remaining one-third being nominated by the government in Prague. Second, early in 1928 the Czechoslovak government reached a *modus vivendi* with the Vatican by which a satisfactory compromise was achieved over questions outstanding between church and state.

4. Foreign Affairs.—The foreign policy of the first Czechoslovak republic enjoyed the continuity, unusual in a democratic state, of being directed by the same person throughout its career. Beneš was the pupil of Masaryk and was foreign minister from 1918 until, on Dec. 18, 1935, he succeeded Masaryk as president. With his own successor, the historian Kamil Krofta, he continued to direct foreign affairs to the end. Masaryk–Beneš policy was essentially western in character; since Great Britain would make no continental alliances and France in the 1920s was eager to ally with the successor states, it was with France, on Jan. 25, 1924, that Czechoslovakia made its most important alliance. Beneš, naturally, was a champion of the *status quo*, which he hoped to fortify by the extension of the power of the League of Nations—he was one of the most active figures at Geneva in its heyday. The enemy of the peace treaties in central Europe was Hungary; it was to curb the revisionism of the Magyars that Beneš, by agreements first made in 1921 and 1922, allied himself with Rumania and Yugoslavia, both of which embodied much former Magyar territory. This alliance was always referred to as the Little Entente (*q.v.*). It should be added that the Slovaks, whose discontent was exploited by the Hungarians against the Czechs, were more violently anti-Magyar than the Czechs (it was they who had suffered from magyarization in the years before 1914); this was true for many years of the majority of the followers of Hlinka. The only obvious failure of Beneš as foreign minister was to be found in Czechoslovak relations with Poland. Apart from the fact that Czechs and Poles had squabbled for many years before, the Poles could never forgive the compromise by which the highly industrialized territory of Teschen (Těšin or Cieszyn) in Silesia had been divided between them on July 28, 1920.

Although Beneš was never popular in Germany he was not on bad terms with the rulers of the Weimar Republic. To some extent this facilitated the activist policy of the more moderate Sudeten German parties which began in 1926. Elections held toward the end of 1929 strengthened the Socialists, both Czech and German, once again; and a German Social Democrat, Ludwig Czech, became minister of social welfare under the new Czech Agrarian prime minister František Udržal, who was succeeded by Jan Malypetr in 1932.

5. Rise of Naziism.—The halcyon period of prosperous cooperation was gradually obscured by the great depression which culminated in 1931 in the collapse of the biggest Austrian and German banks upon which central and eastern European industry still largely depended. As the economic situation worsened, Hitlerism grew: it was a German–Austrian state of mind that was almost new in northern Germany but that had been alive among the Germans of Bohemia since 1848. There had been a German Workers Party in Bohemia before 1914 and it continued in Czechoslovakia after 1920 as a branch of Hitler's party in Bavaria; eight Nazi deputies were elected in 1929 by the Sudeten Germans to the Czechoslovak Parliament. The young Bohemian Nazis were formed into what was called the Volkssport organization, which sent its representatives to the Nazi Party rally at Nürnberg in 1929—indeed the Bohemian Nazis made it clear, as they had before 1914, that they aimed at the incorporation of large parts of the Czechoslovak republic in Germany. In 1932 seven members of the Volkssport were tried by the Czechs for conspiring against the republic and condemned in 1933 to a year or so of imprisonment. In October 1933 in order to forestall their official suppression the Sudeten German Nazi Party and also the Nationalist Party dissolved of their own accord. By this time Hitler had been chancellor of the German *Reich* for nine months, and the aggressive face of Nazi Germany exacerbated relations between the Czechs and the nationalist Sudeten Germans. The Socialist and Clerical Sudeten Germans, who were anti-Nazi, were still represented in the government, but they were regarded with suspicion from both sides and the number of their followers declined.

The situation was envenomed because the predominantly Sudeten German districts were highly industrialized and their industry was of the kind most vulnerable in a slump. Consequently the rate of unemployment was higher among the Germans than among the Czechs. Czech–German relations also suffered from the fact that the Sudeten Germans were concentrated in the fortified regions flanking the German frontiers. From 1933 the Czechs not unnaturally took refuge in special security measures in the frontier districts; this inevitably curtailed the liberties of the German-speaking population and, like their unemployment, was duly exploited by Nazi propaganda.

Urged on by the economic crisis and by *Reich*–German in-

fluences a number of persons began to canvass the political union of all the Sudeten Germans under the leadership of Konrad Henlein, a hitherto obscure bank clerk and gymnastics teacher. This movement was launched on Oct. 1, 1933, as the Sudetendeutsche Heimatfront and it soon became evident that the Nazis and Nationalists would reassemble within it. From the beginning of 1935 the Heimatfront (later called simply the Sudeten German Party) began to disseminate propaganda of a frankly Nazi and violently anti-Semitic kind in preparation for the Czechoslovak elections to be held on May 19 of that year. While declaring himself loyal to the Czechoslovak state, Henlein's attitude to democracy was more than dubious, and he insistently demanded a reversal of Czechoslovak foreign policy. Instead of support of the League of Nations and the French alliance and Little Entente, he asked for a reorientation toward Nazi Germany. It so happened that the elections in Czechoslovakia were immediately preceded by a treaty between Czechoslovakia and the U.S.S.R., a move in the opposite direction which the Nazis, in Germany and beyond, were able to interpret with fantastic distortion as the selling of Europe to Bolshevism. In point of fact the Czechs had first recognized the Soviet regime in the previous summer, and their treaty with the U.S.S.R. committed them only to join France if the French should decide to come to the help of the U.S.S.R. were it attacked.

When the voting took place in Czechoslovakia on May 19, 1935, there was little change among the Czechs, but 1,249,530 Sudeten Germans (nearly two-thirds of the Sudeten German population) voted for Henlein, whose party thus became the biggest single party in the republic. For the moment Henlein and his friends restricted their demands to an ill-defined autonomy. In view of the revival of conscription in Germany (March 1935) and the whole Nazi trend, Beneš initiated his presidency by a drive toward strengthening Czechoslovak defense. After Hitler had remilitarized the Rhineland (March 1936) a Czechoslovak defense law was passed, and the country's fortifications were extended. At the same time the president determined to give more serious attention to valid Sudeten German grievances. It was true that the German-speaking districts were largely, though not exclusively, administered by Czech officials and police, who spoke poor German and often ignored minority rights. Since Nov. 5, 1935, Hodža, a long-standing Slovak leader and a good linguist with many-sided connections, had been prime minister; he seemed a suitable person to embark upon conciliatory negotiations. On Feb. 18, 1937, an agreement was made by Hodža with the anti-Nazi Sudeten German leaders who still cooperated with the Czechoslovak government, an agreement by which the minority obligations of the latter were to be more generously implemented. In collusion with Berlin, Henlein always rejected what the Czechs offered and demanded what they were bound to refuse; a climax seemed to be reached when at Karlovy Vary in April 1938 Henlein asserted the right of the Sudeten Germans to profess Hitler's national socialism as a political faith, although it clearly ran counter to the democratic constitution of Czechoslovakia.

6. The Runciman Mission and Munich Conference.—Already on Nov. 5, 1937, Hitler had secretly informed his military leaders of his intention to seize Austria and Czechoslovakia (the two comprising a single unit in his mind) at the earliest opportunity, and on March 12, 1938, the Germans annexed Austria. This made the situation of Czechoslovakia precarious, and many of the non-Nazi Sudeten Germans quickly joined Henlein. From this time the Sudeten German Party redoubled its encouragement of the discontent of Hlinka and his followers in Slovakia and of all other groups within the republic which were in any degree hostile to Beneš and Hodža. Fearing a German attack at any moment, Beneš ordered a partial mobilization on May 20. Thereupon, on May 30, the infuriated Hitler signed a secret directive for Czechoslovakia to be smashed by military action by Oct. 1, 1938, at the latest. In the mounting tension the British government sent a mission headed by Lord Runciman, who arrived in Prague on Aug. 3, to mediate between Henlein and the Czechoslovak government. Since Henlein had orders from Berlin not to come to terms, all negotiation became merely farcical. On Sept. 12, at the Nürnberg rally of the Nazi Party, Hitler delivered a furious attack upon Beneš, and on Sept. 15 Henlein with many of his followers fled to Germany; other Sudeten Germans, realizing how the Nazis had deceived them, rallied to Prague. At this point Hitler indirectly received unintended British support when Neville Chamberlain flew to Germany to see him. He dealt with the British prime minister rather as Henlein had dealt with Hodža, and on Sept. 28 war seemed inevitable, with the western powers and the U.S.S.R. coming to Czechoslovakia's aid. On Sept. 22 Gen. Jan Syrový, the inspector general of the Czechoslovak Army, had succeeded Hodža as prime minister, and the Czechs prepared for battle.

On Sept. 28, however, Chamberlain appealed to Mussolini who suggested a conference of the heads of the governments of Germany, Italy, Great Britain, and France. Without consulting the Czechs (or the U.S.S.R.), Hitler, Mussolini, Chamberlain, and Edouard Daladier signed an agreement at Munich early on Sept. 30, 1938, by which Czechoslovakia was forced to cede to Germany all those districts of Bohemia and Moravia which had had a 50% or more German-speaking population according to the Austrian census of 1910. The cession had to be carried out by Oct. 10. In fact the German officers on the executive commissions annexed many other small sectors which they claimed as strategically necessary. Meanwhile, both Poland and Hungary had put in their claims. Teschen was ceded to the Poles without foreign intervention, but it was the German and Italian foreign ministers who drew the new frontiers between Slovakia and Hungary by the Vienna award of Nov. 2, 1938. Thus Czechoslovakia was deprived of about a third of its population, 3,576,719 inhabitants going to Germany, 992,496 to Hungary, and 230,282 to Poland. These figures included about 1,200,000 Czechs and Slovaks allotted to the neighbouring states with no minority rights at all. France and Great Britain made an ineffectual attempt to guarantee what was left of Czechoslovakia, but this only increased the bitterness felt against the west by the Czechs.

B. The Second Republic and the German Protectorate

Beneš resigned on Oct. 5 and left the country. German pressure permitted the Slovak and Ruthene autonomists to have their way and a federal Czecho-Slovakia, with a semi-independent Ruthenia attached to it, was established. The latter territory, with Father Augustin Volosin as premier, was advertised all through the autumn as the cradle of Ukrainian nationalism, but it was swallowed up by Hungary in March 1939 before it emerged from its initial chaos.

In Prague on Nov. 30, 1938, Emil Hácha, president of the supreme administrative court, was elected successor to Beneš. A new cabinet was appointed under the Agrarian Party leader Rudolf Beran, who had flirted with Henlein in order to make difficulties for Beneš; a pro-German diplomat, František Chvalkovský, was made foreign minister. In the future, it was stated, only two parties would be allowed, the Party of National Unity on the right and the Party of Labour on the left. The most powerful political figure in the country was Ernst Kundt, the leader of the then considerable and dominant German minority based on Prague.

German Annexation.—Hitler, who always intended to annex all Bohemia and Moravia, was merely annoyed by the delay caused by the Munich agreement. He ordered his agents to stir up both Slovaks and Ruthenes against the government in Prague, and he summoned Hácha and Chvalkovský to Berlin on March 14, 1939, where they were informed that Prague would immediately be destroyed from the air unless they surrendered the Czech territories to him. On March 15 the rump of Bohemia and Moravia, with the big Skoda armaments works, was occupied by the German Army, and Hitler appeared in Prague. On the following day he issued a decree by which the newly seized territories became a protectorate of the *Reich*. On April 5 Konstantin von Neurath arrived in Prague as *Reichsprotektor* accompanied by Karl Hermann Frank, the most ferocious of the Sudeten German leaders, as state secretary.

World War II.—At the outbreak of hostilities a conference was held in Neurath's office on Oct. 9, 1939. The Germans decided upon a policy by which the Czech intellectuals and others who resisted the Nazis should be liquidated, but the rest were to be

assimilated chiefly by sending them to work in Germany. The Czech army was already disbanded. A student demonstration three weeks later caused the Germans to suppress all higher and secondary education for Czechs. When Hitler attacked the Soviet Union in June 1941 the Czechs, although the German police gave them little scope, were obviously restless. Thereupon in September Neurath was replaced by Heinrich Himmler's right-hand man, Reinhard Heydrich, notorious for his cruelty. Summary courts under German Gestapo presidents were set up and hundreds of Czechs were condemned to death or sent to concentration camps.

Meanwhile Beneš and Masaryk's son Jan, with most of the former leaders, had established themselves as a provisional government in London until July 1941 when Great Britain and the U.S.S.R. accorded them full recognition. With British help it proved possible to murder Heydrich on May 27, 1942. The Nazis retaliated with savage mass executions. On June 10 they killed all the adult male inhabitants of a village called Lidice (*q.v.*) and razed it to the ground; the women were sent to concentration camps and the children disappeared. For the next two years there was little change; the Czechs reaped some comfort from the German defeat at Stalingrad and from the news that Beneš was in Moscow in December 1943; on Dec. 12 he signed a Czechoslovak–Soviet treaty of alliance for 20 years.

During the first half of 1944 the Soviet armies, with some Czechoslovak contingents, pushed forward into Ruthenia. A Czechoslovak brigade and three air force squadrons were also serving with the British. In spite of the unprecedented prosperity which the Germans had allowed "independent" Slovakia to enjoy they became ever more unpopular among the Slovaks as the war progressed. On March 13, 1944, the Czechoslovak government in London appealed especially to the Slovaks and Ruthenes to rebel against the Germans. Late in July a Slovak national council prepared the final plan for an uprising which took effect at Banska Bystrica on Aug. 28 and continued until the end of October. The Russians, as elsewhere, arrived too late to save the Slovak partisans, who had been joined by many Czechs, from the Germans. From the beginning of 1945 the Soviet armies advanced more speedily. In March, Beneš left London and, traveling via Moscow, was able to establish a provisional Czechoslovak government at Košice in Slovakia on April 3, one day before the liberation of the Slovak capital Bratislava. On May 4 the population of Prague began to demonstrate against the Germans, whose general in command there capitulated on May 8. However, German planes from elsewhere bombed Prague after the capitulation, and it was not until May 11 that the Russians arrived. Beneš returned to Prague on May 16, 1945.

C. The Third Republic

While still at Košice, Beneš appointed a provisional government with Zdeněk Fierlinger, former diplomat and left-wing Socialist, as premier. His cabinet consisted of seven Communists (of whom three were Slovaks), two other Socialists, three Czech National Socialists, three Czech Populists, and three Slovak Democrats, together with Jan Masaryk as foreign minister and Gen. Ludvik Svoboda as defense minister. The general had Communist sympathies, but more important was the nomination of the Communist Václav Nosek to be minister of the interior with control of the police.

At Košice also, Beneš and Fierlinger worked out a general program based roughly upon a highly socialized economy and a "national state" without privileged minorities. On returning to Prague the most important requirements of the Košice program were carried out by decree, in particular by the decrees of Oct. 24, 1945, which nationalized the key industries and banking. A proclamation of June 18, 1945, announced that Germans and Magyars who could not prove that they had been active anti-Fascists before or during the war were to be expelled; the United States, British, and Soviet governments approved this decision at Potsdam on Aug. 2, 1945. By the end of 1946 the mass of the Germans had fled or were deported; after this the 165,000 who remained were absorbed as Czechoslovak citizens. The Košice program also emphasized the Soviet alliance. In June 1945 the Poles, through Soviet pressure, restored to the Czechs that part of Teschen which had changed hands in October 1938; on June 29, 1945, it was announced in return that Subcarpathian Ruthenia had become a part of the Ukrainian Soviet Socialist Republic. These changes altered the nature of the Czechoslovak state. The formerly Sudeten German areas were colonized by Czech and Slovak peasants. Though the Czechs composed more than two-thirds of the population, the percentage of Slovaks in the country had about doubled by the early 1960s.

A provisional assembly elected by local anti-Fascist committees, which had formed as the country was liberated, met on Oct. 28, 1945, and functioned until a constituent assembly was elected on May 26, 1946. The five chief parties then polled as follows: Communists 2,695,915; Czech National Socialists 1,298,917; Populists 1,110,920; Slovak Democrats 988,275; and Social Democrats 905,654. A new government was appointed with the Communist leader Klement Gottwald as prime minister; otherwise there were only a few unimportant changes among ministers. The first big measure put to the new constituent assembly was a two-year economic plan, essentially a recovery program. This was signed by the president on Oct. 29, 1946, and came into operation on Jan. 1, 1947. It was the year of the drought which hit Czechoslovakia with particular severity. The offer of aid under the European Recovery Program in June 1947 was therefore of great interest to the Prague government, which, however, was informed by the Soviet government that for the Czechs to go to Paris to discuss the U.S. project would be incompatible with their alliance with the U.S.S.R.

Although the voting in May 1946 had shown the Communists to be the strongest party among the Czechs, there was much indignation over the Soviet veto and opinion veered in the other direction so that the situation grew increasingly tense. Within the cabinet a conflict developed over the action of Nosek in substituting Communists for non-Communists in the police force. On Feb. 20, 1948, 11 anti-Communist ministers resigned in protest. The Communists thereupon brought out police reserves from outside Prague and their own action committees, chiefly trade union members; newspapers hostile to them were suppressed, student demonstrations crushed, and many people arrested. After several critical days, on Feb. 25 Beneš gave way and accepted a new Gottwald cabinet without anti-Communists. Jan Masaryk had remained at the foreign office and on March 10 his dead body was found—it was never known whether he had been murdered or had killed himself. He was succeeded by his Communist deputy, Vladimir Clementis, a Slovak.

The Communists had expected to poll well in Slovakia in May 1946; for this reason they began by supporting Slovak autonomy. But after the 1946 election their opponents were dominant in Bratislava; hence on March 2, 1948, the Slovak trustees in that city were deposed and Slovakia was subjected to Prague. On April 18 the Social Democrats, the last major party to survive, merged with the Communists. In the elections held on May 30, 1948, the voters had no choice between voting for a national front which polled 6,431,963 votes and spoiling their papers as 1,573,924 persons did. The new constitution, establishing a "people's democracy" but democratic only in appearance, had been unanimously accepted by the constituent assembly on May 9, but Beneš refused to sign it. He resigned on June 7 and died three months later. The constitution was immediately ratified by the new president, Gottwald, who was succeeded as premier by the trade union leader Antonin Zápotocký, with Rudolf (Salzmann) Slanský, secretary-general of the Communist Party of Czechoslovakia, as vice-premier.

In 1949 relations between the regime and the Roman Catholic Church became strained, and the archbishop of Prague, Josef Beran, was first confined to his palace and later interned at an unknown place. A five-year plan was launched to run from January 1949 to the end of 1953. As its aims were raised in 1951, the difficulties became manifold and the hunt for scapegoats steadily intensified. Clementis, who had been in London during the war, was disgraced and arrested toward the end of 1950. A greater impression was made when Slanský, a trained Muscovite, was arrested in November 1951, and the political trials seemed to culminate in that of Slanský and his associates in November 1952.

After particularly abject confessions, Slanský, Clementis, and nine others were condemned to death. On March 14, 1953, Gottwald died and was succeeded by Zápotocký with the Slovak, Vilem Široký, as the new prime minister. The currency reform of May 30, 1953, reduced real wages drastically and led to serious riots, particularly at Plzeň (Pilsen). Zápotocký died on Nov. 13, 1957, and was succeeded by Antonin Novotný, who retained, however, his position of first secretary of the Communist Party.

By the 1960s most of the farm land in Czechoslovakia was claimed for the "socialist sector"; the growth of agricultural production continued to lag behind that of industry. The relatively high standard of living, coupled with the firmness of the Communist leadership, made Czechoslovakia the model Soviet satellite; it became the chief supplier of engineering goods within the Soviet bloc. Further, the Czechs acquired importance as suppliers not only of industrial goods and skills to the underdeveloped countries of Asia and Africa but also of armaments, notably to Egypt. Their suspicion of the Federal Republic of Germany as the protector of the Sudeten Germans, many of whom claimed the Munich agreement still to be valid, caused Czech public opinion to accept Soviet leadership in foreign policy more or less readily.

On July 11, 1960, a new constitution was promulgated; the country's official title of People's Democracy was changed to Socialist Republic (Československá Socialistická Republika). Novotný explained that the new constitution marked Czechoslovakia's switch from the period of "building Socialism" to the "transition to Communism." (See *Administration and Social Conditions* below.)

The principal preoccupation of the country's leaders in the early 1960s was how to stop the general worsening of the national economy. Between 1951 and 1961 agricultural production increased only 20%. The rate of yearly industrial growth, supposed to be 10.5% according to the 1961–65 five-year plan, fell to 5.9% in 1962 when it was suspended. Protest marches against the regime, its foreign aid programs (20% of the Soviet bloc's total), and its alliance with the U.S.S.R. were symptomatic of the mounting discontent in 1963; the most vocal opposition came from writers, journalists, and students.

Some economic recovery and a mixture of concessions and admonitions enabled the Novotný administration to survive. On June 14, 1964, a new 300-seat National Assembly was elected; only one candidate was on the ballot paper for each seat, but more than 140 were newcomers.

Archbishop Josef Beran, created cardinal by Pope Paul VI, arrived in Rome on Feb. 19, 1965, but was not permitted to resume his functions in Prague. (E. Wi.; X.)

V. POPULATION

The movement of population within the Czechoslovak settlement area became conspicuous long before the formation of the republic in 1918. Within the Austrian Empire, migration in Bohemia and Moravia-Silesia took several forms. One was a steady growth of urban settlement based on manufacture and trade, giving the Czechoslovaks a lead over other Slavonic peoples and exemplified by the expansion of Prague, Plzeň (Pilsen), Brno (Brünn), and Olomouc (Olmütz). Rural population was densest in Polabí, around Žatec (Saaz) in Bohemia, and in the Haná lowlands on the Morava River. Considerable emigration took place to Vienna, the Vienna Basin, and the United States. In Slovakia, by contrast, there was a movement right out of the Carpathians, the Slovak peasantry going mainly to the New World and to a lesser extent as an immigrant proletariat to Budapest. Bratislava (Pressburg) remained largely a German and Magyar city.

Although the new republic spoke of "Czechoslovaks," combining Czechs and Slovaks in the 1921 and 1930 censuses, the two Slavonic majority peoples were far from identical. Moreover, more than one-third of the population were national minorities, chiefly Germans (23.4% in 1921) and Magyars (5.6%). The Czechs outnumbered the Slovaks by about three to one. The Czechoslovak state restored in 1945 lost about 798,000 people (mainly Ruthenes) from the cession of Subcarpathian Ruthenia to the U.S.S.R. (*See* Transcarpathian Oblast.) Violent death and deportation during World War II accounted for most of the Jews, of whom there had been more than 200,000 at the 1930 census. A much larger diminution was caused by the expulsion of about 3,250,000 Germans, chiefly from Bohemia and Moravia-Silesia, in fulfillment of the Potsdam agreement of Aug. 2, 1945. The population in 1938 (excluding Subcarpathian Ruthenia) was estimated at 14,609,102. In 1950 it was 12,338,450 and in 1961 was 13,745,577; but the net decrease after 1938 was offset by the much more homogeneous population. In 1961, 94% of the people were Czechoslovaks (66% Czech, 28.0% Slovak). In 1958 the birth rate at 16.0 per 1,000 was slightly below that of the years 1935–39 (average 17.1); the death rate was 9.7 per 1,000. The birth rate in Slovakia, however, was 22.3 per 1,000.

After World War II the main population movements were caused by attempts to fill the vacuum left by the expelled Germans and by an eastward migration into Slovakia associated with industry based on developing hydroelectric power. A secondary movement was from southern and northeastern Slovakia toward the expanding mining activity in Silesia. In 1961 Czechoslovakia had 119 towns with more than 10,000 inhabitants. The chief cities were the capital Prague (998,493), Brno (323,909), Bratislava (257,856), Ostrava (264,278), and Plzeň (141,583). Other major towns were Košice, Olomouc, and Liberec. (H. G. S.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—After World War II the democratic constitution was abandoned and replaced on June 9, 1948, by a Soviet-type constitution proclaiming that the Czechoslovak People's Democracy consisted of two fraternal nations: Czech and Slovak. The single National Assembly (*Narodni Shromaždeni*) of 368 deputies was elected for six years; a Presidium of 24 members remained in office when the National Assembly was in recess. The president, not less than 35 years old, was elected by the assembly for seven years; his powers were comparatively wide and he was also commander in chief of the armed forces. Technically in Slovakia there was a form of autonomous government consisting of a Slovak National Council (*Slovenska Narodna Rada*) of 104 deputies, serving for six years, and a Board of Commissioners. After the 1948 *coup d'état* (see *History* above) elections became an empty form.

The constitution adopted in 1960 proclaimed the "chief force of society and the state" to be the leadership of the working class by the Communist Party of Czechoslovakia. A National Assembly of 300 members, elected for four years from a single list of candidates chosen by the Communist-controlled National Front, elects a Presidium of 30 to direct affairs between sessions. The president, shorn of the right of veto and of the right to dissolve the assembly, is elected for a five-year term as head of state. In Slovakia administration is by the Slovak National Council, elected for four years and with its seat at Bratislava. Regional and district government is by local national committees, elected for four years, relying on the participation of the inhabitants and guided by the state economic plan. The constitution laid down that education and cultural policy should be "carried out in the spirit of scientific Marxism-Leninism" and it limited personal ownership to "consumer goods" and "savings acquired through work."

2. Regional Organization.—The old provinces were in 1948 replaced by 19 regions (*kraje*), of which 13 were in the České Země or Czech Lands (Bohemia and Moravia-Silesia) and 6 in Slovakia, containing about 200 districts (*okresy*). In 1960 the regions administered by regional national committees (*narodni vybor*) were reduced to 10 (*see* Table).

3. Education.—In the Czechoslovak Lands, school attendance between ages 6 and 14 was compulsory after 1869. The Austrian system of education was of a high standard, but in Slovakia education was neglected by the Hungarians and great efforts were made by the Czechoslovak republic to fight illiteracy there.

Education is government-controlled and free up to and including university level. By the early 1960s there were 6,950 nursery schools with 305,000 pupils; 12,050 basic nine-year schools with about 2,273,000 pupils; 396 general secondary schools with 95,000 pupils; and 705 vocational secondary schools with 255,000 pupils.

Before World War II there were two Czech universities—the

Administrative Divisions

Region (Seat of Regional National Committee in brackets)	Number of districts	Number of localities	Pop. (March 1, 1961, census)*	Area (sq.mi.)†	Density (per sq.mi.)†
Czech Lands					
Hlavní město Praha (City of Prague)‡	1	1	1,005,379	72	13,964
Středočeský (Prague)	10	1,568	1,269,195	4,362	291
Jihočeský (České Budějovice)	8	1,275	649,637	4,382	148
Západočeský (Plzeň)	8	965	828,676	4,195	198
Severočeský (Ústí nad Labem)	10	803	1,086,392	3,018	360
Východočeský (Hradec Králové)	11	1,465	1,199,808	4,345	276
Jihomoravský (Brno)	13	1,692	1,900,865	5,799	328
Severomoravský (Ostrava)	10	957	1,631,579	4,272	382
Slovakia					
Západoslovenský (Bratislava)	11	919	1,760,151	5,737	307
Stredoslovenský (Banska Bystrica)	12	1,110	1,301,011	6,938	188
Východoslovenský (Košice)	9	1,208	1,112,884	6,247	178
Czechoslovakia	103	11,963	13,745,577	49,367	278

*Population is *de jure*. †1 sq.mi. = 2.6 sq.km. ‡The capital, Prague, forms a separate administrative unit with a status equivalent to a region.

famous Charles (Karlova) University at Prague, founded in 1348, and Masaryk (renamed Purkyné) University founded at Brno in 1919—also the Slovak University, Comenius (Komenského) founded in 1919 at Bratislava, and the German University at Prague. After World War II the German University was closed, the Czech Palacký (Palackého) University was reopened at Olomouc in 1946, and the Slovak Šafařik University was founded in 1959 at Košice. By the 1960s there were also technical colleges at Prague, Plzeň, Liberec, Pardubice, Brno, Bratislava, and Košice; a college of mining and metallurgy at Ostrava; agricultural colleges at Prague, Brno, and Nitra; and a college of forestry at Zvoleň. There were in all more than 50 institutions of higher education with 112,000 students and a teaching staff of 11,500.

4. Health and Social Insurance.—There were, in the early 1960s about 250 hospitals with 108,000 beds, 50 tuberculosis sanatoria and mental hospitals, and more than 2,500 health centres. The number of doctors doubled after 1937, to about 25,000.

Social security was reorganized in 1948 by the National Insurance Act which guaranteed to all citizens the right to support in old age, illness, and disability. Extensive changes were made under the Act of 1956. In addition to old-age pensions and health insurance of all employees, workers, and members of the armed forces, provision was made for pensioners in case of illness and for other aspects of social protection, *e.g.*, care for persons with diminished working capacity.

The administration of the health insurance of workers is entrusted to the trade unions and to the Central Union of Producers' Cooperatives for its members. Social security is entrusted to the State Social Security Board. Health insurance benefits include treatment in hospitals and spas, cash benefits, and family allowances.

To be eligible for an old-age pension the insured person must have been employed 20 years and have reached the age of 60 (for women 55). Pension benefits are compiled on the basis of length of employment, average monthly earnings for the last 5 to 10 years of employment, and the employment category. After reaching 65 years (for women 60) the employee who continues to work receives a full old-age pension in addition to earnings.

The trade unions organize low-cost vacations for their members in various recreation centres.

5. Justice.—The Penal Code (revised in 1957) is similar to that of the U.S.S.R. Serious crimes are tried in the state courts and lesser offenses by local committees. The code provides heavier penalties for crimes against the state or state property than for those against individuals. Punishments include the death penalty, imprisonment, loss of civil rights, confiscation of property, and fines.

6. Defense.—In the first republic, military service was compulsory at age 20 and lasted for 2 years. During the crisis provoked by Germany in 1938, the Czechoslovak Army, which was considered a fine and well-trained force, never received the order to fight and after March 15, 1939, was disbanded; its armament fell into German hands. A number of Czechoslovak units fought with the Allied armies and air forces in World War II.

After the war, the Czechoslovak armed forces were reorganized on the Soviet model, being divided into the army, air force, anti-aircraft defense, and forces of the interior. The last-named were subdivided into frontier guards and security troops. The two-year compulsory military service was maintained, and in 1952 the age of conscription was lowered to 19 years. In the mid-1960s the strength of the army was estimated at 14 divisions and of the air force at 700 tactical aircraft. Czechoslovakia is a member of the Warsaw Treaty Organization (*q.v.*) which created a supreme command for the armed forces of the U.S.S.R. and its European satellite states. (K. Sm.)

VII. THE ECONOMY

The Czechs have long excelled among the Slavonic groups in the quality and vigour of their industrial production. In the 14th century, the golden age of medieval Bohemia, and again from the early 19th century onward, their manufacturing and trading competence stood out. It derived in the 19th century from the coal of Silesia and Plzeň, the lignite of the northwest, and the iron of Slovakia. It was also based on wealth which attracted labour and developed metallurgy and chemistry. Besides silver and gold, the resources included copper and graphite, quartz for Bohemian glass, and kaolin for porcelain. There also exists a wealth of timber and considerable farming possibilities on the lowland soils.

Before World War II the discrepancy between the Czechs and Slovaks in production and trade was conspicuous. The Czechs, more numerous, better educated, and with more capital, were the moving economic force. Within the Austrian Empire a wide range of manufacture and trade flourished in which, by 1914, Czech managerial and banking competence were plain. Between the two wars, when foreign markets were contracting, the Czechs sought to export goods embodying special skills: glass, jewelry, precision instruments, leather goods. They could not, however, maintain the earlier Hungarian investment in and development of Slovak mining. Also between the wars the remarkable footwear factory of the Bat'a family at Zlín (modern Gottwaldov) formed the nucleus of the present large state enterprise. During the German occupation the economy was completely disrupted and the natural resources were ruthlessly exploited with little regard to renewal of potential. The postwar phase was distinguished by large-scale nationalization, by a vigorous industrial development in Slovakia, and by a resumption of a wide range of manufactures. It was stimulated and indeed strained by the demands from eastern Europe and from farther afield by countries willing to trade with the Communist bloc.

The main feature of the manufacturing economy is the import of many raw materials—iron ore, oil, coal, material for the chemical industries, raw cotton, wool, and many foodstuffs. The chief exports are machinery, factory equipment in complete units, machine tools, chemical products, textiles, shoes, and glassware. By the 1960s signs of strain were beginning to appear in the form of decreased production rates in many segments of industry. Recognition of the liabilities attached to rigid and centralized planning with little heed to consumer interest appeared in the innovations of Prime Minister J. Lenárt's regime. The importance of quality as well as of production quotas and the noting of consumer tastes were taking the economy away from the initial strait-jacketed pattern which, indeed, was inconsistent with the independent shrewdness of Czechoslovak traditions.

The most noticeable rural postwar development was the nationalization of farming and forestry. Sugar beet and hops remain of substantial industrial importance both for home and export markets. In southern Slovakia increased attention is devoted to maize (corn) and tobacco growing and to pig farming.

The severest strain has been on the labour force. The expulsion of the Germans meant the loss of some of the best workers in the country, and the burden, upon the Czechs in particular, has been heavy, especially in forestry and the timber industries.

Industrial concerns with more than 500 employees were nationalized in October 1945 and those with more than 50 in April 1948. By the end of 1948, 96% of industrial employees belonged to the "socialized sector." Following a two-year reconstruction

plan begun in 1947, industrial development was directed by a series of five-year plans on the Soviet model, with emphasis chiefly on the industrialization of Slovakia and on increasing output from the heavy industry and engineering sectors. By the early 1960s industrial employees exceeded 2,500,000. However, the overall picture was of an active and skilled population, its urban and manufacturing element dominant, engaged to the limits of its capacity in satisfying home and export needs.

The 1961–65 plan was suspended in 1962 as impractical. By 1965 there was an attempt to break away from the "cult of the plan" and as an experiment certain aspects of capitalism such as price mechanism, wage incentive, and market competition were reintroduced. (H. G. S.)

1. Agriculture and Forestry.—In the early 1960s about 58% of the land was devoted to farming including 40% of the arable. The best lowland soils are allotted to sugar beet, wheat, hops, and barley. Pig rearing is also associated with these regions of good arable farm land, the production of pork being much greater than that of beef. On the higher and poorer soils rye, oats, and potatoes are the main crops. Beef and dairy cattle are kept throughout the republic. Sheep are raised chiefly in Slovakia. The professed aim of the Communist government is the collectivization of agriculture, involving a transition from small-scale peasant farming to modern large-scale methods. By the early 1960s there were more than 12,500 agricultural cooperatives farming about 60% of all farm land; cooperatives and state farms together held approximately 90% of all farm land.

The losses to agricultural production because of ideological insistence on collective and state structures appeared to have been considerable. It seemed unlikely, however, that official reconsideration in the mid-1960s of conventional Marxist objectives in economic practice would bring about any resumption of prewar prosperous family farming.

With forests covering about 34% of its area, Czechoslovakia, which is one of the few European countries with a rough balance between forested extent and timber requirements, ranks among the more richly wooded countries of Europe. Forests are owned and managed by the state; in the early 1960s the areas reafforested averaged 370 sq.mi. (958 sq.km.) annually. (*See* also *Vegetation* above).

2. Mining.—Bituminous coal is obtained chiefly from Ostrava and Karviná in Silesia, but the supply of coking coal for steelmaking is limited. Lignite is obtained chiefly around Sokolov, Most, and Chomutov in northwest Bohemia; these beds are among the best in central Europe. Iron ore is largely obtained in the eastern ranges of the Slovak Ore Mountains to the southeast of the Low Tatra, together with some copper, lead, antimony, salt, and gypsum. Lead, copper, and tungsten in limited quantities as well as pitchblende are mined in northwest Bohemia. Jachymov (formerly Joachimsthal) was for centuries a source of silver and later became important as a source of uranium. By the early 1960s the bituminous coal output exceeded 27,000,000 metric tons annually and lignite 65,000,000. Czechoslovak production of petroleum is inconsiderable. An agreement made at the end of 1959 between the U.S.S.R. and other countries of the Soviet bloc included provision for the supply of oil from the Volga fields to Czechoslovakia and Hungary by a pipeline through Uzhgorod (U.S.S.R.) and Bratislava, completed after 1963.

3. Power and Industry.—Most power stations in Czechoslovakia depend upon coal or lignite but by the early 1960s there had been substantial development of hydroelectric resources, particularly in Slovakia. The power output in million kilowatt-hours exceeded 28,000, compared with 12,363 in 1953. In the postwar period more than 30 dams were completed: these include the series of constructions on the Vltava River known as the "Vltava Cascade" of which the Orlik Dam is the most notable.

Iron and steel are produced in Bohemia at Kladno, Chomutov, Plzeň, and in the Prague district; and at Ostrava, Vitkovice, Třinec, and Kuncice in Silesia. The national output of pig iron in the early 1960s exceeded 5,000,000 metric tons and of crude steel 6,000,000 metric tons. Textiles, clothing, and leather are produced mainly in Brno, Prague, Bratislava, Gottwaldov, and in northern Bohemia. Jablonec nad Nisou, Teplice, Ústí nad Labem, and Karlovy Vary are the chief centres for glassware and ceramics. Heavy machinery and machine tools are made at Plzeň (site of the Skoda armament works), Prague, Brno, Bratislava, Gottwaldov, and Ostrava; chemicals are produced at Prague, Bratislava, and in the Ostrava district.

4. Trade and Finance.—In 1937 the U.S.S.R. supplied 1.1% of Czechoslovak imports and took 0.8% of exports, but by the early 1960s more than one-third of the imports came from the U.S.S.R., which also took almost the same proportion of Czechoslovak exports. In general, the greatest volume (about 70%) of foreign trade, which is a state monopoly, was with the U.S.S.R. and the people's democracies (German Democratic Republic, Poland, Hungary, and Rumania). Main exports were engineering equipment and machinery; main imports fuels, raw materials, and foodstuffs. After 1950 statistics of foreign trade were based on accounts of those 18 trade corporations to which the state monopoly in foreign trade was entrusted. The value of imports and exports is that at the frontier of the delivering country.

The whole internal trade network—wholesale and retail, including public catering establishments—is also state-controlled. In the early 1960s there were more than 75,000 retail shops selling food and consumer goods, the great majority of which belonged to the "socialist sector" and were administered by the ministry of internal trade or by the Central Union of Consumers' Cooperatives. Prices are fixed by the government which thus directly controls the consumption.

The first republic established an early equilibrium of state finances and a stable currency with the Czechoslovak crown (koruna) at about U.S. $1 = 33.3 koruny. The world depression compelled devaluation effecting a total depreciation of 30%, but the monetary position remained sound. During the German occupation more than one-quarter of the total production was taken by Germany and paid for with worthless bonds. After World War II the Czechoslovak government found a note circulation of more than 20 times that of 1938. There developed an inflation which was drastically cured by a "monetary reform" that deliberately annulled the value of cash savings. On May 30, 1953, the koruna was pegged to the Soviet ruble at 1.80 koruny = 1.00 ruble, compared with the previous rate of 12.50 koruny = 1.00 ruble. In the mid-1960s the koruna rate of exchange was 20.10 for £1 sterling, 7.20 for U.S. $1, and 8 for 1 new Soviet ruble.

Public finance is of the Soviet type, most capital for industry being provided through the budget; almost two-thirds of the expenditure is earmarked for investment in the national economy. By the early 1960s both the revenue and expenditure exceeded 125,000,000,000 koruny. More than 86% of the revenue consisted of dividends from profits of the nationalized industries and trade; only about 11% came from taxes paid by the citizens. Half of the expenditure was earmarked for investment in the national economy; almost two-fifths went to the cultural and social expenses; only 8.5% (officially) of the budget was spent on national defense and public security. All the banking and insurance is nationalized. (K. Sm.; X.)

5. Transport and Communications.—As a landlocked country in the heart of Europe Czechoslovakia's communication system has significance for much of the continent. The railways from Vienna and Budapest to Leipzig, Berlin, and Warsaw go through Czechoslovakia. The Czechoslovaks own and exploit considerable sections of the Elbe and Danube (*qq.v.*) international waterways. All transport facilities are nationalized.

Rail and road communications in Bohemia radiate from Prague, forming a pattern that has demanded some skill in engineering because of the gorge character of the valleys converging on Prague. The Moravian lowland carries trunk routes between western Hungary, the Vienna Basin, and Silesia, with Brno as a nodal point. Railways cross the North Carpathians to Poland by the Jablunkov Pass and by the Poprad Valley. The Váh Valley in the Carpathians forms the main passage through the highlands to the Danube plains. The total route mileage of railway in Czechoslovakia is 8,169 mi. (13,147 km.).

Since World War II the chief links of Czechoslovakia have been

with eastern Europe where the preoccupation has been with air transport. Prague (Ruzyne Airport), in particular, has become one of the main airline centres of central Europe.

The double orientation of Czechoslovakia is apparent in the pattern of its waterways, the importance of which rests in part on the landlocked character of the country. The rapid and winding courses of many Bohemian waterways, and of the Váh and Hron rivers in Slovakia, limit their usefulness to rafting timber. The convergence of rafting streams on the Vltava above Prague made a considerable timber port of the city. The upper Elbe is navigable for small craft up to Mělník, at its point of confluence with the Vltava; the Vltava in turn is navigable as far as Štěchovice, about 16 mi. (26 km.) above Prague. For about 107 mi. (172 km.) the Danube forms the southern frontier to Slovakia. By the 1960s river traffic—chiefly of long-distance bulky freight (timber, corn, building material, gasoline)—had steadily increased.

Radio, television, telephone, and telegraph services are government monopolies.

See also references under "Czechoslovakia" in the Index.

(H. G. S.)

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CZECHOSLOVAK LITERATURE. The beginnings of vernacular writing in what is now Czechoslovakia are connected with the mission sent to Moravia in 863 by the Byzantine emperor Michael III at the request of Prince Rostislav. Christianity had reached the Slavs of Moravia from the west under the political aegis of the Frankish empire; in order to counter Frankish (*i.e.*, German) influence Rostislav, prince of Great Moravia, sought "a bishop and teacher" from the Byzantine east. The mission was led by an experienced scholar and diplomat, Constantine (better known as Cyril), and his brother Methodius. The brothers translated the greater part of the Scriptures and the essential liturgical texts into a Slavonic literary language of Cyril's devising, based on the Slavonic vernacular of his native Salonika but enriched from other sources, notably Greek and the Slavonic of Moravia. The most notable literary monuments of this language (now known as Old Church Slavonic) are the *Lives* of the two brothers which were almost certainly written before 900, though they are preserved only in later copies. It is not known for certain whether these texts were written in the territory where the brothers carried on their mission; but other Church Slavonic texts can be assigned to the Czech area, notably the probably 10th-century *Legends* about St. Wenceslas (Václav, prince of Bohemia, 920–929) and his grandmother Ludmila.

Similar hagiographical works in Latin from this period bear witness to a notable level of literary culture in the monastic centres of the early Bohemian state.

The Old Church Slavonic language ceased to be used after 1097 when Latin was established as the liturgical language of the country.

CZECH LITERATURE

The earliest preserved texts in the Czech language (other than isolated words and sentences) date from the latter part of the 13th century. Hymns from this period, though of unpretentious style, are accomplished in language and versification. The courts of the Přemyslide kings Václav I (1230–53) and Otakar II (1253–78) gave encouragement to courtly literature in German; but there is no certain evidence of a significant body of literature in Czech before the end of the century.

The 14th Century.—The 14th century saw a continuous stream of Czech literary production, including the epic, the lyric and the drama, as well as historical, religious and didactic works in prose. A group of verse *Legends*, written in the first quarter of the century, is the work of a single author or of a close-knit school, and already shows considerable maturity of technique. The earliest secular work is the epic *Alexandreis*, a life of Alexander the Great in octosyllabic couplets based on Walter of Châtillon's Latin poem and showing some contact with the German epic on the same theme by Ulrich von Eschenbach. This is a poem of marked individuality which with its sustained descriptive passages, skillful handling of language and unobtrusive didacticism is a minor masterpiece of courtly literature. Another striking epic is the Dalimil chronicle of *c.* 1330, which portrays the history of the Czechs in a vivid and forthright style. Under the emperor Charles IV (1346–78) learning and literature flourished in Bohemia in both vernaculars, Czech and German. The emperor's own predilections were reflected in the important place occupied in this literature by hagiography, both in the form of verse legends and of prose. The most notable achievement of this period is the verse *Legend of St. Catherine*.

In addition to hymns there are a few secular lyrics which may date from this period, where influences of courtly literature combine happily with popular elements. The existence of a vernacular drama is attested, among other things, by the *Mastičkář* ("The Quack"), a comic scene which no doubt originally formed part of an Easter play of traditional type. Of less intrinsic value are the verse adaptations of German poems on chivalrous themes (*e.g.*, Tristan and Isolt, Duke Ernest).

From about 1350 prose genres began to be cultivated, first lives of saints, chronicles and the more anecdotal *exempla*, and then, no doubt for the growing urban middle class, versions of several popular medieval tales (Alexander the Great, the Trojan War, etc.). From the last part of the century dates a group of verse, satires and didactical poems which show great originality and character, in particular the anonymous satires of the Hradec manuscript and the political allegory *Nová rada* ("The New Council") written by Smil Flaška of Pardubice (*c.* 1349–1403) to defend the rights of the Bohemian nobility against the power of the crown.

The 15th and 16th Centuries.—A preoccupation with social and moral questions colours much Czech writing in the last part of the 14th century. Tomáš ze Štitného (of Štitný) (*c.* 1333–1405) wrote treatises on moral and theological questions in the vernacular and thus anticipated one of the main tendencies of the Hussite movement. This reform movement, inspired by John Huss (*c.* 1370–1415), dominated the life of Bohemia for the first half of the 15th century; amid the religious controversy and civil strife of this period it was natural for vernacular writing to be directed largely to practical and polemical purposes. Huss's own importance for Czech literature lies not only in his vernacular sermons and in the simple but flexible prose of his letters, but in the reform of the Czech orthography advocated in the treatise *De orthographia bohemica* (*c.* 1410). A direct product of the reform movement were the simple and moving hymns (notably *Ktož jsu boží bojovníci*, "You Who Are Warriors of God") composed by the Hussites. The events of the Hussite wars were reflected in the poems of the Bautzen manuscript (*Budyšínský rukopis*) and in a number of chronicles and other prose works.

Among the successors of Huss the most original was Petr Chelčický (*c.* 1390–*c.* 1460), who developed his radical social ideas and his pacifism in a series of striking treatises and homilies (notably *Sieť viery pravé*, "The net of the true faith"). It was from Chel-

čický's ideas that the *Unitas fratrum* (or Bohemian Brethren) drew their inspiration: this sect was to be one of the most important sources of vernacular Czech literature in the next two centuries.

In the 16th century there was no revival of vernacular poetry, but there is a mass of prose literature in which didactic and scholarly writing predominates. The influence of humanism is apparent in the elegant style of the legal historian Viktorin Kornel of Všehrdy (*c.* 1460–1520). Of considerable interest are the small group of travel books from this period. A 15th-century translation of Marco Polo's *Million* inaugurated this genre; and in the 16th century there are both Czech and Latin works of the same kind. For more popular reading there were various collections of *novelle* and anecdotes, sometimes translated but also from native sources.

The development of Czech prose in this period culminated in the translation of the Bible made by a group of scholars of the *Unitas fratrum* and known as the Bible of Kralice (published 1579–93). The language of this version came to be regarded as the model of classical Czech. The New Testament was based on the earlier translation by Jan Blahoslav (1523–71), the most prominent scholar of the time. Another remarkable scholar classified the riches of humanist Czech in his dictionaries—the historian Daniel Adam z Veleslavína (of Veleslavin) (1545–99).

The 17th and 18th Centuries.—The defeat of the Protestant Bohemian forces by the Habsburgs in the battle of the White mountain (1620) brought the integration of the Czech provinces into the Habsburg empire and the eradication of Protestantism from the country. The old nobility was practically eliminated by execution or exile and replaced by newcomers with little or no knowledge of the Czech language. The literary traditions of the past two centuries, with their Protestant associations, were proscribed: it was only among the émigrés that they continued to find expression. Among these exiles Jan Amos Komenský (Comenius) (1592–1670) was pre-eminent. In addition to his Latin works on educational and theological problems his works in Czech reveal him as a writer and thinker of European stature. His *Labyrint světa a ráj srdce* ("Labyrinth of the World and Paradise of the Heart"), in particular, is one of the supreme achievements of Czech prose literature.

At home the Jesuits attempted to supply a new Catholic literature—hagiography, devotional prose, religious poetry and hymns; some of this is of high quality, notably the poetry of Bedřich Bridel (1619–80). Among writers in Latin a special place is occupied by the Jesuit Bohuslav Balbín (1621–88), whose Czech patriotism expressed itself in studies of his country's past and in a remarkable "defense" of the Czech language.

By the beginning of the 18th century Czech had practically ceased to be used for higher literary purposes. Nevertheless, rough and ready vernacular dramas and chapbooks continued to be produced for the entertainment of the poorer townsfolk and the peasants. In the country too there arose a good deal of popular poetry, not only lyrical and narrative folk songs but rough and forceful expressions of peasant discontent.

The National Revival.—The historicism and antiquarianism of the 18th century led many Czech scholars to investigate the earlier literature and history of their country; a revival of Bohemian patriotism was, moreover, a natural reaction to the centralizing tendencies of the Habsburg government under Maria Theresa and was encouraged by the local nobility in the interests of their own power and prestige. Josef Dobrovský (*q.v.*; 1753–1829) had his roots in the world of *Aufklärung* ("Enlightenment") scholarship and became the arbiter and codifier of a revived Czech literary language. In the leisure which noble patronage enabled him to enjoy he devoted profound and penetrating study to the Czech language and literature of the middle ages and the Renaissance. In his grammar he provided a guide to correct language and a stimulus to good writing; and in his history of the older Czech literature he brought to light the neglected models which Czech writers might profitably follow. He himself wrote almost exclusively in Latin and German; but several of his contemporaries restored Czech to literary currency, notably Antonín Jaroslav Puchmajer (1769–1820) with his poetical Almanachs.

At the same time the social and political developments of the late 18th century created a public for Czech literature. The vernacular plays acted in Prague from 1786 and the beginnings of modern Czech journalism represented by the newspapers of Václav Matěj Kramerius (1753–1808) were directed at the new middle class of the growing Czech towns.

Dobrovský had contented himself with codifying the Czech language: Josef Jungmann (1773–1847) set out to extend and enrich its possibilities in order to render it capable of assuming the tasks of a modern literary language. This task he successfully accomplished through his translations (including that of Milton's *Paradise Lost*, 1811) and above all through his monumental Czech-German dictionary (1835–39). The revival of Czech national culture was also greatly furthered by two scholars: the Slovak philologist and archaeologist Pavel Josef Šafařík (*q.v.*; 1795–1861) and the Moravian historian František Palacky (*q.v.*; 1798–1876), whose history of Bohemia and Moravia is the last masterpiece of classical Czech.

Some Slovaks, particularly Protestants, were being drawn into the orbit of the Czech literary revival; foremost among them was Jan Kollár (*q.v.*; 1793–1852), whose allegorical sonnet cycle *Slávy Dcera* ("The Daughter of Slava"), despite its pedantry and excess of rhetoric, still has a certain fascination and is undoubtedly the first significant work of literature in the revived language.

A special position in this period belongs to the *Rukopis Královédvorský* ("Manuscript of Králové Dvůr") and *Rukopis Zelenohorský* ("Manuscript of Zelená Hora"), ostensibly Czech poems from the early middle ages but in fact forgeries executed by the brilliant and unscrupulous scholar and poet Václav Hanka (1791–1861) and others. Though their spurious character was finally proved toward the end of the century, largely by the efforts of Jan Gebauer and Tomáš G. Masaryk, they can still hold their own as examples of romantic poetry, with echoes of the popular poetry of the southern Slavs. The direct influence of popular poetry can also be discerned in the ballads of František Ladislav Čelakovský (1799–1852) and more subtly in those of Karel Jaromir Erben (1811–70). The plays of Josef Kajetán Tyl (1808–56) and Václav Kliment Klicpera (1792–1859) were of considerable importance in establishing a Czech theatrical tradition but are of little lasting value.

The greatest poet of Czech romanticism, perhaps still the greatest of all Czech poets, was Karel Hynek Mácha (*q.v.*; 1810–36). His lyrics, prose fragments and above all the lyrical epic *Máj* show his indebtedness in externals to Byron, Walter Scott and the Polish romantics; but the derivative character of the material is transcended by the intensity of the poetic vision and the perfection of the language in which it is expressed.

In the 1840s a reaction from the attitudes and literary forms of romanticism became evident in the work of a number of authors, most notably in that of Karel Havlíček-Borovský (1821–56) and Božena Němcová (née Barbora Panklová; 1820–82). Both were concerned with practical issues rather than with romantic visions of Czech past and future greatness; and both were masters of prose style who did much to emancipate Czech prose from the older classical manner and bring it nearer to the language of every day. Havlíček was a political journalist whose achievement lies not only in the numerous critical articles and sketches in which he fought for Czech rights against Habsburg absolutism, but also in his brilliant satirical poems, notably those written in exile at Brixen just before his death (*Král Lávra*—"King Lavra"; *Tyrolské elegie*—"Tyrolese Elegies"; and *Křest svatého Vladimíra*—"The Baptism of St. Vladimir"). Božena Němcová, the first woman to make a significant contribution to Czech literature, is best known for *Babička* ("The Grandmother"), a portrayal of Czech country life in a series of sketches held together by the central figure. Although the conception of peasant existence is an idealized one the descriptions are precise and realistic; and the language has a firmness and individuality which, while drawing from the speech of the common people, nevertheless betrays an artistry which was new in Czech prose. *Babička* was the most successful of the many sketches and stories of country life which

form the main body of Němcová's work.

1848–1918.—The work of Havlíček, Erben and Němcová, all at the peak of their achievement in the 1850s, forms a bridge from the first, romantic phase of the revived Czech literature to the second half of the century in which a more numerous body of authors, writing for an expanding public, try to establish a literature of less parochial character which might occupy a worthy place in its own right among the other literatures of Europe. In 1858 the almanach *Máj* appeared, dedicated to the memory of Mácha and containing the work of a number of young authors among whom Jan Neruda (1834–91) and Vitězslav Hálek (1835–74) were preeminent. In Mácha these authors saw the literary revolutionary whose independence of authority and tradition they proposed to follow. They also owed much to the ideas of Havlíček. Their aim was to create a new Czech literature which should reflect the liberalism and practical nationalism with which they were imbued. Neruda was the most successful author of this group. He was a prolific writer who is now chiefly remembered for his lyrics and his prose. His lyrics, ranging from a melancholy romantic vein to one of patriotic enthusiasm, are often rhetorical; but the best of them (notably *Zpěvy páteční*—"Good Friday Songs"), as well as his lively ballads, are of high merit. Of more interest to the modern reader are his prose sketches, particularly *Povídky malostranské* ("Tales of the Little Quarter"), in which the life of Prague is portrayed with a humour and humanity which has affinities with the "poetic realism" of Gottfried Keller. The work of Neruda's friend Hálek, though highly popular in its day, has proved less lasting: his best achievement was in his lyrics (in particular *Večerní písně*—"Evening Songs").

The most significant novelist of the *Máj* group was Karolina Světlá (pseudonym of Johanna Mužáková; 1830–99). Her novels of early 19th-century Prague society and of the north Bohemian countryside contain romantic elements of theme and plot but show considerable skill in psychological analysis. Moral and social problems, and in particular the position of women in 19th-century society, are among the dominant themes of her work.

It was under the auspices of the *Máj* group that Adolf Heyduk (1835–1923) began his literary career. Of his vast output (lyrics, ballads, epics) his patriotic poetry has best stood the test of time, notably the poems in which he was inspired by the kinship between Czechs and Slovaks. Of all the poets of the *Máj* group the one who was closest in mood to Mácha (though remaining far behind him in achievement) was Rudolf Mayer (1837–65).

By the 1870s Czech literature had fully established itself in poetry and the novel. In the drama progress was slower; even the establishment of a national theatre in 1883 did not cause native talent to spring forward in this field as it had in others. Literary life in the 1870s and 1880s crystallized in the main round two groups or tendencies associated with the periodicals *Lumír* and *Ruch* ("Stir"). The former stressed the necessity to europeanize Czech literature and looked to the literatures of France, Italy and England for inspiration. The latter looked rather to the strength of native traditions and themes, and to those of kindred Slavonic peoples. The difference was one of emphasis rather than a hard and fast division; but it is reflected in the work of some of the main writers of the period.

The leading representative of the cosmopolitan tendency was Jaroslav Vrchlický (pseudonym of Emil Frida; 1853–1912), probably the most prolific of all Czech writers: the rise and fall of his reputation as well as the character of his work recall Tennyson and Victor Hugo. His lyrics, though marred by rhetoric and an excessive metrical virtuosity, nevertheless show an amazing mastery of language. His vast cycle of historical epics (consciously inspired by Hugo and Leconte de Lisle) contains his best work: it has grandeur of conception, felicity of language and a sense both of the complexity of the human personality and of the drama of history. Perhaps his greatest influence on Czech literature was exercised, however, by his numerous (and often admirable) translations (Shakespeare's sonnets, works of Shelley, Byron, Tennyson, Walt Whitman, Goethe, Corneille, Molière, Hugo, Leconte de Lisle, Baudelaire, Dante, Petrarch, Leopardi, Calderón, Camões and much else besides). It is easy to point out the defects in Vrchlický's work, but his importance in the fashioning of the modern Czech poetical language must not be underestimated.

The cosmopolitan trend in the literature of the 1880s also found memorable expression in the poetry and novels of Julius Zeyer (1841–1901). The formal skill of his neoromantic lyrics and epics is considerable. More original are his novels and stories, particularly the semi-autobiographical *Jan Maria Plojhar*. The lyrical poetry of Josef Václav Sládek (1845–1912) shows affinities with Vrchlický and Zeyer; but in many of his themes he shows greater affinity with the "national" group. He is best remembered for his excellent translation of most of Shakespeare's plays.

The principal figure of the *Ruch* group was Svatopluk Čech (1846–1908). His work is inspired by love of his nation and its traditions and by a passionate liberal humanism. In a number of epics he portrayed the Hussite period (*e.g., Adamité, Václav z Michalovic*); and one of his most popular works *Ve stínu lípy* ("In the Shade of the Lime-Tree") gives an idyllic picture of Czech country life. In *Písně otroka* ("Songs of a Slave") the hardships of negro slaves under a ruthless taskmaster were meant to symbolize the position of the Czechs under the Habsburgs. In his prose satires he created the original figure of "Mr. Brouček" who satirized the philistinism of the Czech middle classes.

In the Czech novel of the last quarter of the century a marked trend toward realism of description is the common factor. This is even apparent in the two major historical novelists, Alois Jirásek (*q.v.*; 1851–1930) and Zikmund Winter (1846–1912). Though both of them present a romanticized version of the national history of the Czechs, yet the details of their reconstruction of past scenes and events is based on scholarly research, in sympathy with the efforts of contemporary historians. The novels of Jirásek present the entire history of the Czechs up to his own time, concentrating in particular on the two periods which seemed to him of vital significance: the Hussite period, to which he devoted a vast trilogy, and the national revival of 1780 onward, which is the subject of the five-volume novel *F. L. Věk*. His mature craftsmanship is seen at its best in his novel of the period of national decline *Temno* ("Darkness"). Winter's novels were a by-product of his work as a historian; his *Mistr Kampanus* is a fine portrayal of Bohemia at the time of the battle of the White mountain (1620).

Many novelists now devoted themselves to the description of contemporary life. Realistic pictures of the Czech countryside were painted in the novels of Jan Herben (1857–1936), Karel Václav Rais (1859–1926) and Teréza Nováková (1853–1912). City life and the problems of industrialization had already been treated by Jakub Arbes (1840–1914). They loom large in *Santa Lucia*, the haunting novel of Prague by Vilém Mrštík (1863–1912).

In the last decade of the century new trends in poetry began to show themselves. Lyrics of more subtle content and more complex form (including free rhythms) were written by Antonín Sova (1864–1928). About the turn of the century there appeared the best work of two of the most remarkable of Czech poets: Otakar Březina (*q.v.*; pseudonym of Václav Jebavý; 1868–1929) and Petr Bezruč (*q.v.*; pseudonym of Vladimir Vašek; 1867–1958). Březina expressed his personal religion in a language of great subtlety and originality; his metrical structures (including free rhythms) had great influence on later poets. Bezruč was a regional poet, obsessed by the national and social oppression of the Czechs of Silesia. This theme, sometimes interwoven with autobiographical elements, he developed in poems of elemental force and sincerity. A violent reaction to the restraints of bourgeois civilization expressed itself in the ecstatic sensualism of Stanislav Kostka Neumann (1875–1947) and Fráňa Srámek (1877–1952).

In the 1890s another form of critical reaction to the romantic idealism of the national revival had already inspired the historical and sociological writings of T. G. Masaryk (*q.v.*; 1850–1937), whose importance in Czech life lies mainly outside the field of literature. A new and more mature approach to literary criticism showed itself only a little later in the work of František Xaver Šalda (1867–1937) whose sensitive interpretations of his country's greatest writers have not been surpassed.

After 1918.—With the establishment of an independent Czecho-

slovak state in 1918, new possibilities opened for Czech writers and there was great, even feverish, activity in all fields of literature. Some of the best achievements of Czech literature date from this period, especially in lyrical poetry.

The realistic novel of Prague life had been successfully cultivated before 1918 by Karel Matěj Čapek-Chod (1860–1927) and in lighter vein by Ignát Herrmann (1854–1935). It was not from this direction, however, that the principal achievements of the Czech novel after 1918 were to come. Czech narrative prose reached its peak in the work of three equally versatile but very different writers: Karel Čapek (*q.v.*; 1890–1938), Ivan Olbracht (pseudonym of Kamil Zeman; 1882–1952) and Vladislav Vančura (1891–1942). Čapek wrote Wellsian fantasies, subtle psychological studies and stories of Prague life. His style at its best derives force and colour from the introduction of elements of popular speech. Olbracht's most successful works were those with a Ruthenian background. In contradistinction to the two last-named authors Vančura cultivated a complex, mannered style, often with great success.

Among several novelists preoccupied by personal and national problems in a period of social upheaval the most noteworthy were Marie Majerová (1882–1958), Marie Pujmanová (1893–1958) and Vojtěch Martínek (1887–). A versatile talent showed itself in the work of Jan Drda (1915–).

It was after 1918, too, that the Czech drama came into its own, notably in the idealistic and satirical plays of Karel Čapek and in the versatile talent of František Langer (1888–).

In the period between 1918 and 1945 Czech lyrical poetry was of the utmost variety and some of it of the highest quality. Four poets stand among the greatest figures of modern Czech literature: Josef Hora (1891–1945), František Halas (1901–1949), Vítězslav Nezval (1900–1958) and Jaroslav Seifert (1901–). Of these Hora possessed perhaps the profoundest lyrical vein; the talent of Nezval was the most far-ranging but also the most uncontrolled.

SLOVAK LITERATURE

Until the 18th century there was no systematic attempt to establish a literary language on the basis of the Slovak dialects which, though closely related to Czech, developed an identity of their own from the early middle ages. The work of SS. Cyril and Methodius and their liturgical language may well have influenced western Slovakia, but after the Hungarian conquest in the early 9th century there are no traces of the use of a written Slavonic language in Slovakia for some centuries. It is clear that in the later middle ages Czech (often with an admixture of local Slovak elements) was fairly widely used for legal and administrative purposes: the first substantial Czech text from Slovakia is the Book of Žilina, a translation made in 1473 of a German legal text. Other occasional examples of Czech texts with Slovak colouring (*e.g.*, folk songs) have been preserved from the early modern period. It was not until the middle of the 18th century, however, that any systematic attempt was made to establish a Slovak literary language. The decline of literary Czech in the early 18th century caused an increase of local colouring in the devotional texts produced by both Catholics and Calvinists in Slovakia. With Anton Bernolák (1762–1813) these centrifugal tendencies were consolidated. In a grammar (1790) and a dictionary (6 vol., 1825–27), Bernolák codified a literary language based in the main on western Slovak cultivated usage. In an era of reviving national consciousness this language was taken up by a number of writers. Pre-eminent was Ján Hollý (1785–1849), who wrote lyrics, idylls and national epics in the language and orthography of Bernolák. Among prose writers the most noteworthy follower of Bernolák was Juro Fándli (1750–1811), who wrote a series of religious and practical treatises. Of far greater literary value, however, was the didactic novel *René*, written in a strongly Slovakizing Czech by Jozef Ignác Bajza (1755–1836).

Bernolák's language was not accepted by the Protestants of Slovakia who used Czech as their liturgical language and for the most part accepted with enthusiasm the revived literary Czech codified by Dobrovský and Jungmann. By the 1840s, however, Slovak national feeling among the Catholic majority was so strong that there was little possibility of their accepting Czech as their written language. The narrowly based western Slovak of Bernolák was inadequate to meet the needs of the situation; and when in the 1840s the brilliant linguist and ardent patriot L'udevít Štúr (1815–56) codified a new form of literary Slovak based on the central dialects the way was clear for its acceptance.

The new language was immediately taken up by a group of talented poets. Andrej Sládkovič (pseudonym of Ondrej Braxatoris; 1820–72) produced in his *Marína* a national epic which, though owing an evident debt to Pushkin's *Onegin* and a slighter one to Jan Kollár, had an individuality and freshness of its own. Samo Chalupka (1812–83) composed lyrics which reflect the language of Slovak folk songs. The most significant figure of this group was the romantic figure Janko Král' (1822–76), whose revolutionary exploits in 1848–49 made him into something of a legend in the memory of his countrymen. His ballads, epics and lyrics are among the most original products of Slavonic romanticism.

The dual influence of Slovak folk songs and Slavonic romantic poetry (especially Mácha's *Máj*) are also apparent in the work of Ján Botto (1829–1881), notably in his forceful and moving epic *Smrt' Jánošíkova* ("Jánošik's Death").

The first Slovak dramatist of note was Ján Chalupka (1791–1871) whose works, including the lively satire *Kocourkovo*, were written in Czech. Ján Palárik (1822–1870) wrote in the new literary language: his comedies, produced in the 1850s and 1860s, portray with irony but also with sympathy the Slovak society of his time. The novel was the last genre to be established in the new literary language. Before 1914 it was practised by one writer of unusual talent, Martin Kukučín (pseudonym of Matej Bencúr; 1860–1928), whose best work deals with life on the Dalmatian coast where he spent much of his life.

The chief strength of Slovak literature continued to be found in the lyric; and here the pre-eminent figure before 1914 was Hviezdoslav (pseudonym of Pavol Országh [*q.v.*], 1849–1921). His output was vast and at his best he is a lyric poet of a high order. He enriched the Slovak poetic language not only by his original work but by a series of translations, especially from English, Russian, German and Hungarian.

Other notable poets were the Russophile Svetozár Hurban Vajanský (1847–1916), who also produced interesting social novels, and Ivan Krasko (pseudonym of Ján Botto; 1876–1958) whose two volumes of verse are among the finest achievements of Slovak literature.

After 1918 Slovak literature came of age. While following the general tendencies of European literature Slovak authors retained an individual flavour. Their greatest successes were in lyrical poetry, with such writers as Martin Rázus (1888–1937), Janko Jesenský (1873–1945), Emil Boleslav Lukáč (1900–), Ján Smrek (1899–) and Ján Ponička (1902–). In the novel the country tales of Timrava (pseudonym of Božena Slančíková, 1867–1951) and the vast chronicle of 20th-century Slovakia by Milo Urban (1904–) are particularly noteworthy.

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CZECHOSLOVAK ORTHODOX CHURCH, the national autocephalous representative in Czechoslovakia of the Orthodox Eastern Church (*q.v.*). It follows the traditions estab-

lished by SS. Cyril and Methodius, who in the 9th century brought Christianity to the Czech lands. Though this territory was later lost to the Roman Church the Orthodox position was better in eastern Slovakia until 1649, when many believers were lost to the Uniats. In the 19th century some Czechs formed an Orthodox Church, and by 1910 about 1,000 persons were following the Orthodox faith. After World War I an Orthodox Church was formed in Bohemia and Moravia by Bishop Gorazd, who was consecrated as the first independent bishop in 1921. In World War II, the bishop together with four other members of the Orthodox clergy was executed by the Nazis after members of the resistance movement who had killed Reinhard Heydrich were found hiding in an Orthodox church. All the work of the church was forcibly discontinued and the church disbanded. It continued its work only in the eparchy of Mukachevo in eastern Slovakia.

After the war the church was revived and, having no bishop, a general assembly of laymen and clergy asked to come under the jurisdiction of the Russian Orthodox Church. At the same time about 10,000 Czechs of Orthodox faith returned to Czechoslovakia after having emigrated under the Austrian monarchy to Volhynia. At the 1950 Presev conference the laymen and clergy of the Uniats decided to return to the Orthodox Church. This growth in numbers made possible the establishment of four indigenous bishoprics: Prague, Olomouc, Presov and Michalovce, upon which the Russian Orthodox Church immediately acknowledged the autocephalous status of the Czechoslovak Orthodox Church. The head of the church is the metropolitan of Prague and Czechoslovakia. There is a theological faculty at Presov, and the church brings out three monthly publications in Czech, Slovak and Ukrainian.

CZERNY, KARL (1791–1857), Austrian pianist, teacher and composer known for his pedagogical works for the piano, was born in Vienna on Feb. 20, 1791, and studied the piano first with his father, Wenzel Czerny, and later with Beethoven. He was a teacher in Vienna at the age of 15, his pupils including Beethoven's nephew and Liszt. His published works of all kinds number nearly 1,000. He made ingenious arrangements of orchestral works including versions for eight pianos, four hands at each, of two overtures of Rossini. He is known, however, by his studies, greatly esteemed by later teachers, which include the *School of Velocity*, the *School of Virtuosity* and the *School of the Left Hand*. Czerny died in Vienna on July 15, 1857.

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CZESTOCHOWA is the chief town of a district in the Katowice *wojewodztwo* of Poland. After 1925 it was the see of a bishop. Pop. (1960) 163,800. It lies on the Warta river, at the northern edge of the limestone highlands of the Cracow Jura, 201 km. (125 mi.) S.W. of Warsaw. The town originated as two separate parts: old Czestochowa and a settlement at the foot of the Jasna Gora ("hill of light"). On the hill Wladyslaw, duke of Opole, built in 1382 a fortified monastery occupied by monks of the order of Paul the Hermit, which possesses a miraculous portrait of the Virgin Mary. Pilgrimages draw from 2,500,000 to 3,000,000 persons to Czestochowa every year. The main axis of the present town is a broad avenue linking both parts and ending with the imposing tower of Jasna Gora church (344½ ft.). The town has a higher school of engineering, a higher teachers' training college and two theatres.

Czestochowa is an important communications centre situated on the Warsaw-Vienna railway with branches to Opole and Kielce. Between 1870 and 1910 the textile industry (wool, cotton and jute) developed in Czestochowa and the town has something of a monopoly of jute. The iron-ore deposits near the town led to the development of smelting; one of the largest iron and steel plants in Poland was established there after World War II. Manufactures include needles (the only factory in Poland), baby carriages, metal and devotional goods. (T. K. W.)

CZETWERTYNSKI (SWIATOPELK-CZETWERTYNSKI), a Polish ducal family descended from the impoverished Ruthenian branch of the Rurik dynasty, the descendants of Svyatopolk II Izyaslavich, grand duke of Kiev (d. 1113). Their seat was the Stara Czetwertnia castle on the Styr river in Volhynia. In the 17th century they supported the Orthodox Church against union with the Roman Catholic Church. One of the family, Grzegorz Gedeon (d. 1690), was Orthodox metropolitan of Kiev, while Stefan Sylwester (d. 1727) was Orthodox bishop of Mogilev. From the end of the 17th century the main branch turned to Roman Catholicism and began to consider themselves as Poles; the younger branch remained Orthodox and became Russian. During the 17th and 18th centuries several members of the elder branch held senatorial office in Poland. The most renowned was the notorious Antoni Stanislaw (1748–94), castellan of Przemysl, who sold his services to Russia and was the last leader of the confederation of Targowica, which opposed reforms of state. During the Kosciuszko insurrection he was hanged as a traitor on June 28, 1794. Several of the Czetwertynskis, however, took part in the national insurrections of 1830 and 1863. The most distinguished was Wlodzimierz (1837–1918), a collector and philanthropist. His son Seweryn Franciszek Kalikst (1873–1945) was a member of the Russian *duma* (1906) and of the Polish *sejm* (1922–28). Arrested by the Germans in World War II, he was sent to a concentration camp in 1943, and freed by the Allies in 1945. He died soon afterward in Edinburgh, Scot.

See Józef Wolff, *Kniaziowie litewsko-ruscy* ("The Lithuanian-Ruthenian Princes") (1895). (ST. HE.)

D THIS letter has retained the fourth place in the alphabet from the earliest point at which it appears in history. It corresponds to Semitic ◁ (daleth) and Greek Δ (delta). The form is thought to derive from an early pictograph, possibly Egyptian, indicating the folding door of a tent. The rounded form D occurs in the Chalcidic alphabet, whence the Latin alphabet may have acquired it by way of the Etruscans. The letter has retained the rounded form that it had in the Latin alphabet until the present day.

Latin cursive forms were (5th century) and (6th century). In these the right-hand rounded line of the majuscule letter is carried far above the level of its junction with the stroke. From these forms and from the uncial arose the Carolingian and our own minuscule *d*.

The sound consistently represented by the letter in Semitic, Greek, Latin and the modern languages of Europe is the voiced

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	1200 B.C.	
CRETAN	1100-900	
THERAEAN	700-600	
ARCHAIC LATIN	700-500	
ATTIC	600	
CORINTHIAN	600	
CHALCIDIAN	600	
IONIC	400	
ROMAN COLONIAL	PRECLASSICAL AND CLASSICAL TIMES	D
URBAN ROMAN		D
FALISCAN		
OSCAN		
UMBRIAN		
CLASSICAL LATIN AND ONWARD		D

THE DEVELOPMENT OF THE LETTER "D" FROM THE PHOENICIAN THROUGH CLASSICAL LATIN TO THE PRESENT FORM

dental stop. In English this sound, as well as the unvoiced sound represented by *t*, has become alveolar, that is to say, is pronounced by the pressure of the tongue upon the gums rather than upon the teeth.

The etymological value of *d* in words of native English origin is generally the same as that of German *t* (*th*), Sanskrit *dh*, Greek *θ*, Latin *f* (initial) or *d* or *b* (medial), all being derived from *dh* in the parent Indo-European speech (*e.g.*, English *do*, German *thun*, Sanskrit *dadhâmi*, Greek *τίθημι*, Latin *facio* but *condo*). In some other instances *d* is derived from Indo-European *t* when the Þ originally resulting from the *t* has been subsequently altered by the change familiarly known as "Verner's Law," the occurrence of which depended on the place of the Indo-European accent (so, for example, the prior *d* in *hundred*, Sanskrit *śatám*, Greek *ἑκατόν*, Latin *centum*). (*See* also GERMANIC LANGUAGES.)

In music, D is the fourth note of the musical alphabet and the second note of the scale of C. In former times it gave its name also to one of two or three clefs which are now no longer in use. (*See* MUSICAL NOTATION.) Used as an abbreviation, D has several meanings, e.g., *m.d.* = *main droite; d.c.* = *da capo; d.s.* = *dal segno*.

In chemistry, the letter D is used as the symbol for deuterium. The British penny is signified by *d*, from the Latin *denarius*, the name of a Roman silver coin. The Roman numeral D stands for "500" or one-half of the uncial form of M, "1,000." (J. W. P.)

DAB, a common name applied to several species of flounder belonging to the families Bothidae and Pleuronectidae, especially to *Limanda* and *Citharichthys* species. The North American dabs include the speckled sand dab (*C. stigmaeus*) and the longhead dab (*L. proboscidea*), both of the Pacific coast. The European dab (*L. limanda*) is typical: it is brown or ashen gray with irregular dark markings and close-set scales, and attains a length of 12 in. *See* also FLATFISH.

DABCHICK, the popular name of the little grebe (*Podiceps ruficollis*), a diving bird, the smallest European member of the family Podicipedidae. The dabchick frequents ponds and rivers throughout most of the old world, exclusive of the arctic regions. It feeds on crustaceans, mollusks and insects and some vegetable matter. The bulky nest, composed of wet, decaying aquatic plants, may rest in shallow water or may float. The name dabchick is also applied to small American grebes, especially the piedbilled (*Podilymbus podiceps*). *See* GREBE. (E. R. BE.)

ERIC HOSKING

EUROPEAN DABCHICK OR LITTLE GREBE (PODICEPS RUFICOLLIS) WITH NESTLINGS

DABROWA GORNICZA, a town in the *wojewodztwo* of Katowice, Poland, part of the urban group of the Upper Silesian industrial region, lies on the eastern edge of the Silesian uplands, on the Czarna Przemsza river (a tributary of the Vistula), 9 mi. E.N.E. of Katowice city. Pop. (1960) 42,000. Dabrowa Gornicza is an old mining and iron-foundry centre where exploitation of one of the thickest coal-seams in the world (up to 24 m. [78.7 ft.]), known as the "Reden" seam, was started in 1796. Part of the coal-seam is now a national preserve. The town is on the Katowice-Warsaw railway line. Dabrowa Gornicza flourished during the Congress kingdom (19th century), when it was a centre for Polish scientific research in mining and metallurgy.

(K. M. WI.)

DACCA, the capital of East Pakistan and second seat of the Pakistan government, also gives its name to a district and division of the province. The city is situated on the left bank of the Burhi Ganga, a tributary of the Dhaleswari which flows from the Jamuna

(the main stream of the Brahmaputra) into the Meghna river. It is 10 mi. from Narayanganj, a great river port which links it by steamer with many other centres. Pop. (1961) 556,712.

Much of Dacca's great past is preserved in rich monuments of impressive beauty such as the Lal Bagh fort which was begun by Azam Shah, the third son of the emperor Aurangzeb, in 1678 but was never completed. Architecturally the most interesting building in the fort is the tomb of Bibi Peri (daughter of Shaista Khan and great-niece of Nur Jahan), who died in 1684. It is built entirely of black basalt, gray sandstone and white marble with intricate design and workmanship. Other buildings of the Mogul period are the Bara Katra great caravansary (built by Mir Abdul Qasim in 1664), the Chhota Katra small caravansary (built by Shaista Khan in 1663) and Husaini Dalan, a religious monument of the Shi'ah sect (built by Mir Murad in 1642). There are not less than 700 mosques dating from as far back as 1456, several Hindu temples, the most notable of which is Dhakeswari (17th century), pagodas of Burmese origin, monasteries of Siamese workmanship and several churches. Tejgaon church (1677) was built by the Portuguese mission. The principal modern buildings include those of the high court (1911), Dacca university and other colleges, the museum, government secretariat, public library, Shah Bagh hotel, New market, Dacca club and the stadium. Many of these are grouped round a large park, the Ramna, one mile from the city centre. New residential accommodation includes the Azimpur colony. Nawabpur road is the main shopping centre inside the city and its extension, Jinnah avenue, leading to the Ramna area, is the chief commercial quarter. The city is noted for its cottage industries. Dacca was once world famous for its extremely fine muslins and good muslin known as *jamdani* continues to be woven there with machine yarn. Dacca embroidery is unique: *chikan* and *kasidas* (muslin embroidered with silk) are two of the chief products. The city is also the centre of the manufacture of cotton saris and jute carpets. Other industries include the making of silk, conch-shell bangles and bracelets, mother-of-pearl bangles and horn combs, gold and silver (especially silver filigree) work and boatbuilding. The greatest industrial area of East Pakistan extends from Dacca to Narayanganj, with jute and cotton textile, hosiery and oil mills and match, shoe and soap factories and glassworks. The light industrial area of Tejgaon has rubber, oil and engineering industries. By rail Dacca is connected with Chittagong in the south and Bahadurabad on the Jamuna in the north. Dacca airport (3 mi. away at Tejgaon) is used by international airlines.

The origin of the name Dacca (Dhaka) is uncertain. Alternative derivations are: from the dhak (*Butea frondosa*), a tree said to have once been common there, or from Dhakeswari ("the hidden goddess"), whose shrine is in the western part of the city. Odd finds of coins and antiquities take its history back to the end of the 1st millennium A.D. In the 15th century Dacca was ruled by a line of Muslim sultans. From 1608 to 1639 the city was the capital of the province of Bengal, but in the latter year the government was transferred to the Rajmahal hills, where it remained for 21 years. In 1660 Mir Jumla, viceroy of Aurangzeb, again made Dacca the capital and it remained so until 1704, when the court was moved to Murshidabad. Dacca was a great centre of trade, mostly conducted by sea. In the 17th–18th centuries there were English, Dutch and French factories there. The population of the city at that time is variously estimated at 900,000 to 1,000,000. With the shift of the capital to Murshidabad and the decay of the muslin industry in the 18th century, it began to decline in size and population. In 1765 it passed under British rule. In 1824 Bishop Reginald Heber estimated its population at 300,000 but by the first census in 1872 it had decreased to 69,212. Subsequently the population steadily increased, stimulated from 1905 by its status for seven years as capital of the newly created province of Eastern Bengal and Assam during the first partition of Bengal. Dacca college (1842) formed the nucleus of Dacca university, established finally in 1921. Even after the annulment of the first partition in April 1912, Dacca retained its importance as a seat of learning and as a commercial centre, lying in the heart of the richest agricultural part of undivided Bengal. After the establishment of Pakistan, Dacca became the capital of East Bengal and later of East Pakistan. While most of the Hindu population fled to India there was a large influx of Muslim refugees, mainly from West Bengal.

Dacca District has an area of 2,882 sq.mi. and a population (1961) of 5,095,745. The district consists of a level plain bounded on three sides by the Meghna, the Ganges (or Padma) and the Jamuna, and watered by a network of rivers and streams such as the Dhaleswari, the Burhi Ganga and the Lakhya. About 20 mi. N. of Dacca city small ridges not more than 50–60 ft. high occur in the Madhupur jungle, stretching into Mymensingh district. Rice is the principal crop, followed by jute. The industries consist of jute pressing, rope-, string- and basketmaking, the weaving of cotton fabrics and boatbuilding. At Vikrampur (15 mi. from Dacca city) is an ancient city site, formerly the capital of the Pala rulers of Bengal (8th–13th centuries).

Dacca Division lies in the central part of the province of East Pakistan, flanked by Chittagong division on the east and Rajshahi and Khulna divisions on the northwest and southwest. Pop. (1961) 15,293,596. Area 11,937 sq.mi. It consists of the three districts of Dacca, Mymensingh (*q.v.*) and Faridpur (*q.v.*).

See S. M. Taifoor, *Glimpses of old Dhaka* (1952); A. H. Dani, *Dacca, a Record of Its Changing Fortunes* (1956). (K. S. Ad.)

DACE, a common name applied to any of several edible freshwater fishes of the carp family, Cyprinidae, closely related to the European chub (*q.v.*) but having a smaller head and smaller mouth. The North American daces include the redbellies (*Chrosomus*); the redside and rosyside daces (*Clinostomus*); the creek chub or horned dace (*Semotilus atromaculatus*); and the blacknose, speckled and longnose daces (*Rhinichthys*). The European dace (dare or dart) is *Leuciscus leuciscus,* found in the rivers of Siberia, of Europe north of the Alps and Pyrenees, and of England. All daces are slender, active fishes, generally silvery; they rarely exceed 12 in.

DACH, SIMON (1605–1659), German poet, is noted for the sweetness and simplicity of his lyrics. Dach was born at Memel, in East Prussia, on July 29, 1605. He was professor of poetry at the University of Königsberg from 1639 and became a leader of the Königsberg group of poets which played a significant part in the early baroque movement (*see* German Literature). Dach died at Königsberg on April 15, 1659.

His best-known lyric, frequently found in anthologies, is "Der Mensch hat nichts so eigen." "Anke von Tharau" is no longer attributed to him. In addition to secular lyrics Dach wrote excellent hymns. His works have been edited by W. Ziesemer, in four volumes (1936–38).

DACHAU, a town of Germany, which after partition of the nation following World War II was in the *Land* of Bavaria, Federal Republic of Germany. It lies 17 km. (11 mi.) N.W. of Munich by road. Pop. (1961) 29,068. Dachau is on a hill on whose summit are the castle of the Wittelsbacher and a parish church (1625). Industries include the production of paper, cardboard and electrical equipment. First mentioned in 805, Dachau remained a small market town until the 20th century. It was given civic status in 1934.

In March 1933, on the site of an ammunition factory erected in 1917, a concentration camp, infamous for the brutalities practised in it, was opened within the boundaries of Dachau. It was set up and run by the Nazi S.S. (*Schutzstaffel*). About 70,000 out of 206,202 detainees lost their lives in the gas chamber or in other ways. The camp later housed refugees, but the crematorium area was preserved as a shrine and a warning. A monument to the dead was unveiled in 1960.

DACIA, the ancient Roman name given primarily to the area in modern Rumania of the Carpathian mountains and Transylvania, though the Dacian people had earlier also occupied lands south of the Danube river and north of the mountains, and the Roman province eventually included wider territories both to the north and east. The Dacians were a westerly branch of the Getae (*q.v.*) and first appear in the Athenian slave market in the 4th century B.C., after which *Daos* (Lat. *Davus*) is common as a slave name in comedy. Though speaking a Thracian dialect the Dacians

had absorbed considerable Scythian influence, of which the most important indication was their cult of the Scythian deity Zalmoxis (plausibly identified with the bearskin) and their belief in immortality. They were sedentary grain growers; they traded with Greece from early Hellenistic times; they used Greek coins; and they worked their rich mines of silver, iron and above all gold.

Dacians appear in alliance with other tribes against Roman generals in 112, 109 and 75 B.C., but the unified kingdom erected about 60–50 B.C. by the Dacian king Burebista was much more formidable. His power extended to the Black sea (where the Greek cities of south Russia were overwhelmed), west beyond the Tisa (Tisza) river, north to modern Slovakia (*see* Boii), and south of the Danube to Thrace and to the area beyond Belgrade. Burebista seems to have offered Pompey assistance in 49, and in 44 Caesar was planning a vast expedition against the new kingdom; but Caesar was murdered, and soon afterward Burebista also. His kingdom broke up into at least four parts, but the Dacians continued to harass Rome, an invasion in 11 or 10 B.C. being particularly devastating. Augustan generals gradually pushed them back from the left bank of the Danube, while also settling 80,000 men within the Roman province of Moesia on the right bank, and no further trouble is recorded until autumn A.D. 69 when the Dacians found Moesia denuded by the departure of the legions to fight Vitellius (*q.v.*). After capturing a number of forts they were beaten back by Vespasian's general Gaius Licinius Mucianus, then on his way to Italy.

The origins of the more serious wars under the emperors Domitian and Trajan are hard to discern (*see* Decebalus). Roman provocation is not ruled out, but the first event was a Dacian raid in A.D. 85, the Moesian governor Oppius Sabinus being killed. Domitian restored the situation next year, but his commander Cornelius Fuscus was then killed with a large part of his army in an attempted invasion. In 88 Rome won a victory at Tapae near the Iron Gate pass, but owing to difficulties with tribes farther west (*see* Marcomanni) Domitian gave Dacia a favourable peace; Roman suzerainty was recognized, but the Dacians received a subsidy and the loan of engineers.

In 101 Trajan (his pretext is not recorded) reopened the struggle and at the end of two years dictated a peace under which the Dacian capital, Sarmisegetusa or Sarmizigethusa (Hung. Várhely), received a Roman garrison. In 105 the war was renewed, and in 106 the whole country was subdued, large parts of its population being exterminated or driven northward. Trajan acquired enormous booty, and the mines, perhaps a motive for the conquest, were immediately exploited; important roads were built; and Sarmisegetusa and Tsierna (mod. Orşova) became colonies. The new Roman province was at first put under a consular legate with at least two legions, but under Hadrian it was divided: Dacia Superior under a praetorian legate comprised Transylvania, with a single legion at Apulum (Alba Iulia, Ger. Karlsburg), while Dacia Inferior in what was afterward Walachia was governed by a procurator. In 159 Antoninus Pius redivided the area into three provinces, the *Tres Daciae* (Dacia Porolissensis, Dacia Apulensis and Dacia Malvensis), all subordinate to one governor of consular rank; Marcus Aurelius made them a single military area about 168.

The limits of Roman territory were probably never clearly defined, but militarily the occupation had great advantages for Rome. It was not so much the unsatisfactory character of the Dacian frontiers as the need for troops south of the Danube that caused the abandonment of the province by Aurelian about 270. For the later history of the area *see* Rumania; Vlachs.

Both Dacian warriors and Dacian peasants are portrayed realistically on Trajan's column in Rome. The sculptor also depicts the strength of their mountain fortresses, some of which have been excavated. By Domitian's time the Dacians enjoyed a compact government and a fairly advanced culture, though they retained the division into the upper class of *pileati* (wearing the felt hat) and the proletariat of *capillati* (who wore their hair long). But the people who entered after the conquest were able to impose new cults and customs from all parts of the Roman empire, and the influence of the Latin language on modern Rumanian remains the most striking survival in this region from ancient times (*see* Rumanian Language).

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DACIER, ANDRÉ (1651–1722), French classical scholar, who, with his wife (*see* below), was responsible for some of the famous Delphin series of editions of Latin classics. Born at Castres, Languedoc, in 1651, he studied at Saumur with the humanist Tannegui Lefebvre (1615–1672), whose daughter, Anne, he married in 1683.

Dacier was made keeper of the library of the Louvre and in 1695 was elected to the Académie Française, of which he became permanent secretary in 1713. He died in Paris, Sept. 18, 1722. His pedantic, somewhat uninspired, works include editions of Horace, Aristotle's *Poetics*, two plays by Sophocles, some Epictetus and Hippocrates, Plutarch's *Lives*, and, for the Delphin series, of Festus and Flaccus.

His wife, Anne Lefebvre, was born in Preuilly-sur-Claise in 1654 and educated by her father. Her work as classical commentator, translator and editor, begun before her marriage, attained greater fame than that of her husband. Her most celebrated work, her prose translations of the *Iliad* (1699) and the *Odyssey* (1708), rapidly became known throughout Europe, and by making Homer widely read among French men of letters, played an important part in the famous controversy about the merits of ancient and modern authors, in which she herself became keenly involved. Mme Dacier's own enthusiastic admiration of Homer and scholarly study of the texts override her occasional inadequacies as stylist and translator. Her other works include Delphin editions of Florus, Dictys Cretensis, Aurelius Victor and Eutropius; an edition of Callimachus; and translations of Anacreon, Sappho, Terence and plays by Plautus and Aristophanes, and, with her husband, of Horace. She died in Paris, Aug. 7, 1720.

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DACITE, in petrology, a volcanic rock which may be considered a quartz-bearing variety of andesite (*q.v.*). Like the latter it consists for the most part of plagioclase feldspar with biotite, hornblende, augite or enstatite, and generally has a porphyritic structure with scattered larger crystals in a fine-grained groundmass, but contains also quartz as rounded, corroded phenocrysts or grains, or as an element of the groundmass. When its structure is glassy it is known as dacite-pitchstone (*see* Pitchstone). The feldspar content of dacite ranges from oligoclase to andesite and labradorite; sanidine occurs also in some dacites, and when abundant gives rise to rocks which form transitions to the rhyolites. From this list of minerals it is readily seen that the dacites are the volcanic equivalent of the plutonic tonalites. Many of the hornblende- and biotite-dacites are gray or pale brown and yellow rocks with white feldspars and black crystals of biotite and hornblende; others, especially augite- and enstatite-dacites, are darker coloured. The name is from Dacia (*q.v.*), a district of central Europe, and rocks of this group occur in Rumania, Almeria (Spain), Argyllshire and other parts of Scotland, Victoria, New Zealand, the Andes, Martinique, Nevada and other districts of western North America, Greece, etc. They are mostly associated with andesites and trachytes, and form lava flows, dikes and in some cases massive intrusions in the centres of old volcanoes.

Among continental petrographers the older dacites (Carboniferous, etc.) are often known as porphyrites.

DACRON (Terylene), a man-made polyester fibre. Groundwork for its development was laid by E. I. du Pont de Nemours and Company in the 1930s. Polyesters were among the first man-made fibres developed, although the Du Pont program ultimately led to polyamides (nylon). British research chemists of Calico Printers Association, Ltd., continued the study of polyesters and

developed the polyester fibre now known as Terylene.

Du Pont continued working on its own program and independently prepared the same polyester developed in England. As a result of these parallel developments, du Pont purchased the United States patent application filed by the British and subsequently was granted a patent in 1946. Du Pont named its fibre Dacron.

In the production of Dacron, dimethyl terephthalate and ethylene glycol, derived from coal, air, water and petroleum, are polymerized. Then the substance is melt spun into filaments. The dimensional stability and springiness of the fibre contributed considerably to the popularity of wash and wear clothing.

(C. H. Ru.)

DACTYL, a foot or metron in verse. The classical dactyl consists of long and biceps: — ⏑⏑. The form — ⏑⏑ is commonly called a dactyl, the form — — a spondee. The most common type of dactylic verse is the hexameter (*q.v.*). Dactylic cola of various lengths, notably the pentameter ending in a spondee and the tetrameter ending in either a spondee or a dactyl, are found in Greek lyric poetry (Alcman, Attic drama, etc.). In Latin, dactylic tetrameters with final dactyl are found among the fragments of Ennius' tragedies and in lyric passages of Seneca's. In *Odes* I, iv, Horace uses a verse compounded of dactylic tetrameter and ithyphallic (— ⏑ — | ⏑ — —) alternating with a catalectic iambic trimeter; *e.g.,*

Sōlvĭtŭr | ācrīs hī | ēms grā | tā vĭcĕ || vērīs ēt | Făvōnī,
trāhūntquĕ sīc | cās māchĭnāē | cărīnās

Dactylic tetrameters with final spondee alternating with hexameters are used in two of Horace's *Odes* (I, vii and xxviii), *e.g.,*

mēcūm | saēpĕ vĭr | ī || nūnc | vīnō | pēllĭtĕ | cūrās;
crās īn | gēns ītĕr | ābĭmŭs | aēqŭor.

The so-called "aeolic dactyls" of Sappho, Alcaeus and Theocritus (xxix) are really prosodiacs with aeolic base (*see* Prosody, Classical).

The type of Greek lyric metre called "dactylo-epitrite" is in no way akin to true dactyls (*see* Prosody, Classical).

Dactylic rhythm in English verse produces a lilting movement; *e.g.,*

Knów yĕ thĕ lánd whĕre thĕ cýprĕss ănd mýrtlĕ (Byron, *Bride of Abydos*). (L. P. E. P.)

DADAISM was a literary and artistic movement, international in scope and nihilist in character, which lasted from 1915 until 1922. It was named and embodied in Zürich by a group of writers and artists who found refuge from World War I, among them the Rumanian poet Tristan Tzara, the German writers Hugo Ball and Richard Hülsenbeck and the Alsatian poet and sculptor Hans Arp. Hülsenbeck wrote (in 1920): "The word 'Dada' was accidentally discovered by Hugo Ball and myself in a German-French dictionary . . . Dada is French for a wooden horse. It is impressive in its brevity and suggestiveness." For his part, Tzara claimed to have discovered the word at 6 P.M. one evening at the Terrace café at Zürich. An arts club, the Cabaret Voltaire, was founded as a setting for exhibitions and deliberately outrageous lectures and entertainments. The periodical *Dada,* edited by Tzara, commenced publication in 1917. *Dada 3* included the Dada manifesto, which announced a program of demolishing all existing ethical and artistic standards.

Meanwhile in New York the painters Marcel Duchamp and Francis Picabia, both archetypal Dadaists, heralded the movement with Alfred Stieglitz, who published an antiartistic periodical called *291.* Duchamp ridiculed accepted values with his "ready-mades" (mass-produced articles, signed by him and exhibited as works of art), Picabia with pictures of completely purposeless machines.

In 1917 Picabia returned to Europe, founded a Dada review in Barcelona and joined Tzara in Zürich, where the movement was expressing disgust for the war in sustained abuse of the established order. In the following year, Hülsenbeck started a political Dada movement in Germany, a savage denunciation of militarism, illustrated by exhibitions by Georg Grosz. In Cologne, Max Ernst was the leader of an active group, while in Hanover, Kurt Schwitters, under Dadaist auspices, created collages of discarded rubbish which he called *Merzbilden.* After *Dada 4–5* (called "Anthologie Dada"), which contained work by nearly all the known Dadaists, Tzara moved to Paris where he collaborated in producing the review *Littéraire.* Dada survived, mainly as a literary movement, until 1922 when it was engulfed by Surrealism (*q.v.*). In its assault on the very sources of its own origin, it was inevitably self-destroying. *See* also Painting: *Dadaism.*

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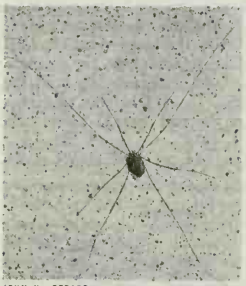
DADDY LONGLEGS, a popular name given to arachnids of the order Opiliones (Phalangida). They are often called harvesters, harvest spiders or harvestmen, especially in Europe, on account of their abundance in the late summer and early autumn. Daddy longlegs differs from all true spiders (order Araneae or Araneida) by the extreme length and thinness of the legs, and by the small size and spherical or oval shape of the body, which is not divided into two regions by a constriction. The French name *faucheurs* ("mower," "reaper") given to these arachnids alludes to the ability of detached legs to contract and extend in a fashion reminiscent of the mower swinging the scythe. They are very widely distributed, being abundant in temperate countries of both hemispheres and common in the tropics.



JOHN H. GERARD

DADDY LONGLEGS (OPILIO PARIETINUS)

Daddy longlegs are predacious, feeding upon small insects, mites and spiders. The males are smaller than the females, and often differ markedly from them. The male has a long protrusible penis. After the pairs mate in the autumn, the female, by means of her long, protrusible ovipositor, lays her eggs in some cleft or hole in the soil. Shortly after breeding, the parents die. The eggs hatch with the warmth of spring.

The adults are provided with a pair of glands, situated one on each side of the carapace, that secrete an evil-smelling fluid. The long legs of harvestmen serve them not only as organs of rapid locomotion, but also as props to raise the body well off the ground, thus enabling the animals to stalk unmolested from the midst of an army of raiding ants. Harvester is sometimes, but erroneously, used as a synonym for harvest bug (*see* Chigger).

See also Arachnida.

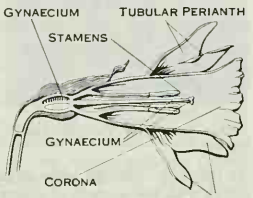
DAEDALUS, a mythical Greek architect and sculptor, who was said to have built the labyrinth for Minos of Crete, to have made a wooden cow for Minos' wife, Pasiphaë, and a bronze man who resisted the Argonauts. Falling under the displeasure of Minos, he fashioned wings for himself and his son Icarus and escaped to Sicily. These legends seem primarily to belong to Crete, and the Athenian element, which connected Daedalus with the royal house of Erechtheus, is a later fabrication. The Greeks of the historic age were in the habit of attributing to Daedalus buildings and statues the origin of which was lost in the past. In many cities of Greece there were archaic statues, said to be by him. Later critics ascribed to Daedalus such improvements as separating the legs of statues and opening their eyes. In fact, the name Daedalus (literally "cunningly wrought") is a mere symbol, standing for a particular phase of early Greek art, when wood was the chief material for carving. In the *Iliad* he is mentioned as the maker of a dancing place in Crete. This Daedalus must not be confused with the historic personage Daedalus of Sicyon, a great sculptor of the early part of the 4th century B.C., none of whose works is extant.

DAEMON, a general Greek term for a supernatural power, in Homer used almost interchangeably with *theos* for a god. The

distinction is that *theos* emphasizes the personality of the god and *daemon* his activity. Hence *daemon* is regularly applied to sudden or unexpected supernatural interventions not due to any particular deity. It became commonly the power determining a person's fate, and a man could have a personal *daemon*. As early as Hesiod the dead of the golden age became *daemones*, and later philosophical speculation envisaged these as lower than the gods (possibly mortal) but as superior to humanity. The Christians therefore attributed the actions of the pagan gods to *daemones*, identified as fallen angels. (H. W. Pa.)

DAENDELS, HERMAN WILLEM (1762–1818), Dutch soldier who served with distinction in the army of the Batavian republic and later ably administered the Dutch East Indian possessions, was born at Hattem, in Gelderland, Oct. 21, 1762. He became a solicitor at Hattem, where he led the anti-Orangist "Patriot" movement. In 1787 he took part in the defense of Amsterdam against the Prussian intervention on behalf of the Orangists and after the defeat of the Patriots went to live in France. Joining the French Revolutionary army, he took part in the invasion of Holland in 1793. During the period of the Batavian republic he rose to the rank of lieutenant-general and twice helped to overthrow the government by force (Jan. and June 1798) in order to give it a more centralized character. In 1799 he commanded a Dutch army against the British and Russians at Alkmaar. Made governor general of the "Asian colonies and possessions" in 1807 by Louis Napoleon, then king of Holland, he ended the financial abuses of the former Dutch East India company and built the great highway through central Java. In 1815 he was appointed governor of the Dutch possessions on the west coast of Africa. He died at Elmina, Gold Coast, May 2, 1818. (F. De J.)

DAFFODIL, the common name of a group of plants of the genus *Narcissus*, family Amaryllidaceae (*see* Narcissus). The common daffodil or trumpet narcissus, *N. pseudo-narcissus*, is frequent in woods and thickets in most parts of northern Europe, but is rare in Scotland. It is sparingly naturalized in the eastern United States as an escape from cultivation. Its leaves are five or six in number, are about a foot in length and an inch in breadth, and have a blunt keel and flat edges. The flower stalk is about 18 in. long, the spathe single flowered. The flowers appear early in the year. They are large, yellow, scented and a little drooping, with a corolla deeply cleft into six lobes and a central bell-shaped crown or corona which is crisped at the margin. This "trumpet" is at least as long as the petals. The stamens are shorter than the cup, the anthers oblong and converging; the ovary is globose and has three furrows; the seeds are roundish and black. The bulbs are large, orbicular, and have a parchmentlike coat.



FROM GROOM'S "ELEMENTARY BOTANY" (G. BELL & SONS LTD.)

DAFFODIL (NARCISSUS PSEUDO-NARCISSUS), DIAGRAM OF SECTION OF THE FLOWER

The daffodil is a native of England and is widely cultivated in America. Each stem has one yellow trumpet-shaped blossom

ROCHE

COMMON DAFFODIL OR TRUMPET NARCISSUS (NARCISSUS PSEUDO-NARCISSUS)

The trumpet narcissus or common daffodil is ubiquitous in European and American gardens. Its popularity has resulted in the production of many varieties differing from the parent yellow form mostly in colour. Varieties are offered with white flowers; with pink trumpet and white petals; with orange trumpet and yellow petals; with white petals and yellow trumpet and many others (over 40), but none red or blue. The plants are superb when naturalized in masses in the lawn and should be replanted every three or four years as crowding reduces bloom, which explains why many old plants produce only foliage. The Peruvian daffodil and the sea daffodil are species of the genera *Hymenocallis* and *Pancratium*. (N. Tr.)

DAFYDD AP GWILYM (fl. *c.* 1340–1370), the greatest Welsh poet of the 14th century, was born of a noble family *c.* 1320 at Brogynin, Cardiganshire. Little is known of his life, except that he visited Anglesey and Caernarvonshire and knew many prominent families in Cardiganshire. He died *c.* 1380. His *awdlau* (odes) and *cywyddau* (a form of short ode) show that he was trained in the Welsh bardic art and connect him historically with the native poets of the princes, but his use of certain poetic conventions proves that he was influenced by the troubadours and wandering scholars. The main subjects of his authentic poems (about 139) are nature and love, which he treats with great sensibility and wit, and unrivaled mastery of the intricate system of *cynghanedd* (*q.v.*). *See* also Welsh Literature.

Bibliography.—I. Williams, *Cywyddau Dafydd ap Gwilym a'i Gyfoeswyr* (1935); *Dafydd ap Gwilym, Fifty Poems*, trans. by H. I. and D. Bell (1942); T. Parry, *Gwaith Dafydd ap Gwilym* (1952). (T. Js.)

DAGENHAM, a municipal borough (1938) of Essex, Eng., which under the London Government Act 1963 was divided on April 1, 1965: the southern part (on the Thames) was amalgamated with Barking (to the west) to form the new London borough of Barking, and the northern was joined with Ilford (to the west), Wanstead, and Woodford, and a small part of Chigwell to form that of Redbridge. (*See* London.) Dagenham had a population (1961) of 108,363. It is a parliamentary constituency. The town developed rapidly from a country parish (pop. 1921, 9,127) to a big residential and industrial community, largely because of the building of the Becontree housing estate and the introduction of large-scale industries, such as the Ford Motor company works (1931–32) near the river. Another industrial belt in the north includes Chadwell Heath, near Central Park, part of the old Hainault Forest. Cables, paints, and electrical goods are made.

DAGESTAN AUTONOMOUS SOVIET SOCIALIST REPUBLIC (Dagestanskaya Avtonomnaya Sovetskaya Sotsialisticheskaya Respublika), in the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the northern flank of the Greater Caucasus range at its eastern end and along the western shore of the Caspian sea. Pop. (1959) 1,062,472. Area 19,421 sq.mi. Russia annexed the Persian province of Dagestan in 1813, but rule was not enforced over the rebellious Khans until 1877. The republic was formed in 1921 after civil war, but from World War II to 1957 the northern part was transferred to Grozny *oblast*, now Chechen-Ingush Autonomous Soviet Socialist Republic.

Physical Features.—Dagestan can be divided into five physical regions. The first, occupying most of the southern half of the republic, consists of the Caucasus mountains, there at their widest. The southern boundary of Dagestan runs along the main crest ridge, which rises to 11,634 ft. in Mt. Guton and 14,698 ft. in Mt. Bazar-Dyuzi. North of the main range the Andiyski-Salatau and Gimrinski ranges enclose a huge triangle of extremely rugged mountains, very difficult of access. The chief ranges of this so-called Dagestan Interior highland are the Bogosski and Kukatl ranges. These mountains, of highly folded limestones and sandstones, are cut up by the deep valleys and canyons of the many rapid rivers flowing down to the Caspian, notably the Sulak (with its headstreams the Karakoysu and Andiyskoye Koysu), the Samur and the Kurakh. The canyon of the Sulak, as it breaks through the mountain rim, is up to 5,000 ft. deep. Rainfall is very low in the mountains, especially on south-facing slopes, and wide areas are devoid of vegetation. Only in the valleys and canyons are there patches of deciduous forest. On the higher main range are forests of pine and birch, giving place higher up to Alpine pastures.

Secondly, north of this wild and forbidding complex of mountains, is the zone of foreland hills, about 12–25 mi. wide and rising to 2,000–3,000 ft. There rainfall is much higher, from northerly

and northwesterly winds, about 20–30 in. a year. This allows a dense forest cover of oak, beech, hornbeam, maple, poplar and black alder. The lower slopes have good chestnut soils and even patches of black earths, with a grass steppe vegetation.

The third region is the narrow coastal plain between the mountains and the Caspian, from 2 to 20 mi. wide, and crossed by the rivers debouching from their gorges. This plain has only recently emerged from the Caspian and is covered by marine sediments, especially sand. Petroleum and natural gas occur there.

The fourth area continues the coastal plain northward, at the narrower "waist" of the republic, and consists of the low, swampy plain in the lower course of the Terek river and its delta. Saline swamp soils are common. The Terek and its distributaries flow between artificial dykes, 10–12 ft. above the surrounding land. Just off the delta is the long, sandy Agrakhanski peninsula.

Finally, north of the Terek, Dagestan broadens out again to include most of the rolling, sandy plain of the Nogai steppe, as far as the river Kuma, the northern boundary. In this area low, latitudinal ridges and depressions alternate. The climate is hot and dry, with only 8–10 in. of rain a year. Vegetation is thus of a semidesert character, dominated by sagebrush, developed on poor chestnut soils.

Population.—The great difficulty of access made Dagestan both an area of refuge and an area where peoples have developed into separate tribes, largely cut off from each other. As a result few areas of the world show such great ethnic complexity, and it is sometimes said that every valley has its own nationality and language. There are about 30 ethnic groups in all, most of which are Caucasian, Turkic or Iranian. By the 1959 census the largest Caucasian nationalities were the Avars (268,000), who include the Andiy groups, followed by the Lezgians (223,000), Darghins (158,000), Laks (64,000), Tabasarans (35,000), Aguls (8,000), Rutuls (7,000) and Tsakhurs (6,000). The largest Turkic groups are the Kumyks (135,000) and Nogai (41,000), while the Tats are the main representatives of the Iranians. Only in the lowlands and towns are found Russians (about 15% of the population), Azerbaijanis, Armenians, Jews and Ukrainians. In all, 81 nationalities are distinguished. The total population in 1959 was 1,062,472, of whom 315,000 (30%) lived in the 7 towns and 6 urban districts. The chief towns are the capital, Makhachkala (119,000), Derbent (*q.v.*), Kislyar and Buynaksk. (*See* also CAUCASUS, PEOPLES OF.)

Economy.—Dagestan is rich in minerals, including coal, iron ore and nonferrous metals, as yet little exploited, because of the difficulty of the country (the name Dagestan is a Turkic term meaning "mountain country"), but petroleum and natural gas are obtained along the coastal plain, centred on Makhachkala, Achi-Su and Izberbash. The fast-flowing rivers provide hydroelectric power. There are large plants on the Karakoysu at Gergebil and on the Terek at Kargalinskaya and about 80 small, local stations. A big plant was constructed at Kizil-Yurt on the Sulak after 1960. Glassmaking is an important industry, and there is a large glassworks at Dagestanskiye Ogni, just northwest of Derbent (the latter place is on the main railway line to Baku and is a centre for the oil fields to the northwest). But, apart from engineering in Makhachkala, other industry is largely confined to the processing of agricultural products and to traditional handicrafts, especially iron-working and carpet making. Timber is exploited, but the scale is limited by the rugged terrain.

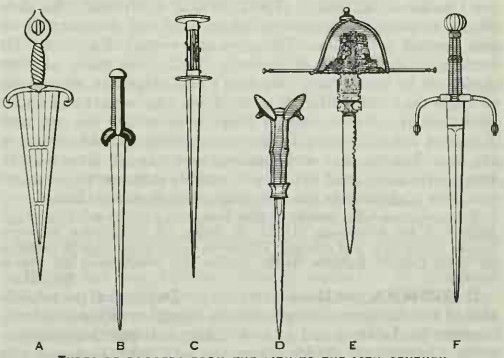
The bulk of the population derive their living from agriculture, above all from livestock, since only 15% of the area is arable. Sheep, in particular, are kept in very large numbers. There is considerable transhumance from winter pastures on the Nogai steppe to summer pastures high in the mountains. Arable farming, where it is carried on, is usually intensive. Hillsides are often terraced, while the Terek delta and the coastal plain have many irrigation schemes, supplying water to 74% of the arable. Vineyards are extensive, especially around Derbent on the coastal plain and Kislyar in the Terek delta, while fruit and vegetables, including cherries, apricots, apples, pears, quince and melons, are grown in quantity. Subtropical fruits, pomegranates, figs and almonds are also grown and a start has been made in growing tea. Wheat and maize (corn) dominate the cereal crops, with rice in the Terek delta. Settlements along the Caspian shore engage in fishing. *See* also CAUCASUS. (R. A. F.)

DAGGER, a hand weapon with a short blade, the diminutive of the sword. In the study of ancient times it is often impossible to distinguish the dagger from the primitive sword, and at a later date the distinction between a long dagger and a short sword is frequently vague. An excellent example is the medieval scramasax of northern Europe; its blade ranged in length from 4 to 20 in. Still later, the broad-bladed cinquedeas of 1475–1550 had almost as great a range and could be used as either swords or daggers. By 1300, however, the dagger was generally recognized as a distinct weapon.

Among the European daggers of the 14th, 15th and 16th centuries, the principal types were the *quillon* dagger with a simple cross guard; the basilard, a variation of the *quillon* dagger with parallel bars for the guard and pommel; the kidney dagger with a guard formed by two lobes; the rondel dagger with disk-shaped guard and pommel; the eared dagger with a pommel formed by two disks set at an angle flaring outward; and the stiletto, usually a quillon dagger with a narrow three- or four-sided blade. These were all stabbing weapons, and since it was often necessary to penetrate armour with the blow, they were held with the blade below the hand. This limited the variety of strokes but afforded greater power.

During the 16th century a new school of fencing evolved in which the dagger was held in the left hand and used for parrying the opponent's sword, thus leaving the user's own sword free for attack. For this new use, the left-hand dagger developed. Since its principal function was parrying, it needed a large guard. In northern Europe this need was met by lengthening the guard of the *quillon* dagger and sometimes adding a ring to protect the knuckles. In southern Europe, the cross guard was lengthened, a triangular knuckle guard was added, and the widened blade was frequently notched as a further aid in entrapping an enemy's blade. This form of left-hand dagger is usually called a main gauche to distinguish it from its northern counterpart. Both types were held with the blade above the hand in the manner of a sword.

Because of its convenient size a dagger could be drawn quickly, worn inconspicuously and used in a confined space. Its general utility as both a weapon and a tool has made the dagger popular with both soldiers and civilians of all ages and cultures. The many varieties of specialized European daggers and the wealth of African, Asian and native American types make it impossible even to list their names in a short article. They include, for example, the wavy-bladed Malayan kris, the short curved-bladed kukri with its broad heavy point used so dextrously by the Gurkhas as late as World War II, and the Hindu katar with its flat triangular blade and cross-bar grip designed so that the user "punched" with it. Among the strictly military daggers would be the musketeer's dagger which developed into the bayonet, the artillerist's



TYPES OF DAGGERS FROM THE 14TH TO THE 16TH CENTURY

(A) Cinquedea; (B) kidney dagger; (C) rondel dagger; (D) eared dagger; (E) main gauche; (F) left-hand dagger

stiletto with his scales etched on the blade, and so on down through many of the trench knives of World Wars I and II.

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DAGNAN-BOUVERET, PASCAL ADOLPHE JEAN (1852–1929), French painter of realistic scenes of everyday life, was born in Paris on Jan. 7, 1852. He studied under Gérome at the École des Beaux-Arts, and first attracted notice by his picture "A Wedding at the Photographers" in the Salon of 1879. He joined the movement, initiated by Bastien-Lepage in France, which took up the study of contemporary life. From 1880 onward he made Brittany with its rustic types and religious festivals his special sphere. A harmonious green tone pervades his open-air effects. He was a fine draftsman and also practised lithography. For the Sorbonne he painted a large panel representing Apollo and the Muses. Dagnan-Bouveret died at Quincey (Haute-Saône), July 3, 1929.

DAGOBERT I (d. A.D. 639), Frankish king of the Merovingian dynasty, was the elder son of Clotaire II. His father in 623 made him king of part of Austrasia, appointing Arnulf, bishop of Metz, and Pepin of Landen to be his advisers. Married to his stepmother's sister Gomatrude in 625 or 626, Dagobert then made his father cede to him Reims, Toul and Verdun, as having formerly belonged to Austrasia. On his father's death (629), he raised an army, marched on Soissons and made the magnates of Neustria recognize him as their king also, leaving his half-brother Charibert (d. 632) the control only of Toulouse, Agen, Cahors, Périgueux and Saintes, with orders to set up a march or mark on the Gascon (Basque) frontier. His tours of inspection in Burgundy and in Austrasia (630–631) won him a reputation for justice. He then fixed his residence in Paris, where his ancestor Clovis had had his capital. To appease the Austrasians' resentment at this move he gave them his three-year-old son Sigebert as king (634). A Gascon revolt was quelled by an army raised in Burgundy, after which the Gascon duke Aegyna came to Clichy to make his submission (637), as the Breton chief Judicaël had already done (636). The peace that he enforced within his kingdom made Dagobert respected abroad: he signed a treaty of friendship with the Byzantine emperor Heraclius (629) and was able to intervene in Spain (631), to conciliate the Lombards and to obtain by diplomacy what warfare had failed to obtain from the Saxons and from the Bohemian Wends. The historian Fredegarius, hostile to the house of Dagobert, represents him as greedy and lecherous, and debauchery may have shortened his life, but even so Dagobert was a great king whose enterprises in many respects foreshadowed those of the Carolingian rulers.

The prosperity of Dagobert's reign and the revival of the arts under him can be judged from the rich contents of the tombs of the period and from the goldsmiths' work for the churches; *e.g.*, the Chelles chalice and St. Éloi's cross at St. Denis. The techniques of cloisonné ornamentation on gold and damascening on iron reached perfection. The reign also witnessed a remarkable increase in the number of monastic foundations, many of them sponsored by members of Dagobert's own entourage, such as his protégés the bishops Éloi (Eligius), Ouen (Audoenus) and Didier (Desiderius). Excavations in 1955 demonstrated the part that Dagobert himself played in the construction and decoration of the great basilica that was then replacing the old church at St. Denis. He was buried in it in 639, and his monument (re-erected with new sculptures in the 13th century) still stands there.

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DAGOMBA, the Hausa name for the Dagbamba, the inhabitants of the chiefdom of Dagbon in the Northern region of Ghana, bounded on the north and south by Mamprusi and Gonja respectively. In 1960, the chiefdom incorporated 150,000 Dagomba who speak Dagbane (a Gur language); 40,000 Konkomba (*q.v.*), an autochthonous people; and 10,000 Akan-speaking Chakosi, originally brought in as mercenaries. The main occupation of the Dagomba is farming, the chief crops being sorghum, pennisetum, maize, yams and groundnuts. Dwarf shorthorn cattle, sheep, goats, chickens and guinea fowl are kept. The paramount chief, the Ya-Na, lives at Yendi, while the largest town is Tamale (pop. [1948] 16,164), the administrative and commercial centre for the Northern region.

Apart from Muslims and strangers, the population is divided into chiefly families and commoners. Only sons of previous paramounts may rise to the highest office, which is filled in rotation by a divisional chief of Karaga, Mion or Savelugu. The rulers, claiming common descent with the chiefs of Mossi, Mamprusi, Nanumba and Wa, regard themselves as invaders from the north. Formerly the chiefdom extended south to the Black Volta but was reduced in size by the conquests of the Gonja in the mid-17th century. At the end of that century, the Dagomba were subjugated by the Ashanti (*q.v.*), who forced them to pay an annual tribute of slaves, which only ceased in 1874 when the Ashanti were defeated by British forces.

See M. Manoukian, *Tribes of the Northern Territories of the Gold Coast* (1952). (JO. R. G.)

DAGUERRE, LOUIS JACQUES MANDÉ (1789–1851), French painter and physicist, inventor of the daguerreotype, was born at Cormeilles, in the *département* of Seine-et-Oise, and died on July 12, 1851, at Petit-Brie-sur-Marne, near Paris. He was at first an inland revenue officer and then a scene painter for the opera. In 1822, in conjunction with Bouton, he opened at Paris the Diorama, an exhibition of pictorial views, the effect of which was heightened by changes in the light thrown upon them. A similar establishment was opened by Daguerre in Regent's Park, London; it was destroyed by fire on March 3, 1839. This reverse was more than compensated by the success of his daguerreotype photographic process. J. Nicéphore Niepce, who since 1814 had been seeking to obtain permanent pictures by the action of sunlight, learned in 1826 that Daguerre was similarly occupied. The two investigators worked together on their "heliographic pictures" from 1829 until the death of Niepce in 1833. Daguerre, continuing his experiments, discovered eventually the process connected with his name. On Jan. 9, 1839, at a meeting of the Academy of Sciences, D. F. J. Arago emphasized the importance of the discovery, and Daguerre was appointed an officer of the Legion of Honour. A law of 1839 assigned to Daguerre and the heir of Niepce annuities of 6,000 fr. and 4,000 fr. respectively, on condition that their process should be communicated to the Academy. Daguerre's process, together with his system of transparent and opaque painting, was accordingly published by the government. *See* also PHOTOGRAPHY: *History*.

See H. and A. Gernsheim, *L. J. M. Daguerre* (1956).

DAGUR (DAUR), a Mongolian people living in the Heilungkiang province of northern Manchuria, reportedly numbering 200,000 but probably less than 10,000. Their language, formerly thought to be Tungusic or a mixture of Mongolian and Tungus, is now known to be an archaic Mongolian dialect preserving features found in 13th-century documents. Their own name is Dagur (*daɣur*), but the Manchu form Dahur is found in Latin plant names such as *dahurica*. The Russian form Daur occurs in the name of the Daur mountain range.

Russian settlers in the 17th century found Dagurs well-established in eastern Transbaikalia and the Amur region, and the first Siberian ecclesiastical mission went to them in 1682. The Chinese government, however, not wishing them to fall under Russian sway, resettled them. By the early 20th century, Dagurs lived largely in Heilungkiang, around the city of Hailar, and in the Nonni river valley near the city of Tsitsihar. Their chief occupations are agriculture, logging, hunting, stock raising and horse-breeding. The clan system prevails, and their religion is shamanistic, with some Lamaists.

The Dagur used Manchu or written Mongolian until a Dagur, Merse, devised a Latin transcription in 1920, since abandoned. There is a well-developed oral epic literature in which the works of the mid-19th-century poet Rabdan are outstanding.

According to Soviet reports, the Solon, a Tungus tribe number-

ing 17,000 in the valley of the I-li Ho (Ili river) of the Sinkiang Uighur autonomous region, were renamed Dagur in 1954 by government decree. Some western investigators, however, are skeptical that the Solon, Manchu and Sibo, so listed in censuses, still exist as ethnic groups. *See* also TUNGUSES.

See N. Poppe, *The Dagur Dialect,* in Russian (1930); S. E. Martin, *Dagur Mongolian Grammar, Texts and Lexicon* (1961); "Dagor Mongols of the Nonni River Valley," ch. 4 of H. H. Vreeland III, *Mongol Community and Kinship Structure* (1954). (J. KR.)

DAHABEAH: *see* BOAT.

DAHLBERGH, ERIK JÖNSSON, COUNT (1625–1703), Swedish soldier, civil servant and graphic artist, was born on Oct. 10, 1625. From 1655 to 1657 he served as an engineer during Charles X Gustavus' Polish campaign and in 1656 he was appointed lieutenant quartermaster. During the Danish campaign of 1658 he was present at the crossing of the frozen Belts, but though he claims in his diary to have played a decisive role it is unlikely that he did so. He became a colonel and quartermaster-general in 1674 and played an important part in the Danish war of 1675–79. In 1680 he was put in charge of fortifications in Sweden and was responsible for the building of many new fortresses and the reconstruction of others. In 1693 he was created privy counsellor, count and field marshal, and in 1696 he was appointed governor-general of Livonia. At the outbreak of the Great Northern War in 1700 he conducted the defense of Riga with great energy and repulsed the Saxon surprise attack. He retired in 1702 and died in Stockholm on Jan. 16, 1703. As a draftsman, he is best known for his illustrations to *Suecia antiqua et hodierna* (not published till 1717) and to Samuel Pufendorf's history of Charles Gustavus (1697).

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DAHLGREN, JOHN ADOLPHUS BERNARD (1809–1870), U.S. admiral, noted for his contributions to naval ordnance, was born in Philadelphia, Pa., on Nov. 13, 1809. He entered the navy in 1826 and saw some service in the Civil War in command of the South Atlantic blockading squadron, but he is chiefly remembered as a scientific officer. His knowledge of mathematics caused him to be employed on the coast survey in 1834, and in 1847 he was transferred to the ordnance department. Dahlgren was the inventor of the smooth-bore gun which carried his name, but was from its shape familiarly known as "the soda water bottle." It was used in the Civil War and for several years afterward in the U.S. navy. Dahlgren's guns were first mounted in a vessel which cruised under his command from 1857 until 1859. They were "the first practical application of results obtained by experimental determinations of pressure at different points along the bore . . . that is by boring holes in the walls of the gun, through which the pressure acts upon other bodies, such as pistol balls, pistons, etc." When the Civil War broke out, he was on ordnance duty in the Washington navy yard, and he was one of the three officers who did not resign from Confederate sympathies. His rank at the time was commander, and the command could be held only by a captain. Pres. Abraham Lincoln insisted on retaining Commander Dahlgren, however, and he was qualified to keep the post by special act of congress. He became post captain in 1862, rear admiral in 1863, and was in command of the Washington navy yard when he died on July 12, 1870. (D. H.)

DAHLIA, a genus of herbs or near-herbs of the family Compositae (*q.v.*), containing 18 species that fall readily into three generic sections. They are indigenous to the higher altitudes of Mexico and Central America. The first section, Pseudodendron, has three species, often called somewhat inexactly tree dahlias, with rigid, erect and more or less perennial stems, these often clothed toward base with elongate, fibrous roots and in age becoming woody, very tall (even 20 to 30 ft.), internally septate at nodes but otherwise hollow or filled with a watery sap; the leaves are much subdivided and large (principal ones 2 to 3.5 ft. long). The second section, Epiphytum, has only one species, the anomalous *Dahlia macdougallii,* a white-flowered epiphyte growing upon tall trees and spreading over their tops in the rain forests of Oaxaca, Mex. The third section, Dahlia (syn. Neocaulon), contains the 14 species that typify dahlias to most people. Their stems are annual, tall (to seven or eight feet or, rarely, taller) or dwarf, erect or procumbent, internally open or imperfectly septate at nodes, elsewhere solid or hollow but devoid of watery sap, not externally covered toward the base with fibrous roots; the principal leaves are under two feet long.

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FORMAL DECORATIVE DAHLIA

The dahlia was first introduced into Great Britain from Spain in 1798 by the marchioness of Bute. The species was assumedly *D pinnata,* which later was bred with *D. coccinea* to produce many of the forms now common. The cactus dahlias of today are derived from *D. juarezii,* a cultigen, doubtless a mutant, of Mexican origin.

Varieties of cultivated dahlias belong to 13 different types, the best known being: (1) single dahlias, with a disk of tubular florets surrounded by large ray florets; (2) show dahlias, with large and double flowers, quilled florets self- or pale-coloured and edged or tipped with a darker colour; (3) fancy dahlias, unlike the show in having the florets striped or tipped with a second tint; (4) bouquet or pompon dahlias, with much smaller double, quilled flowers of various colours; (5) cactus dahlias, a race with long, acicular rays; and (6) peony-flowered dahlias, with large, floppy heads, broad florets and several tubular florets in the centre.

New varieties are procured from seed, which should be sown in pots or pans toward the end of March, or placed in a hotbed or propagating pit, the young plants being transplanted into pots or boxes and gradually hardened off for planting out in June; they will flower the first summer under favourable conditions. The older varieties are propagated by dividing the large tuberous roots, taking care to leave an eye to each portion of tuber. Valuable varieties are sometimes perpetuated through root grafts. Young, nonflowering shoots are often used in making cuttings for commercial propagation. These produce tubers, good for planting the second year. Dahlias succeed best in an open situation, and in rich, deep loam, but will succeed in most garden soils if these are manured. They flower until interrupted by frost in the autumn. The tubers are not hardy, but must be stored in a cool, dry place over winter.

The name dahlia was created by the Spanish botanist Cavanilles in honour of the Swedish botanist Andreas Dahl.

See Earl Edward Sherff, "Dahlia," *North American Flora,* series 2, part 2, pp. 45–59 (1955). (E. E. SF.)

DAHLMANN, FRIEDRICH CHRISTOPH (1785–1860), German historian and the first political writer of the "Kleindeutsch" (non-Austrian) party, was born at Wismar, then Swedish, on May 13, 1785. He studied classical philology at the universities of Copenhagen (1802) and Halle (1804). In 1812 he was invited to a chair in history at Kiel university, where he first entered politics as a vocal champion of the rights of the Schleswig-Holstein duchies. He left Kiel in 1829 for a chair of history in Göttingen, where he took part in forming the Hanoverian constitution of 1833. When in 1837 the king, Ernest Augustus, repudiated the constitution, Dahlmann led the famous protest of the seven Göttingen professors which, though without apparent effect, roused and concentrated popular feeling in Germany. Dahlmann was deprived of his post and banished. After some years in Leipzig and Jena, however, where he worked on his *Geschichte Dänmarks,* three volumes (1840–43), he was appointed by Frederick William IV of Prussia to a chair at Bonn university (1842).

Dahlmann made his reputation as a writer with his *Politik auf den Grund und das Mass der gegebenen Zustände zurückgeführt* (1835); but the books most significant of his own viewpoint and his place in the movement for national unity were his *Geschichte*

der englischen Revolution (1844) and *Geschichte der französischen Revolution.* In these works he showed a strong preference for the English form of constitution as analyzed by Montesquieu and this view and preference determined his work after 1848 on the proposed German constitution. In 1848, at Frankfurt, he was a member of the preliminary parliament and of the national assembly in the Paulskirche. He was appointed to the constitutional committee, and the draft constitution was largely influenced by his ideas. A Protestant and a northerner, Dahlmann had no emotional ties with the historic medieval empire or with Austria and he wished for the exclusion of the non-German Austrian dominions from a unified Germany. His thinking on German unity envisaged a constitutional monarchy under Prussian leadership, supported by a strong middle class. Absolutism and radicalism were alike alien to his thinking. When Frederick William IV was elected emperor by the Frankfurt assembly on March 28, 1849, Dahlmann was one of the deputation which offered him the crown in Berlin. After the king's refusal Dahlmann retired from the national assembly (May 21) and gradually from political life. He was still, however, one of the chief promoters of the Gotha conference in June 1849 and sat in the Prussian parliament (1849–50) and in the Union parliament at Erfurt (1850). He died in Bonn on Dec. 5, 1860. Dahlmann's writings influenced H. von Sybel and H. von Treitschke.

Of his other works the most important is *Quellenkunde der deutschen Geschichte* (1830), which, revised by G. Waitz and later by others, appeared in its 9th edition, under the title *Dahlmann-Waitz,* in 1931.

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DAHN, (JULIUS SOPHUS) FELIX (1834–1912), German poet, jurist and historian, author of historical novels with a didactic intent inspired by the writer's attitude to contemporary issues. He was born on Feb. 9, 1834, in Hamburg. His father, Friedrich Dahn, and his mother, Konstanze Dahn (*née* Le Gay), were on the stage and the family had been connected with the theatre for several generations. Felix Dahn grew up in Munich in an intellectual and artistic atmosphere and studied law and philosophy in Munich and Berlin (1849–53). His parents separated in 1850 and the shock drove him into a solitary asceticism which remained characteristic. His *Erinnerungen* (6 vol., 1890–95) give a vivid picture of his early life as a member of a Protestant family living in predominantly Roman Catholic Bavaria and of the growth of the liberal and monistic ideas which were to inform his work. He was appointed *Privatdozent* at Munich university (1857), after publishing several works in jurisprudence, but had already begun composing verse-epics on subjects from early German history, encouraged by Theodor Fontane and influenced by de la Motte Fouqué and Graf von Platen-Hallermünde (*Harald und Theano,* 1854–55; *Die Amalungen,* written in 1857–58, published in 1876). He was appointed to a professorship at Würzburg in 1863, then moved to the University of Königsberg in 1872 and settled at Breslau in 1888, where he achieved great popular fame as teacher, lecturer and poet. His liberal principles developed strongly at this time in the direction of Bismarckian patriotism. He became rector of the university in 1895.

His work as a scholar is enshrined in a great number of books and monographs on historical subjects, the most substantial being *Die Könige der Germanen* (11 vol., 1861–1907), *Die Urgeschichte der germanischen und romanischen Völker* (4 vol., 1881–90) and *Deutsche Geschichte von der Urzeit bis 843* (1883–88). All reveal immense erudition and great imaginative insight. Many of his essays and articles were collected in *Bausteine* (8 vol., 1879–84). His historical novels enjoyed an enormous success at the time, but are not widely read today. The best is probably *Ein Kampf um Rom* (4 vol., 1876–78), where he succeeds in infusing a tense and theatrical story about the decline of the power of the Goths in Italy with a good deal of contemporary relevance. Its success led him to produce a series of similar works, treating historical subjects in an emotional way with a pedagogic aim. His first volume of poems was published in 1857 and he produced a steady stream of poetry, mostly ballads, till the end of his life. His first marriage was dissolved. His second wife, Therese (née Freiin von Droste-Hülshoff), collaborated in some of his novels. His *Sämtliche Werke poetischen Inhalts* (21 vol.) appeared in 1899 and were augmented by four more volumes in 1903. He died in Breslau on Jan. 3, 1912.

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DAHOMEY (Fon), the name of a people living in the south of the Republic of Dahomey in Africa; they speak Fõn, a language belonging to the Kwa subfamily of the Niger-Congo family of African languages. According to a Dahoman tradition, first recorded in the late 17th century, the kingdom was formed when the conqueror of a group living on the plateau of Abomey slit open the corpse of his defeated enemy, Dã, and reared his compound over it, naming it "in the belly of Dã" or *Dã-ho-mé.* The Aladahonu dynasty, which later conquered its way to the coast, continued to reign until it fell before the French in 1894.

The traditional economy of Dahomey was based on agriculture. There was considerable craft specialization, and cowrie shells used as money laid the basis for an intricate market system. Specialists included administrators, tax collectors, priests and diviners. Social structures ranged from the polygynous immediate family (*hwe*), through the extended family (*gbe*) to the totemic clan (*xenu*). Secret societies were banned, these being regarded as potential instruments of political subversion.

World view and ritual organization are complex. The offspring of an androgynous Great God (Mawu-Lisa) constitute pantheons of nature deities; there are personal gods and forces, an ancestral cult, developing out of a complicated series of beliefs in multiple souls, magic and an intricate divining system, the cult of Fa. The whole comprises a tightly integrated conceptual unity that supports the economic, social and political systems. Dahoman culture has extensive aesthetic resources in wood carving, brass working and cloth weaving. Art has both religious and secular significance, brass figurines and appliquéd cloths being symbols of wealth and high political position. There is a wealth of narrative forms and a rich musical tradition. *See* also Dahomey, Republic of: *History; The People.*

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DAHOMEY, REPUBLIC OF (République du Dahomey), since 1960 an independent republic in West Africa, extends from the Bight of Benin in the south to the Republic of Niger in the north, where the Niger River (*q.v.*) forms its boundary. On the east it is bounded by Nigeria, on the west by the Republic of Togo, and on the northwest by the Republic of Upper Volta. It lies approximately between latitude 6° and 12° 30′ N and longitude 0° 45′ and 3° 45′ E. Measuring about 416 mi. (670 km.) north-south and about 78 mi. (125 km.) east-west (except toward the Niger where it widens to about 202 mi.), Dahomey is small compared with other African countries; its area is 43,483 sq.mi. (112,622 sq.km.) and its population (1964 est.) 2,244,000. The capital is Porto-Novo (*q.v.*).

Physical Geography.—Four regions are distinguishable: (1) the coastal belt, low, flat, and with clumps of coconut palms, an extensive sand bar forming an obstacle to the establishment of ports. Behind the sandy fringe is a depression occupied by lagoons, some interconnected (Porto-Novo Lagoon, 12 mi. [19 km.] long; Cotonou or Nokoué-Lake; Ouidah Lagoon, 25 mi. long; Grand-Popo Lagoon, connected with those of Togo), but they join the sea only at Grand-Popo and at Cotonou; (2) farther north the *terre de barre* ("bar country"), a fertile clay plateau crossed by a wide marshy depression, the Lama, between Allada and Abomey. This region is flat and uniform except for some isolated hills not exceeding 1,300 ft. (400 m.); the greater part

of Dahomey forming a plain on a crystalline base, gently undulating or dominated by occasional banks of bare rocks; (3) the Atakora massif in the northwest, reaching 2,146 ft. (654 m.), a dissected quartzite plateau flanked by escarpments from which streams flow toward the sea, toward the Niger (Mékrou, Alibori), and toward the Volta (Pandjari); (4) the eastern plains, the Borgu, and the plain of Kandi, crossed by the tributaries of the Niger and sloping down to it. Apart from the Niger, Dahomey is traversed by three large rivers: the Mono, which rises in Togo and near the coast forms the frontier between Togo and Dahomey; the small Couffo flowing into the network of lagoons at Ahémé Lake; and the Ouémé (about 310 mi. [500 km.] long). The Ouémé rises in the Atakora, is joined on the right by the Zou and then divides into two branches, one discharging into Nokoué Lake and the other into Porto-Novo Lagoon.

Climate.—The coastal region has an equatorial climate with a steady temperature of 72°–93° F (22°–34° C). It has four seasons: two wet, one March–July and the other late September–November, separated by two dry seasons, in the longer of which appears the harmattan, a dry, cold wind from the northeast. A sea breeze is felt inland as far as Abomey. In upper Dahomey there are only two seasons, one dry and the other wet, the wet season becoming shorter toward the north (May–September). In this part the ranges are of much more consequence. A peculiarity of the country is its comparatively low rainfall, especially in lower Dahomey where in the shelter of the uplands of Togo and of Cape Three Points it is less than 39 in. annually.

Vegetation and Animal Life.—Except along the rivers the rain forest has largely been cleared, chiefly by the Fon, who have planted oil palms and cultivate food crops, especially maize (corn). Woodland savanna covers the crystalline rocks and the sparsely inhabited regions. In the northern part of the woodland savanna region is a national park and game reserve, the Parc National du "W," which also extends into Niger and Upper Volta. There are the usual savanna species: various antelopes, elephant, buffalo, warthog, and several carnivores including lion and leopard.

(J. D.)

History.—The history of the peoples of northern Dahomey has not yet been compiled. The Dahomey or Fon, who occupy the southern part, established the three kingdoms of Allada, Porto-Novo, and Dahomey, of which the name of the most celebrated was extended by the French conquest to the whole country.

Legend relates that the daughter of the king of Tado (a town on the Mono River) while on her way to draw water, was impregnated by a leopard and bore a son, who became the founder of the dynasty. His descendants settled in the 16th century at Allada and founded a kingdom (the "kingdom of Ardra" of the old maps) with which the Portuguese established contacts. At the beginning of the 17th century three brothers, Kokpon, Do-Aklin, and Te-Agdanlin, disputed the throne. The first kept Allada, the second founded Abomey, and the third Adjatché, or Porto-Novo.

The traditional date for the founding of the kingdom of Dahomey is A.D. 1625. The son of Do-Aklin, Dakodonou, enlarged his kingdom, but it was Dakodonou's son Ouegbadja (*c.* 1645–85) who made it into a powerful state. He continually harassed Dã or Dan, the king of a small neighbouring state, with perpetual demands for more land until Dã, exasperated, asked whether he did not wish to set himself up on his (Dã's) stomach. Whereupon Ouegbadja attacked Dã, defeated him, and took him back to Abomey, where he beheaded him and threw his body into the foundations of the palace he was building; hence the name Dahomey (*Dã-ho-mé,* "in the belly of Dã").

Desirous of establishing communication with the coast in order to obtain arms by trading with Europeans, King Agadja (1708–32), one of the sons of Ouegbadja, conquered Allada and Ouidah, where European forts were already established. Thus was constituted, within definite boundaries, the old kingdom of Dahomey, of which certain peculiar customs deserve mention.

The Dahomey "Customs."—These were of two kinds: the grand customs performed on the death of a king, when people were sacrificed at his grave to provide him with wives and attendants in the spirit world; and the minor customs, held twice yearly. At the grand customs held from January to March 1791, no fewer than 500 men, women, and children were said to have been put to death. The minor customs were held periodically to replenish the dead king's train of attendants in the spirit world.

Of the victims, chiefly prisoners of war, some tied in baskets were at one stage of the proceedings taken to the top of a high platform, together with an alligator, a cat, and a hawk in similar baskets, and paraded on the heads of the Amazons (*see* below). After a speech by the king, all of them were hurled down into the middle of a surging crowd and butchered. Sir Richard Burton (*q.v.*) in *A Mission to Gelele, King of Dahome,* insisted that the horrors of these rites were exaggerated. On the death of the king the wives destroyed everything within reach and attacked and murdered each other, the uproar continuing until order was restored by the new sovereign.

The Amazons.—The training of women as soldiers was begun by King Agadja on the occasion of his capture of Ouidah. About one-fourth of the whole female population were said to be "married to the fetich." The most favoured were chosen as wives of the king or enlisted into the Amazon regiments; they took the post of honour in all battles. Burton, who in 1862 saw an army marching out of Kana on an expedition, computed the number of female troops as 2,500, of whom one-third were unarmed or only half armed. Their weapons were blunderbusses, flint muskets, and bows and arrows. The system of warfare was one of surprise. When the army was within a few days' march of the town to be attacked, silence was ordered and fires prohibited. Highways were avoided, the advance being by a track specially cut through the bush. The town was surrounded at night, and just before daybreak a rush was made and every soul captured if possible; none were killed except in self-defense, as the object was not to kill but to take prisoners to sell at the coast in order to obtain arms.

Gezo and the Forts.—King Gezo (1818–58) greatly reduced human sacrifice and ordered that there was to be no general sacrifice of the palace women on his death. He also strengthened the kingdom, extending its frontiers northward. He conducted many campaigns in Nigeria against the Yoruba (*q.v.*) to obtain slaves, but his attack in 1861 on Abeokuta was repulsed. In the same year he signed a commercial treaty with the French.

A French fort had been established at Ouidah by the Compagnie des Indes in the 17th century, but its garrison was withdrawn in 1797. In 1842 a trading firm was set up in Ouidah with French authorization. British, Portuguese, and Brazilian forts there had fallen into ruin, and when the British in 1852 blockaded the coast to prevent slaving, both France and Portugal protested. In 1857 the French established themselves at Grand-Popo.

Gezo's successor Glélé or Gelele (1858–89) offended the British and French by attacking his neighbours, persecuting Dahomean Christians and encouraging the slave trade. To check his aggressions the British in 1861 annexed Lagos. In 1863 the French signed a treaty with the king of Porto-Novo and also acquired Little Popo (Anécho). By a treaty of 1868, Glélé authorized the French to establish themselves at Cotonou. The Franco-German treaty of 1885, determining the limits of German colonization on the Togo coast, gave Little Popo and Porto-Seguro to Germany. The Portuguese claimed a protectorate over the coast but retained only their old fort at Ouidah.

French Rule and Independence.—The establishment of the French on the coast was a source of annoyance to the kingdom of Dahomey and hindered the slave trade. The death of Glélé and the accession (1890) of his son Behanzin (1889–94) precipitated hostilities. Cotonou and Porto-Novo were attacked and some missionaries were abducted from Ouidah to Abomey. One of them negotiated the Treaty of Ouidah (Oct. 3, 1890) which recognized French protection of Porto-Novo and indefinite occupation of Cotonou, in compensation for which the king of Dahomey was to receive a pension. The treaty was adversely criticized in France and little respected by Behanzin, who soon resumed his raids. The French in 1892 mounted a fresh expedition under Col. (later Gen.) Alfred Amédée Dodds (*q.v.*). The Dahomeans were defeated, and Behanzin fled. A French protectorate was established over Abomey, where a brother of Behanzin's took his place. After

BY COURTESY OF THE SERVICE DE L'INFORMATION DU DAHOMEY

PEOPLE OF DAHOMEY: (LEFT) SOMBA FROM THE FAR NORTH; (CENTRE) DAHOMEAN OF OUIDAH; (RIGHT) PEUL WOMAN FROM THE NORTHEAST

14 months of resistance and negotiation, Behanzin himself surrendered in January 1894 and was deported. The three protected kingdoms of Abomey, Allada, and Porto-Novo were absorbed into the colony of Dahomey.

In order to link the colony to their other west African possessions, the French set to work to secure the northern hinterland of Dahomey. This they achieved chiefly through the expeditions in 1895–96 of Capt. J. M. L. Baud. The convention of 1898 added the western part of Borgu to Dahomey, but did not concede access to the navigable part of the Niger, which France desired. In 1899 Dahomey was incorporated in French West Africa. On the outbreak of World War I French forces from Dahomey took part in the conquest of Togoland from Germany (August 1914).

In World War II Dahomey followed the fortunes of French West Africa (*q.v.*), adhering to the Allied cause in 1942. It became an oversea territory of France in 1946, and by 1959 achieved the status of an autonomous state of the French Community. Dahomey's independence was proclaimed on Aug. 1, 1960. In the ensuing months the republic was on several occasions disturbed by disorders, and in November 1960 a new authoritarian constitution was adopted. (See *Administration and Economy* below.)

(Hu. De.)

In 1961, under the leadership of Hubert Maga, Dahomey moved toward a single-party system of government. In October 1963 the army seized power and Col. Christophe Soglo became head of a new government. In January 1964 Sourou Migan Apithy and Justin Timotin Ahomadegbé were respectively elected president and vice-president of the republic after a constitutional referendum. The officers who led the revolution the previous October received promotion.

After a boundary dispute between Dahomey and Niger in December 1963, Niger announced its intention of expelling all Dahomean citizens. Dahomey retaliated by closing all roads and railroads into Niger. The quarrel was settled after the intervention of the Union Africaine et Malgache, but broke out again in November 1964 when Dahomey was accused of granting political asylum to political refugees from Niger. A conference held at Cotonou in May 1964 considered the possibility of creating a regional economic union between Ghana, Togo, Dahomey, and Nigeria. (X.)

The People.—Apart from a few Nago of the Yoruba family along the frontier and some Popo and Mina fishermen along the coast, southern Dahomey is inhabited by the Fon or Dahomey (*q.v.*), a patrilineal people who established the kingdom of Dahomey and the neighbouring states and who make up about half the total population. Like other members of the Kwa linguistic group (Ashanti, Ewe, Yoruba) the Fon developed an advanced civilization with full clothing, plastic arts, and a composite religion in which secondary gods, monasteries, secret societies, and divination were prominent. Their northern neighbours, the Chabe (Tshabe) and Itsha, also speak Kwa dialects.

Farther north live a large number of small tribes collectively known as Somba, paleonegritic naked cultivators who hunt with poisoned arrows and have no political organization. To the northeast, in the Borgou, are the Baroba, who speak a language related to Songhai and were formerly organized in kingdoms. Their civilization is of Sudanese type. Islam has made some progress in this region, where some nomad Fulani (*q.v.*; or Peuls) are also found. The other peoples are pagan and adhere to animistic religions, but Christianity has made important progress among the Fon. (Hu. De.)

Administration and Economy.—The first constitution was adopted in February 1959 following a popular referendum, and was replaced by a second constitution adopted by the national assembly in November 1960. French is the official language. A legislative assembly elected for five years by direct vote elects a prime minister, who himself appoints the members of his council, holds executive power, and is responsible to the assembly. In 1959 was created the *conseil de l'entente*, a cooperation agreement between Ivory Coast, Niger, Upper Volta, and Dahomey; it provided for a full customs union and a common fund of capital on which each country might draw.

There were in the early 1960s more than 500 public and private primary schools, about equally divided. Secondary schools numbered 22 and there were 8 vocational schools.

Economy.—Most of the Dahomean peoples are good cultivators, although their methods are often primitive; and vast areas have been exploited. In the south, the chief subsistence crops are maize (corn) and cassava. The peoples of northern Dahomey (especially the Somba in the Atakoras) prefer to grow large and small millet (*fonio*), supplemented by sweet potatoes and yams. The Ouémé Valley development scheme is the largest single project for the improvement of agriculture.

The main wealth of the country derives from the oil palm. The palm plantations over the plateau of the *terre de barre* and around Porto-Novo, Athiémé, Ouidah, and Abomey cover more than 2,000 sq.mi. and are continually replanted. The palm oil is extracted locally in modern mills and the crushed kernels shipped to France for extraction of the palm-kernel oil. Other exports are copra from the coastal region, cotton (a modern introduction), shea nuts, coffee, and peanuts, grown around Abomey and Parakou and in the Kandi plain. Fishing in the lagoons and rivers is more important than in the sea; fish (dried and smoked) are largely exported to Nigeria and Togo.

Minerals exist but have been little exploited. Chrome has been found in the Natitingou district in the northwest, and the iron ore of the Atakoras has long been known and was formerly worked by the Africans. Easily worked iron deposits of high quality also exist around Kandi. The gold mines of the Perma gorges near Natitingou are now inactive. Their distance from the coast has discouraged the exploitation of these mineral resources, as also that of the titanium-bearing alluviums in the centre and north of the country. Ilmenite was discovered on the coast in 1958. Industry is insignificant except for oil mills, ginning plants for cotton and kapok, and soap factories at Porto-Novo, Cotonou, and Ouidah. From the 1950's Cotonou tended to replace the administrative capital Porto-Novo as the chief port and commercial centre. Other towns are Abomey, Ouidah, Parakou, and Djougou.

Communications.—Dahomey has nearly 2,500 mi. (about 4,000 km.) of roads and 750 mi. (1,200 km.) of tracks, but the three metre-gauge railways of the Benin-Niger system, which start from

Cotonou, total only 360 mi. (580 km.) and are always in deficit. The principal line runs north to Parakou. Airlines link Cotonou with other main centres in west Africa and with France.

See also references under "Dahomey, Republic of" in the Index. (J. D.)

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DAILLÉ (Dallaeus), **JEAN** (1594–1670), French Protestant theologian, was born at Châtellerault and educated at Poitiers and Saumur. From 1612 to 1621 he was tutor to two of the grandsons of Philippe de Mornay, seigneur du Plessis-Marly. Ordained to the ministry in 1623, he was in 1625 appointed minister of the church of Saumur and in 1626 of the church of Charenton. Of his works, which were principally controversial, one of the best known is the *Traité de l'emploi des saints pères* (1632), in which he denied the authority of the Church Fathers. In his *Sermons* on the Philippians and Colossians, Daillé vindicated his claim to rank as a great preacher as well as an able controversialist. He was president of the last national synod held in France, which met at Loudun in 1659, when he defended the universalism of Moïse Amyraut. He wrote also *Apologie pour les Églises Réformées* and *La Foi fondée sur les saintes écritures*.

DAIMLER, GOTTLIEB (1834–1900), German mechanical engineer and inventor who patented one of the first successful high-speed internal-combustion engines and was also among the first to use gasoline as fuel, thereby making the engine available for automotive purposes, was born at Schorndorf in Württemberg, March 17, 1834. He attended the polytechnical school in Stuttgart and worked in England and Germany before he became technical director, working on a high-speed four-cycle engine, for the Gasmotorenfabrik Deutz in Cologne. In 1883 he founded an experimental workshop at Cannstatt, where he developed the internal-combustion engine and used it on a bicycle (1885), a four-wheeled vehicle (1886) and a boat (1887). After selling the French rights to his patent to the firm of Panhard-Levassor, with whom Carl Benz (*q.v.*) had become associated, Daimler founded the Daimler Motor Co., at Cannstatt in 1890; the firm's manufactures included Mercedes (later Mercedes-Benz) automobiles. Daimler died at Cannstatt on March 6, 1900.

DAIMYŌ (Daimio), the term used to designate the largest of the landholding magnates in Japan from approximately the 10th century onward. During the 16th century the term became limited in application to territorial lords with lands assessed at 10,000 koku (one koku equals 5.2 bu.) or more of annual grain production. In the term, *dai* means large and *myō* signifies "name-land" or private land. As the 8th century system of public domain broke down, private holdings (*myōden*) of various sorts came into being. These holdings were first consolidated into estates (*shōen*) organized under the authority of the civil nobility and religious establishments and remained within the framework of imperial government. As the military class (*buke*) became differentiated during the 11th century, private holdings of the warriors were interrelated with superior-inferior relationships among the *buke*. It is this phenomenon which has given rise to the analogy between European feudalism and Japanese society after the 12th century. The term daimyō has been applied only to the military or "feudal" territorial magnates.

Historians regard the history of the daimyō in Japan in three stages. During the 14th and 15th centuries the *shugo-daimyō*, serving as military governors (*shugo*) under the Ashikaga shogunate, held legal jurisdiction over areas as large as provinces. Their own private holdings were quite limited and their finances depended in part on dues from estates held by the court families and temples. After 1467 the country dissolved into a state of general warfare during which new local powers (*sengoku-daimyō*) created, through warfare, small but consolidated domains in which all territory belonged to themselves or was held in fief by their vassals. During this time the lands of the old court were absorbed by the *buke*. The *sengoku-daimyō* built castles in the hill country from which they controlled their vassals, who likewise were petty landholders with castles. In the 16th century these daimyō fought among themselves, creating larger and larger domains. In 1568, Oda Nobunaga began the movement of military conquest over the daimyō that was later carried on by Toyotomi Hideyoshi and completed in 1603 by Tokugawa Ieyasu (*q.v.*). By this time roughly 200 *kinsei-daimyō* had been brought under the hegemony of the Tokugawa house, the head of which served as shogun (*q.v.*). By 1869 the number of daimyō had increased to 272.

The daimyō of the Tokugawa period served as local rulers in the three quarters of the country not held as granary land (*tenryō*) by the shogun. Daimyō were joined to the shogun by oath and received their lands as grants under his vermilion seal (*shuin*). Daimyō were classed according to their relationships to the shogun as kinsmen (*shimpan*), former housemen (*fudai*) and allies (*tozama*). As of 1865, there were 23 *shimpan* holding an aggregate of 2,679,000 koku, 145 *fudai* with 6,176,000 koku, and 98 *tozama* with 9,834,700 koku. Shogunal lands amounted to 6,800,000 koku. The balance among these various classes of daimyō holdings and the shogun's own territory became the basis of the long, stable Tokugawa hegemony.

The *kinsei-daimyō* differed from their predecessors in being more nearly petty monarchs within their domains. Their own housemen were no longer holders of outlying castles but had been drawn off the land and brought into garrison residence at the daimyō's own great castle, which alone stood at the centre of the domain. The daimyō divided his domain between his granary land and the land on which his chief housemen were enfeoffed. Normally his granary land amounted to from 30% to 40% of the whole. The daimyō's housemen were divided between fief holders (*chigyō-dori*) and salaried retainers (*kirimai-dori*), the former numbering from 10% to 15% of the latter. But all daimyō worked to convert their enfeoffed vassals to the salaried status, and by the 18th century most fiefs had been absorbed under the daimyō's expanding authority.

The daimyō used his band of housemen (*kashindan*) to administer his domain. A council of elders (*karō*) held the responsibility for policy and superintendence of other officials, among whom were the heads of military units, superintendents of the castle town, rural administration, finance, security, works, religious affairs, education, a secretariat and many other specific posts. Taxes were collected primarily in kind but domains maintained active trade with the two chief entrepôts of Osaka and Edo. Within their domains the larger daimyō had considerable freedom even to the point of issuing their own paper currency with the shogun's permission.

Daimyō came under the centralizing influence of the shogunate (*bakufu*) in two chief ways. Required to alternate their residence between their domains and Edo, they became involved in the cosmopolitan life of the shogun's court. Secondly, since *bakufu* law took precedence within the country, domains adopted the general principles of Tokugawa law and bureaucratic procedure.

By the end of the Tokugawa regime, the daimyō had become removed from the actualities of government, serving as aristocratic figureheads in their domains. This in part accounted for the success of the effort to abolish the daimyō. In 1868 the *bakufu* was abolished and in 1869 the daimyō were obliged to turn back their land patents to the emperor, being made governors (*chihanji*) of territories corresponding roughly to their former domains. In 1871 the domains were abolished and the former daimyō converted into a pensioned nobility residing in Tokyo.

See also Japan: *History*. (J. W. H.)

DAINGERFIELD, ELLIOTT (1859–1932), U.S. painter, best known for his religious pictures and evanescent landscapes, was born at Harpers Ferry, Va. (now W.Va.), March 26, 1859. He received his early education at Fayetteville, N.C., and went to New York city in 1880 to study art. He exhibited first at the

National Academy of Design in 1880. Among his best-known pictures are "Christ Stilling the Tempest," "Slumbering Fog," "Storm Breaking Up," "The Child of Mary" and "The Midnight Moon." He executed the beautiful mural decorations in the Lady chapel of the Church of St. Mary the Virgin, New York city. He won the Clarke prize of the National Academy of Design, 1902. Daingerfield was the author of monographs on George Inness (1911) and on R. A. Blakelock (1914). He died Oct. 22, 1932.

DAIREN (TA-LIEN), a modern Chinese seaport city on the south coast of the Liaotung peninsula in south Manchuria. It was first developed as a seaport by the Russians in 1898 to be the terminus of the Siberian railroad and was opened to commerce in 1901. The city is usually grouped with Port Arthur (Lü-shun) and called Luta in Chinese. After the Russo-Japanese War (1904–05) when it was occupied by the Japanese, the Luta area was transferred to Japanese control and became the Kwantung leased territory. Following World War II, Lü-shun was set up in 1945 as a joint Soviet-Chinese naval base area, but Ta-lien was put under Chinese administration. On Sept. 15, 1952, the People's Republic of China and the U.S.S.R. agreed that Lü-shun would remain a joint naval base until the signing of a peace treaty between Peking and Tokyo. However, in 1955 all Soviet troops were withdrawn from Lü-shun. The urban population in the Luta region in 1957 was about 1,508,000, including 1,000,000 in Dairen. Ta-lien's population in 1938 was 515,743 of whom 351,919 were Chinese, 158,223 Japanese and 3,900 Koreans.

Ta-lien is the leading port in northeast China and one of the first-rate harbours of China. The port is sheltered by a mole 2½ mi. long, and can accommodate ships up to 20,000 tons along a row of piers extending about 3 mi. The port is well equipped with wharves, dry docks, warehouses and special loading facilities for coal and oil. It has a wide, deep and ice-free harbour. It is one of the leading shipbuilding centres of China, where 10,000-ton ocean-going vessels have been constructed. Extensive storage facilities are provided for soybeans, the principal export. In addition, it is a centre of machinery manufacturing, including railway cars, streetcars, cranes, electrical and mining equipment, machine tools, precision instruments, chemicals, cement and textiles. A petroleum refinery is also located there. (KN. C.)

DAIRY INDUSTRY. The dairy industry embraces the production of milk and its preparation for sale as well as the manufacture, distribution and marketing of dairy products. This article deals with the development of dairying as an industry. For additional information about milk and milk products the reader is referred to the separate articles on BUTTER; CHEESE; CASEIN; ICE CREAM; and MILK. For agricultural aspects of dairying *see* also the articles AGRICULTURE; CATTLE; and GRASSLAND. The role of dairying in the economy of various lands is dealt with in the articles on individual states and countries, as AUSTRALIA, COMMONWEALTH OF; DENMARK; NEW YORK; WISCONSIN.

DAIRY PRODUCTS

Milk provides nearly all of the nutritive factors essential to a good diet. These are combined in the proportions and amounts needed for the growth of infants and children and the promotion of nutritive welfare in the adult. Milk contains about 3.9% butterfat, 3.5% protein, 4.8% milk sugar and 0.7% minerals, as well as vitamins. In buttermaking, cream, which contains a concentration of the tiny fat globules of milk, is agitated (churned) under suitable conditions until the fat globules clump together. The resulting product, butter, contains from 80% to 85% milk fat, less than 1% protein and about 16% water. A small amount of salt may be added. In cheese making most of the protein and milk fat are collected from the liquid portion of the milk. Different procedures in manufacture produce dozens of kinds of cheese. A typical cheddar cheese contains about 32% milk fat, 24% protein and 5% minerals. Removal of water by evaporation under controlled procedures is the basis for the preparation of sweetened condensed milk, evaporated milk, dried milk and sterile concentrated milk (*see* FOOD PRESERVATION: *Drying and Dehydration*). If water equal in volume to that removed is added to these latter products, milk with essentially the same food value as the original product is obtained. Cream and some form of concentrated milk, e.g., condensed milk, together with cane sugar, gelatin and a stabilizer are mixed and frozen to form ice cream. To ice-cream mixes may be added such food products as fruits, nuts and chocolate. A typical commercial ice cream may contain 13% milk fat, 10% solids other than fat and 14% cane sugar. Other frozen-milk products include sherbets, ices, custards, ice milk, etc. When cream is separated from milk, the remainder, known as skim milk, contains the same components as the milk except for the fat. Skim milk, in addition to consumption by humans, is fed to young farm livestock and casein made from skim milk is extensively used in industry. Dried skim milk (nonfat dry milk) is used in meat, bakery and confectionery products as well as in the household. Buttermilk, the liquid remaining after removal of butter in the churning process, is essentially the same in composition and food value as liquid skim milk.

MILK PRODUCTION

History.—The earliest historical records note the keeping of cattle, goats and sheep for the production of milk, butter and cheese. From southwest Asia, the area of first domestication of herd animals, the custom of using milk and milk products as food for man spread to other countries. Dairy cattle thrive best in areas where pasturage and other green forage are grown in abundance. Extremely cold climates are not suitable because of the lack of green forage and the great expense of protecting the animals from the weather.

Modern dairy farming is recent in origin. At first, dairy cows were kept to furnish milk for the farm family. The marketing of milk began when customers called at the farm or farmers distributed their milk directly to users. These practices still exist but the volume of milk sold in this manner in countries where dairying is most advanced is relatively small. Within the past 100 years advances along five different lines have caused milk and milk products to become important articles of commerce: (1) The factory system of processing milk was inaugurated about the middle of the 19th century, resulting in greater uniformity of product than was possible under farm processing. (2) About the same time a method was developed for concentrating milk and sealing it in containers in sterile condition. Approximately 25 years later the distribution of milk in glass bottles was begun. Many other technological advances followed. (3) The first milk sold in towns and cities came from nearby farms. The coming of refrigeration (*q.v.*) not only aided in keeping milk fresh for a longer time than formerly but also made possible the shipping of dairy products to all parts of the world. (4) An early method of transporting milk to large cities was to ship it on railways. Motor vehicles and paved roads made possible the supplying of fresh milk to markets hundreds or even thousands of miles distant from the farms where the milk is produced. A development of the second half of the 20th century was the greatly expanded use of bulk cooling tanks on farms from which tank trucks made direct pickups. (5) The wide adoption of pasteurization and the enforcement of laws requiring proper food value in dairy products greatly benefited the entire dairy industry.

Herds.—For reasons of economy of production, most dairy farmers who sell milk employ only dairy-cattle breeds or strains of beef cattle which have been developed particularly for their milk-production qualities. Well-defined dairy breeds are found in most European countries. Outstanding dairy breeds of European origin which have become numerous outside their homelands are the Ayrshire from Scotland, Brown Swiss from Switzerland, Holstein-Friesian or Holstein from Holland and Friesland (known in some countries as Holland or Friesian) and Guernsey and Jersey from the Channel Islands. These are the predominant dairy breeds in North America, South America, South Africa, Australia and New Zealand. Milk from species other than cattle (buffaloes, goats and sheep) is relatively small in volume (11% of the total) and is largely consumed in or near the community in which it is produced. Some goat and sheep milk enters trade channels, mostly in the form of cheese.

Breeding and Herd Improvement.—About the middle of the

18th century, farmers of Great Britain began the improvement of cattle and other farm livestock. The chief practices followed were the mating of related animals and close culling. Breeders of dairy cattle early recognized the value of production records as guides to herd improvement and each of the dairy cattle registry associations in the United States opened an "advanced" or "official" registry division for recording and publishing milk yields. These tests are limited to registered cattle.

A cow-testing association for obtaining production records of any dairy herd was first established in Denmark in 1895 and such organizations are common in all dairy countries. The plan was introduced into the United States in 1905. The work is supervised by the United States department of agriculture in co-operation with the state agricultural colleges and is known as the national co-operative dairy herd improvement program. Three plans of testing are carried on. Under the standard dairy herd improvement association program, a supervisor spends one day each month with each herd. The supervisor weighs the milk produced and the feed consumed by each cow and tests a sample of each cow's milk by the Babcock method (*see* BABCOCK, STEPHEN MOULTON). That day's production is used as the average for the month. A yearly summary is reported to the state agricultural college and to the United States department of agriculture. Identification records are maintained for use in the proving of sires. Under the owner-sampler plan, the farmer takes the milk weights and samples and the supervisor completes the records. In the weigh-a-day-a-month plan, the farmer records milk weights for the individual cows and feed records for the herd. In the second half of the 20th century about 1,500,000 cows or nearly 6.5% of all milk cows in the United States were enrolled in 1,700 standard dairy herd improvement associations. These cows produced at a rate of about 9,700 lb. of milk containing 380 lb. of butterfat as compared with 6,000 lb. of milk and 240 lb. of fat as a national average.

Production records of standard dairy herd improvement associations were used in progeny testing; *i.e.*, dam-daughter comparisons and the proving of sires. In a typical year 4,586 sires were proved. After about 1940 the program of artificial breeding of dairy cows was greatly expanded. In a single year in the second half of the 20th century, 675,000 herds having a total of 6,000,000 cows were enrolled in artificial breeding work. Over 2,600 superior bulls, of which slightly more than one-third were proved sires, were in service. Programs of herd classification were given much attention by breeders of registered dairy cattle. In these programs official inspectors score each animal according to the official score card for the breed. Registration of low-scoring animals is restricted. Scientific investigations of the possibility of improving herds through hybridization and also through the transplanting of eggs of a superior cow to inferior cows for incubation were under way. (*See* also ANIMAL BREEDING.)

Feeding.—Points which are stressed in the feeding of cows for high milk yields are liberal feeding throughout the year with especial attention to improved pastures; high-quality hay from legume or grass-legume crops; the use of good-quality silage; and supplementing the roughage with grain mixtures whenever justified by price conditions. Pasture investigations have shown increased returns from heavy fertilization and such management practices as the use of legumes and heavier-yielding grasses in pasture mixtures, alternate or rotational grazing and, in some cases, hauling the chopped green forage to the herd. Hay quality was improved by the employment of conditioners which crush the stems and promote rapid field curing and by barn drying with forced draft of unheated air or of artificially heated air. Field baling and field chopping of hay increased in popularity (*see* CROP DRYING AND PROCESSING). Silage made from legumes and grasses, as well as from corn and sorghums, received much attention in the second half of the 20th century, with trench- and bunker-type silos finding increased use. Pelleted feeds were under investigation. Concentrate mixtures consisting of ground farm grains, protein supplement (*e.g.*, soybean meal, cottonseed meal, linseed meal) and minerals, with a total protein content of 13% to 18%, were commonly fed in proportion to milk yields. Antibiotic and chemical preparations used as growth or fattening stimulants for other classes of livestock had but limited place in the feeding of dairy cows because of their possible passage into the milk.

New Zealand dairy cows subsist mainly on grass pastures, hay and grass silage. The farms are small and heavily stocked, 50 or more cows being kept on 100 ac. Average herd size in the second half of the 20th century was 59 cows. Jersey cattle predominate. Herd improvement associations and artificial breeding programs are in operation. Yields of butterfat per cow are moderate but yield per acre is unusually high, ranging from 150 to 200 lb. on farms where grasslands are heavily fertilized. Airplanes are extensively used in fertilizing, seeding and spraying pastures.

Dairy farming in Denmark and the Netherlands is characterized by small farms, intensive cultivation of the soil, heavy stocking with cows and high production per cow. Pastures supply much of the feed for five to six months of the year. Winter feeds are mangels, hay, straw, silage and concentrates. Danish farmers have been leaders in keeping production records, in selecting cattle by type and in artificial breeding of their herds. The principal dairy-cattle breed in Denmark is the Red Danish and in the Netherlands the Holland or Friesian, a breed having both black-and-white and red-and-white types. (*See* also FEEDS, ANIMAL.)

Milking.—Dairy cows commonly calve at 2 to 2½ years of age and thereafter at about 12-month intervals. Usually they are milked for nine or ten months of each year. The milk produced during the first three or four days of the lactation is unfit for sale and is fed to the calf. From that time on, most of the milk not consumed by the farm family is marketed. Less than 3% of the milk produced in the United States is fed to calves. Milking in small herds is done by hand but in the larger herds nearly all of it is done by suction machines. Morning and evening milking is the general practice except in the case of unusually high-producing cows which may be milked three or four times daily. In some European countries cows in summer are milked while at pasture.

Disease Prevention.—Serious losses in dairy-cattle herds may be caused by tuberculosis, foot-and-mouth disease, anthrax and brucellosis (*qq.v.*) and by mastitis and calf ailments. In the United States bovine tuberculosis has been nearly eradicated because of a testing program carried on by the federal government since 1917. Rare outbreaks of foot-and-mouth disease and of anthrax have been brought under control promptly. Mastitis is an infectious disease of the udder. Reduced milk yields and unprofitable cows often result. The disease is combated by a strict sanitation program together with injection of antibiotics and other compounds into the teat canal. Brucellosis or Bang's disease has been reduced greatly in extent in the United States through a federal-state program begun in 1934. The disease causes abortions and reduced milk yields and is one of the sources of undulant fever in man. Dairy calves are beset with pneumonia, scours or diarrhea and other ailments, most of which can be prevented wholly or in part by good management.

DAIRY MACHINERY AND MANUFACTURING PROCESSES

The development of modern dairy equipment has been influenced by: (1) increased labour costs; (2) increased milk production; (3) increased size of farm units; (4) general adoption of pasteurization; (5) improvement in fabrication of metals, particularly stainless steels; (6) improvement in mechanical refrigeration equipment; (7) improvement in transportation facilities, equipment and roads; (8) increase in restrictions imposed on dairy farmers and dairy plants by boards of health. Comparable changes have occurred in the dairy industry in Europe and in the U.S.

History.—Through many centuries improvement in techniques and equipment for the handling of dairy products took place slowly. Until recent times, little or nothing was known of sanitation and the proper care of perishable foods. Because milk soured and spoiled quickly, cows and goats were driven from house to house, milked at the door, and the milk placed in the customer's receptacle. This practice still is followed in some regions.

Milk was often unsafe to drink unless it was boiled, an objectionable procedure because of flavour and composition changes. Infectious diseases, including bovine tuberculosis, were sometimes

transmitted through raw milk to humans, especially children. There are two safeguards against these diseases, namely, pasteurization of dairy products, initially used about 1895, and the eradication of tuberculosis from cattle herds by means of tuberculin-testing programs.

For good keeping quality, milk must be cooled immediately after it has been drawn from the cow. Until recent years, the common method of cooling milk was to place the containers in a tank of cold water, followed by hand stirring of the milk. In some cases, ice was added to the water. Flowing spring water was especially prized for cooling milk and cream and springhouses for this purpose were common in the early history of the United States. The milk house or well house usually surrounded or was adjacent to the farm well.

BY COURTESY OF CHERRY-BURRELL CORP.

FIG. 1.—ICE-BANK TYPE OF FARM BULK COOLER TANK

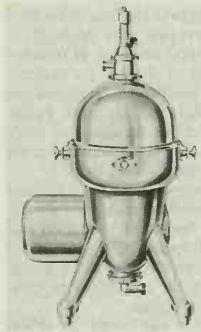
Up to the early part of the 20th century, when milking machines came into use in the larger herds, nearly all milk stock was hand milked. When hand milking a cow, the milker sits on a low stool on the right side, holding a pail between his knees. Grasping two teats at a time, he firmly but gently squeezes and pulls downward and then releases the pressure, repeating at rapid intervals. The operation is best completed quickly and quietly without disturbing the cow.

Open-top pails were in general use for hand milking until early in the 20th century when covered pails were put into use on some farms. These pails were of two types, one being completely covered but having a small, circular, fine-mesh screen fitted into the top and the other having a solid metal cover containing a small opening. The use of these pails reduced the amount of dust, dirt and other foreign matter falling into the pail during milking.

The earliest churns were goatskins or any simple container in which cream could be agitated. A type widely used in farm homes and small dairies was the dash churn. This consisted of a tall, narrow, nearly cylindrical wooden or stone tub with a capacity of five to ten gallons. The tub was fitted with a wooden cover and cream was agitated by means of a hand-operated vertical wooden plunger or dash.

Another popular churn for home use was shaped like a small barrel and mounted in a framework. Operation of a hand crank caused the barrel to revolve end over end.

A simple but effective hand ice-cream freezer comprised a covered cylindrical metal container of two to four quarts capacity which was placed in a wooden tub. Inside the metal container was a stirrer and this was connected to a gear and hand crank arrangement fitted to the top of the tub. Freezing of the ice-cream mix was effected by surrounding the metal container with a mixture of ice and salt and turning the crank.



BY COURTESY OF THE DELAVAL SEPARATOR COMPANY

FIG. 2.—CREAM SEPARATOR

Creameries for making butter were established in several European countries and in the United States shortly after the middle of the 19th century. At first farmers delivered whole milk to the factory where the cream was separated by gravity after the cooled milk had stood overnight. In some areas farmers set the milk in narrow, deep cans or in pans to separate it and a hauler followed a regular route to gather the cream. The wide adoption of farm-size centrifugal cream separators revolutionized and greatly expanded cream production and brought an increase in the number of creameries.

Beginning in the 1940s, creameries became large-volume, general-purpose factories, purchasing whole milk and producing the milk products most in demand, including bottled milk, butter, cheese and dried skim milk. In great contrast to the early-day, locally owned small units, most creameries in the second half of the 20th century were either controlled by large national dairy corporations or were members of large farmer-owned co-operative organizations.

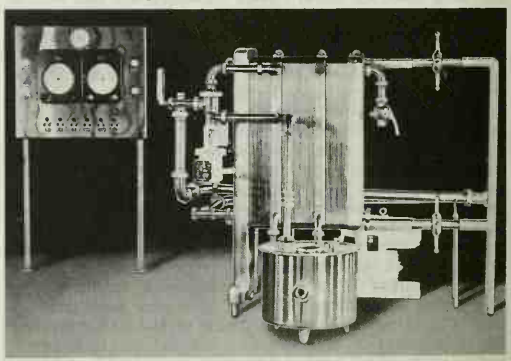
Milking Machines.—The need to increase efficiency and to reduce labour costs on dairy farms extended the use of milking machines. One manufacturer estimated that in the second half of the 20th century more than 98% of herds having ten or more cows were being milked by machine.

The milking machine has been developed to imitate the suction of the calf on the cow's teats and research has demonstrated that machine milking can be as satisfactory as that done by hand. Introduction of the separate milking room or parlour and pipeline milking have improved the sanitary conditions under which milk is handled on the farm (*see* FARM BUILDINGS). The milking parlour is generally used when the cows are not housed in a stanchion barn, but are allowed to run loose. The cows enter the parlour, their flanks and udders are washed and dried, and then the cows are machine milked as they are fed grain. Two to five cows can be milked simultaneously under these conditions. The cows are in the parlour five to eight minutes. In pipeline milking, which has eliminated the manual transportation of milk from the barn or parlour to the milk house to be cooled, the milk is drawn by vacuum through glass, stainless-steel or plastic pipes to the bulk cooler after it is released from the milker bucket in which it is weighed.

Milk Coolers.—Milk must be cooled quickly to 50° F. or below and kept cold while it is stored on the farm in order to prevent rapid bacterial growth. The simplest and cheapest method of cooling milk is to immerse ten-gallon cans of milk in cold water. Before mechanical refrigeration units were available, ice was used in some areas to provide cold water, but usually milk was cooled only to the temperature of the well water on the farm. Bulk milk tank coolers are a corollary to pipeline milkers. In this type of installation milk is drawn by vacuum through pipes from the milking machine to the stainless-steel cooling tank, which may hold 200 to 500 gal. of milk. Mechanical refrigeration is required to cool the milk and maintain its temperature at 40° F. With this system milk cans are completely eliminated. As a further saving, when local health departments permit, milk is collected only every other day.

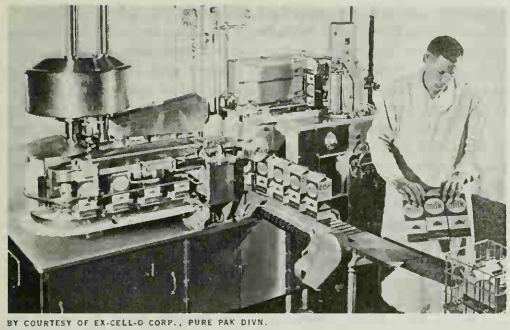
Milk is transported from the farm to the dairy plant in stainless-steel tank trucks that hold 1,000 to 2,500 gal. of milk. Mechanical equipment has tended to make the dairy farm unit larger and to encourage greater operating efficiency.

The Cream Separator.—The mechanical separator has re-



BY COURTESY OF CHERRY-BURRELL CORP.

FIG. 3.—HTST PLATE REGENERATIVE PASTEURIZER FOR MILK, WITH CONTROL PANEL AT THE LEFT



BY COURTESY OF EX-CELL-O CORP., PURE PAK DIVN.

FIG. 4.—FORMING AND FILLING PAPER MILK CONTAINERS

placed gravity systems of separation of milk as a means of securing cream because the speed and completeness of separation are much greater.

The essential feature of the centrifugal separator is a rapidly revolving bowl which contains a series of disks. The bowl is mounted on a spindle underneath the supply tank which holds the milk. Milk enters the bowl through an opening at the top and is distributed to the disks through a series of openings known as the distributor. Thin films of milk are generated as the whole milk is forced out between the disks. The milk immediately assumes the speed of the bowl, which is turning at 6,000 to 8,000 r.p.m., and cream separation begins immediately. The heavier skim milk is thrown to the outer edge of the bowl and is led off through the skim-milk opening at the top. The cream, being lighter in weight, is concentrated in the interior and moves up to the cream outlet near the centre of the bowl. Machines which operate efficiently will leave in the skim milk less than .01% fat as determined by the Babcock test.

The Milk Clarifier.—This machine also uses centrifugal force in accomplishing its purpose in dairy-plant operations—that of clarifying or removing extraneous matter from milk. The clarifier resembles the separator with the exception of the bowl, which is constructed so that there will be no cream separation in the milk. There is a greater distance between disks and the inside of the bowl. The milk flows through the rapidly revolving bowl and out a single outlet.

Pasteurizers.—Milk and milk products are pasteurized to make them safe, that is, pathogenic organisms are destroyed by the process and keeping quality is prolonged. In general, there are two types of pasteurizers: (1) vat or holding equipment which heats milk to 145° F. for 30 minutes; (2) high-temperature short-time (HTST) or continuous-flow equipment which processes milk at 161° F. for 15 seconds. Vats are made of stainless steel with a double-walled jacket and are either rectangular or round in shape. They are equipped with a tight-fitting cover, an agitator and a recording thermometer. Either steam or hot water is circulated in the double-walled jacket as the heating medium and cooling is accomplished either by circulating cold water in the jacket or by pumping the product over a separate cooler.

Bottling.—At one time milk was dispensed from 10- or 20-gal. cans by the seller into the consumer's container whether it was a bucket, jar, pan or pitcher. In the United States this method of selling milk has long been outlawed. Milk containers must be automatically filled and sealed by machine in the milk plant following pasteurization and cooling of the milk. Milk was bottled in glass containers almost exclusively for many years. Glass bottles were easily sterilized and the customer wanted to see the cream layer on the milk. Since the acceptance of homogenized milk, single-service paper containers have become widely used. The increased sale of milk through stores has favoured paper containers because of lower delivery expense and the elimination of the need for bottle return.

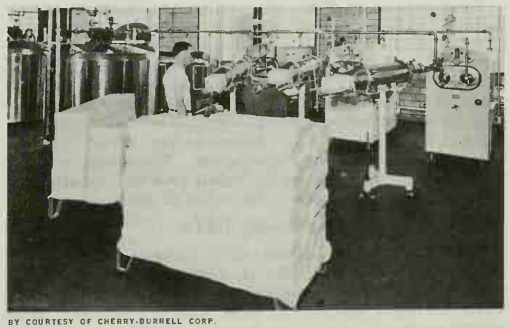
Buttermaking.—The first step in the manufacture of butter is the concentration of the fat of milk into cream by the cream separator. The first cream separators developed were factory-sized machines. Whole milk had to be delivered to the plant by the producer, who was also required to haul the skim milk back again for feeding purposes. Soon farm-sized separators were built and from 1915 to 1940 were used extensively. Then the farmer delivered sweet or sour cream to the creamery and kept the skim milk at home to feed to calves, poultry or hogs.

After 1940 there was a trend toward the return of shipping whole milk to creameries, which had become larger and more diversified in their operations. A further change also occurred: the entire product was utilized for human food. The cream is churned into butter, the sweet-cream buttermilk is dried and used by bakers and ice-cream manufacturers and the skim milk is dried and utilized in many ways for human consumption.

Pasteurization of cream for buttermaking is essential. In fact, the butter industry was the first branch of the dairy industry to use heat treatment to prolong the keeping quality of the product. Denmark in 1898 required that all cream for buttermaking be pasteurized. Although pasteurization was not made mandatory in the United States, buttermakers soon adopted the practice because it destroyed the enzymes which caused the butter to develop rancidity.

Cream is churned into butter in a revolving barrel-type churn which may be made of either wood or metal. Metal churns were perfected after World War II and are most desirable because they are easily sterilized. Churning consists in agitation of the cream until the microscopic fat globules clump together as butter granules which separate from the liquid portion. The liquid (buttermilk) is drained and the butter is washed with sterilized water. Salt may be added after the wash water has been drained and the butter granules are worked into a uniform compact mass of butter which must contain at least 80% fat. The conventional churn handles cream in 1,000- to 5,000-lb. batches. Continuous churns, which were developed in Europe prior to World War II and in the United States immediately thereafter, produce 1,000 to 2,000 lb. of butter per hour.

Cheese Making.—Cheddar cheese, one of the most popular varieties, is made from whole milk which may be either raw or pasteurized. Cheese curd is formed by the action of rennet extract, an enzyme preparation, upon the main protein constituent, casein. After the curd has been formed, it is cut into small cubes, stirred and heated so as to expel the whey. Bacteria which are added to the fresh milk produce lactic acid. This in turn also aids in whey expulsion as well as in control of flavour in the ripened cheese. After the curd has firmed properly, the whey is drained and the curd is allowed to fuse together on the bottom of the vat. Following this step, the slabs of curd are cut into small pieces for uniform salting. The curd is then put into hoops and molds and pressed into the desired shapes in a hydraulic press for 12 to 18 hours. Aging takes place at approximately 50° F. for one month to a year. Cheddar cheese, to have a well-ripened flavour, should be aged six to nine months.



BY COURTESY OF CHERRY-BURRELL CORP.

FIG. 5.—CONTINUOUS SYSTEM OF BUTTER MANUFACTURE

There are 18 distinct varieties of cheese with about 500 names. Cheese has frequently been named for the locality where it was made and not because it was a unique variety. Although cheese is made in almost all parts of the world, the varieties that are common in the United States are of European origin. They have come mainly from England, France, Italy, Germany, Switzerland, Belgium, the Netherlands, Denmark, Norway and Sweden.

Processed cheese originated in the United States and Switzerland almost simultaneously. This cheese is a blend of several different lots of the same variety, such as cheddar or swiss. These are shredded, mixed and heated to 160°–165° F. in the presence of a small amount of an alkaline solution.

Ice-Cream Manufacture.—Ice cream has perhaps more popular appeal the world over than any other dairy product. Technological developments since 1900 have exerted a profound influence on the manufacture of ice cream. The industry which started in a modest manner with a tub freezer using salt and ice has progressed to the stage where automation is more extensively developed and applied than in any branch of the dairy industry. The invention of the homogenizer, mechanical refrigeration, stainless steel, high-temperature short-time pasteurization and modern transportation equipment have each contributed to the development of ice-cream manufacture. Automatic weighing and blending of ingredients, *i.e.*, cream, concentrated milk, fresh milk, liquid sugars and stabilizers, followed by continuous pasteurization at 220° F. or higher, continuous freezing and continuous tunnel hardening at −40° F. make it possible to complete in two or three hours a process of manufacture that formerly required two or three days.

Distributing ice cream in grocery stores and supermarkets was a post-World War II marketing development and an important factor that contributed to increased consumption of ice cream.

DISTRIBUTION OF DAIRY PRODUCTS

The distribution of dairy products is almost world-wide. Improvements in production and processing techniques have made it possible to keep milk in fresh condition for many weeks and to ship it around the world. All-weather roads and transport vehicles have widened markets through bringing milk hundreds of miles from regions of heavy or surplus production to areas of deficient supply. A marked trend beginning in the 1940s and continuing in the second half of the 20th century has been increased sales of dairy products through stores and a smaller proportion of the total sales through deliveries to homes. The use of milk has been promoted through the placing of vending machines in factories, office buildings and convenient outdoor locations. Much milk also was distributed for use in school lunch programs.

In nations having an advanced dairy industry, distribution of milk in bottles or cartons is the general practice but in some other countries milk is carried in bulk to homes and dispensed into containers provided by the housewife. In many cases the milk distributed in bulk lacks the benefits of refrigeration and pasteurization.

GOVERNMENT SUPERVISION AND INSPECTION

Regulations aimed at providing sanitary procedures in the production, processing, storage and distribution of dairy products, as well as standards prescribing food composition, have been established by several levels of government in countries having an advanced dairy industry. In the United States prices paid for fluid milk to producers in many of the major milksheds are regulated by federal milk-marketing orders. The milk dealers and handlers of a local area are required to pay certain minimum prices for the various use classifications. The portion used for fluid milk and cream receives the highest price and manufactured products receive lower prices. The orders do not fix retail prices.

ECONOMIC DATA

Employment and Labour.—The scarcity of farm labour which began during World War II, together with higher costs in other phases of milk production, impelled United States dairy farmers to reduce the amount of hired labour to a minimum. High production of milk per farm worker is recognized as an economic advantage and goal just as is high milk yield per cow. To this end, labour-saving machinery, including such items as forage harvesters, silo unloaders, automatic feeders and waterers, barn cleaners, pipeline milking machines, bulk milk coolers and bulk milk pickup at the farm found increased use and replaced much hired labour. A large amount of family labour is utilized to advantage in the care of dairy cattle, especially the help of children before and after school hours. In the second half of the 20th century, however, in spite of a reduction in the number of cows and increased use of machines, more than 2,600,000,000 man-hours of labour were expended on milk cows in the United States in a single year and dairy products were handled in 11,000 dairy establishments which had 280,000 employees. Thousands of other persons were engaged, during at least part of their working time, in the handling of dairy products in transportation, industry and food stores and services.

Farms and Milk Cows.—Of 791,000,000 head of cattle reported in the second half of the 20th century, 100,000,000 were classed as milk cows, with the following distribution: Europe 39,000,000, North America 27,000,000, Asia (India and Pakistan) 26,000,000, Oceania (Australia and New Zealand) 5,000,000 and Africa 3,000,000.

The agricultural census of the United States (1954) showed 2,936,000 farms keeping milk cows or 1,700,000 fewer farms than five years earlier. Those which had sales from the dairy enterprise comprising 50% or more of the total farm sales were classed as dairy farms and numbered 548,763. On 70% of the farms the herds contained from 1 to 9 cows, forming 27% of the total cows; on 12% of the farms, each herd had 10 to 14 cows, comprising 16% of the total; while the remaining 18% of the farms with herds numbering 15 or more cows had 57% of all milk cows. The average number of cows per farm was 6.9 as compared with 5.8 reported in 1950. Sales of milk per farm rose to 87,600 lb. from 62,500 lb. in 1949. In the second half of the 20th century the trend was toward fewer dairy farms, larger herds and higher production per cow.

Amount of Production.—New Zealand in the second half of the 20th century was the most intensive dairy country in the world when milk production per capita was used as the yardstick. Other countries with high production per capita were Denmark, Ireland, the Netherlands, Finland, Australia and Switzerland. Among the countries for which dependable statistics were available, the United States led in the total production of milk, butter, cheese, canned milk and dried milk. The Federal Republic of Germany and France were second and third, respectively, in total production of butter while Italy and France held second and third places in the total production of cheese. The Netherlands was second and the Federal Republic of Germany third in the total production of canned milk. Of a world production, not including the U.S.S.R., of more than 269,000,000 metric tons (over 297,000,000 short tons) of milk, 90% consisted of cow's milk, 5% buffalo milk (principally in the far east), 3% goat milk and 2% sheep milk. Of the reported total world milk supply, European countries produced about 46%, North America produced about 24% while the production figures for Latin America were 7%, the near east 5%, the far east 11%, Africa 3% and Oceania 4%.

Exports and Imports.—New Zealand, Denmark, Australia, the Netherlands and the United States were leading exporters of butter and cheese. The Netherlands led in the exporting of condensed milk and the United States in the exporting of milk powder. Argentina was a leading exporter of casein. The United Kingdom, the principal importer of dairy products, in the second half of the 20th century became an exporter of condensed milk. Immediately prior to World War II the United States exported 2,000,000 to 3,000,000 lb. of butter and 1,500,000 to 2,000,000 lb. of cheese yearly. During the war years the amounts exported reached 100,000,000 lb. of butter and 150,000,000 to 300,000,000 lb. of cheese. In the second half of the 20th century large quantities of butter, cheese and nonfat dry milk were shipped abroad under various aid programs. Total shipments, including exports, in one year reached 180,000,000 lb. of butter, 174,000,000 lb. of cheese and 600,000,000 lb. of nonfat dried milk. Cheese imports amounted to about 54,000,000 lb. yearly.

Income.—Yearly cash receipts of United States farmers from marketings of milk and cream in the second half of the 20th century formed 14.6% of all farm marketings and totaled nearly $4,500,000,000. About 88% of this came from milk sold to plants and dealers, 7% from cream sold to plants and dealers and 5% from sales of milk and cream retailed by farmers. Not included in these receipts was an item of $500,000,000, the estimated value of milk and farm butter used for farm consumption. Dairy farmers also received an estimated $1,250,000,000 from the sale of dairy cattle. The farm value of products sold represented the following approximate proportions of the retail prices: fluid milk 45%, butter 70%, cheese 50%, evaporated milk 45% and ice cream 20%.

Location of Industry.—In the United States milk cows are kept in all states. Those having the largest number of farms keeping milk cows, as reported in the 1954 census of agriculture, were Texas, Missouri, Tennessee, Iowa, Kentucky and North Carolina. However, the average number of cows per farm in these states was small. Dairy farmers in each of six states, Wisconsin, New York, California, Pennsylvania, Minnesota and Ohio, received yearly more than $200,000,000 cash receipts from marketings of all milk and cream. Farmers in each of six other states, Michigan, Illinois, Iowa, Texas, Indiana and Missouri, received more than $100,000,000 cash receipts from such marketings. Small creameries and cheese factories in rural communities have largely been replaced by centralized processing plants in urban centres. Plants with the largest total capacity are located in or near large cities.

See also references under "Dairy Industry" in the Index volume.

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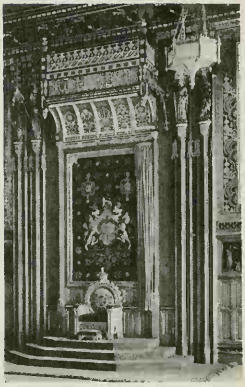
(W. B. N.; S. L. T.)



A. F. KERSTING

DAIS OF THE ROYAL ROBING ROOM IN THE HOUSE OF LORDS, LONDON; c. 1860

DAIS, originally the raised part of the floor at the end of a medieval hall. On this the lord of the mansion dined with his friends at the high table, apart from the retainers and servants. There was generally a deep-recessed bay window at one or at each end of the dais to give greater privacy than the open hall could afford. In France the word is understood as a canopy (*q.v.*) or hanging over a seat, probably from the fact that the seats of great men were often surmounted by such a feature. In ordinary usage the term means any raised platform in a room, for ceremonial use.

END OF VOLUME SIX

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